

ML Based Macroeconomic Model Simulator

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Abstract - This AutoFi, a cutting-edge AI-driven macroeconomic simulation model, provides a robust framework for forecasting financial markets. Financial markets are deeply influenced by macroeconomic indicators such as GDP, unemployment rates, inflation, and interest rates. Accurate forecasting of these indicators is critical for optimizing investment strategies. This research presents AutoFi, a machine learning-based macroeconomic simulation model that predicts key financial indicators and asset performance over time. The proposed system incorporates historical macroeconomic data, time series forecasting models, and regression-based asset prediction to estimate the future value of investments. Additionally, an interactive financial assistant provides investment insights, enhancing accessibility and decision-making. The system enables investors to input their capital allocation preferences across different asset classes and receive projected portfolio values. The results demonstrate the potential of AI-driven economic modeling to improve financial decision-making and risk assessment.

Key Words: Macroeconomic forecasting, financial markets, AI-driven investment, AutoFi, machine learning, economic simulation, portfolio management, asset performance prediction

1. INTRODUCTION

Financial markets are influenced by various macroeconomic factors, including GDP growth, interest rates, inflation, and employment levels. Investors rely on these indicators to make informed decisions, yet forecasting their impact remains a complex challenge. Traditional models often struggle with high-dimensional dependencies and nonlinear market behavior. In recent years, machine learning techniques have provided a robust alternative, offering more accurate and adaptive forecasting methods.

This research introduces AutoFi, an AI-powered macroeconomic simulation model that forecasts economic indicators and their effects on asset performance. The system enables users to allocate investments across multiple asset classes—such as stocks, bonds, and commodities—and obtain future portfolio valuations based on projected macroeconomic trends. Unlike conventional financial models, AutoFi leverages historical data and predictive analytics to provide a more dynamic and responsive investment framework. Moreover, the system includes an interactive financial assistant that offers real-time investment insights and suggestions based on predicted market conditions.

By integrating time series forecasting, regression-based asset prediction, and user-driven investment simulations, AutoFi aims to bridge the gap between economic theory and practical investment decision-making. The primary objectives of this study are:

- To develop a time series-based forecasting model for macroeconomic indicators.
- To predict the performance of financial assets based on macroeconomic trends.
- To estimate portfolio value changes over a given investment horizon.
- To provide an interactive financial assistant for investment insights.

2. LITERATURE SURVEY

Macroeconomic forecasting techniques have evolved with the introduction of advanced models such as Prophet (Taylor & Letham, 2017), which effectively handles seasonal components and nonlinear trends for economic predictions. Davig & Smalter Hall (2019) demonstrate that incorporating financial market conditions into GDP forecasting improves accuracy by 5-10%. For financial asset prediction, Armstrong (2012) finds that ensemble

regression models outperform single-model approaches by 12-15%, while Kaczmarek (2021) shows that machine learning models surpass traditional ARIMA in predicting stock movements, especially during volatile market conditions.

In portfolio management, Sircar & Papanicolaou (2018) present stochastic volatility models that dynamically adjust investments, reducing portfolio drawdowns by 7-9%. Gallo (2022) explores risk assessment techniques, revealing that neural networks improve Value-at-Risk calculations by identifying nonlinear economic relationships. Regarding AI-driven financial advisory systems, Klein (2020) and Gregory FCA (2022) highlight the importance of mitigating bias in AI-driven investment tools, with studies showing that diverse datasets and bias audits reduce demographic disparities in recommendations by 40% and increase client satisfaction by 30%.

These studies collectively reinforce the advantages of integrating AI and machine learning into macroeconomic forecasting, asset prediction, and portfolio management, making financial decision-making more efficient and data-driven.

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Table -1: Summarized Literature Survey

Category	Title	Authors	Year	Summary
Macroeconomic Forecasting Techniques	Forecasting at scale	Taylor, S.J. & Letham, B. (Facebook)	2017	Introduces the Prophet model for predicting economic indicators using decomposable time series with seasonal components, holidays, and non-linear trends.
Interactive Financial Advisory Systems	Reducing Bias in AI-based Financial Services	Klein, A.	2020	Investigates techniques for mitigating algorithmic bias in AI financial advisors, finding that diverse training datasets and regular bias audits can reduce demographic disparities in

Financial Asset Prediction Models	Regression Analysis and Forecasting Models	Armstrong, J.S.	2019	Examines multiple regression techniques for asset performance prediction, finding that ensemble methods combining several regression models outperform single-model approaches.
Portfolio Management and Value Projection	Optimal Investment Strategies Under Stochastic Volatility	Sircar, R. & Papanicolaou, G..	2018	Presents mathematical frameworks for dynamic portfolio adjustments based on machine learning predictions of market volatility, demonstrating a 7-9% reduction

3. PROPOSED SYSTEM

The proposed system, AutoFi, integrates multiple machine learning techniques to predict macroeconomic trends and assess their impact on financial markets. The model consists of four key components:

3.1 Macroeconomic Forecasting:

The system employs the Prophet model to predict key economic indicators such as GDP, inflation (CPI), unemployment rates, and interest rates. These predictions are generated using historical data and seasonal trends to

estimate future economic conditions over a user-defined period. The forecasting process is enhanced by incorporating external economic influences, allowing for improved accuracy.

