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A Comparative Study of Time Series Models in Forecasting the UK Household Saving Rate: ETS vs. ARIMA

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Abstract. Household saving rate is an indispensable reference for people to grasp household economic behavior and analyze macroeconomic trends, and has a significant impact on capital accumulation, consumption and policy design. Taking UK household saving rate as the research object, this study compares the forecasting ability of Autoregressive Integrated Moving Average (ARIMA) model and Exponential Smoothing (ETS) model systematically based on the quarterly data from 2007Q1 to 2025Q1. Due to the economic fluctuations shown in UK from 2007Q1 to 2025Q1, it is particularly valuable to identify a robust model to forecast it. The empirical results show that the ETS (M, N, M) model is more robust than ARIMA (1,0,0) model in terms of root mean square error (RMSE), mean absolute error (MAE) and mean absolute percentage error (MAPE) in out-of-sample forecasting. The in-sample fit of ARIMA model is better, but it may be over-fitted. This study can provide a reliable basis for the model selection of forecasting UK household saving rate, and the methodological approach and research conclusions of this study are also available for other similar countries.

Keywords: Household saving rate, time series forecasting, ARIMA model, ETS model, United Kingdom.

1. Introduction

Household saving rates are one of the most important macro indicators. It is directly related to the strength of households' finances, the ability of national wealth accumulation and long-term economic growth. Understanding its implications and accurately predicting its changing trend plays an indelible role in judging the development period, assessing policy effects and preventing financial risks.

In recent years, the study of household saving behavior has been widely conducted from multiple dimensions and regions around the world. A large number of reports have explored its determinants and forecasting methods in different scenarios.

One the one hand, scholars have explored its intrinsic connection with macroeconomic fundamentals like GDP and constructed forecasting models by incorporating some "soft" indicators like consumer confidence [1-3]. On the other hand, scholars have focused on exploring the impact of micro-level institutional factors, such as public sector employment, financial innovation, and

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demographic factors like the marriage market [4-6]. It has also been evidenced from UK-based studies that the housing market is an important dimension to explore household saving behavior [7]. Most recently, the saving classic theories have been applied and tested in unconventional policy environment, such as negative interest rate [8]. All these findings revealed the complexity of saving behavior mechanism.

Nevertheless, despite the richness of existing scholarship, there remains a notable gap in systematically evaluating the performance of traditional time series models such as ARIMA and ETS in forecasting the UK household saving rate, an indicator of particular relevance for one of the world's leading advanced economies. Against this backdrop, this paper employs the latest quarterly data for the UK, develops both ARIMA and ETS models, and rigorously compares their predictive accuracy through out-of-sample validation. The contribution of this study lies in providing empirical evidence for anticipating future trends in the UK saving rate, while addressing an underexplored aspect of model evaluation in this field.

2. Data

The household saving rate is a core macroeconomic indicator for gauging resident saving behavior, analyzing economic growth potential, and forecasting consumption trends. As a major global advanced economy, changes in the UK's saving rate hold significant research value, providing critical insights into understanding economic cycles and policy effects. This study utilizes quarterly data on the UK Household Saving Rate, spanning from the first quarter of 2007 to the first quarter of 2025, comprising 73 observations. The data was sourced from the Organisation for Economic Co-operation and Development (OECD) database.

During the data preprocessing stage, an anomalously