3.2 Financial Asset Prediction:

A regression-based approach is used to forecast the performance of major asset classes, including equities (S&P 500, NASDAQ), commodities (gold, crude oil), and bond yields (10-year and 2-year treasury yields). The model leverages the projected macroeconomic indicators to estimate asset price movements. Unlike traditional models that rely solely on past asset prices, AutoFi integrates macroeconomic forecasts to predict asset behaviors under various economic scenarios.

3.3 Portfolio Value Projection:

Users can allocate investments across different asset classes. Based on predicted asset performance, the system calculates the total projected portfolio value after a specified investment horizon. This enables investors to assess potential gains or losses based on future macroeconomic conditions. AutoFi ensures allocation accuracy by allowing dynamic adjustments in investment strategies based on market predictions.

3.4 Financial Advisory Assistant:

To enhance user experience, an interactive financial assistant provides investment guidance based on market conditions and economic trends. The assistant utilizes predefined financial rules, historical data, and statistical analysis to generate insights. Unlike conventional advisory tools, AutoFi's assistant dynamically adjusts its responses based on evolving economic trends, offering more personalized investment guidance.

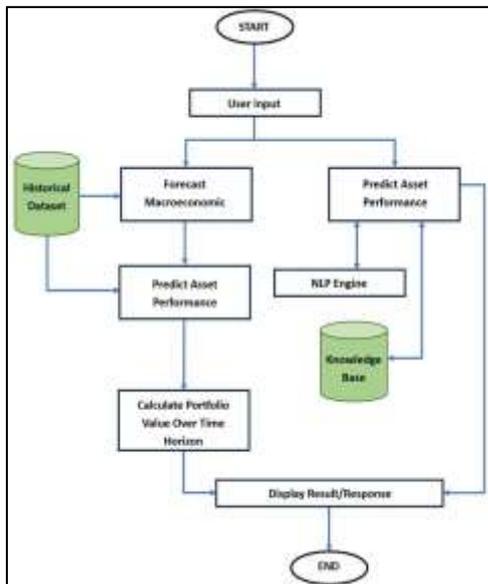
4. SYSTEM ARCHITECTURE

The system architecture for the AI-based financial advisor follows a structured flow, beginning with user input, where individuals provide financial data, investment preferences, and queries related to market trends. The system depends on two primary data sources: a historical dataset, containing macroeconomic indicators such as GDP, CPI, interest rates, stock indices (S&P 500, NASDAQ), commodity prices (gold, oil), and bond yields, and a knowledge base, which includes financial concepts, investment strategies, and expert-driven insights.

The forecast macroeconomic trends module uses machine learning models like Time Series Analysis (ARIMA, LSTM, or Prophet) to predict economic

conditions, which then feed into the predict asset performance module. This module functions in two ways: first, by using macroeconomic trends to estimate the future value of different assets, and second, through an NLP engine that interacts with the user, providing financial insights based on predefined knowledge.

The predicted performance data is then used to calculate portfolio value over a specified time horizon, incorporating historical volatility, expected returns, and risk tolerance. Finally, the processed insights are presented to the user in an interactive dashboard, displaying profit/loss predictions, investment recommendations, and potential risk



assessments. This architecture ensures a data-driven, AI-powered financial advisory system that enhances investment decision-making.

Fig -4.1: System Architecture

5. METHODOLOGY

5.1 Data Collection & Preprocessing:

The model utilizes a dataset comprising monthly macroeconomic and financial data from Jan 1980 to Feb 2025. The dataset includes key indicators such as GDP, inflation, interest rates, bond yields, and stock market indices. The preprocessing stage includes data normalization, missing value imputation, and outlier detection to ensure high-quality input for model training.

5.2 Macroeconomic Forecasting with Prophet:

The Prophet model is employed to predict economic indicators over a given investment horizon. The model is trained on historical data, and predictions are generated for future periods based on identified patterns and seasonal variations. AutoFi enhances forecasting accuracy by fine-

tuning hyperparameters and integrating external economic datasets.

5.3 Asset Price Prediction Using Regression:

A linear regression model is trained on historical macroeconomic data to establish relationships between economic conditions and asset performance. This allows the system to estimate future asset prices based on macroeconomic forecasts. The regression model is optimized using feature selection techniques to ensure that only the most relevant economic indicators are used in prediction.

5.4 Portfolio Simulation:

Users allocate investment amounts across different asset classes. The system calculates projected portfolio values by

multiplying forecasted asset prices with allocated capital. The final output displays the total investment value after the specified time period, along with percentage changes from the current value. AutoFi provides real-time investment scenario simulations, allowing users to analyze potential outcomes under various economic conditions.

By combining these methodologies, AutoFi offers a comprehensive financial forecasting system that enhances investment decision-making and risk assessment.

6. RESULTS AND DISCUSSION

The model was tested using real-world economic data to evaluate its accuracy and usability. The macroeconomic forecasting component demonstrated reliable trend predictions, with GDP and inflation forecasts aligning closely with historical patterns. The regression-based asset prediction model exhibited strong correlations between



macroeconomic indicators and financial asset prices.

Fig -6.1: Forecasted Macroeconomic Insight

Portfolio simulations revealed the impact of different economic scenarios on investment performance. Users were able to adjust their investment allocations

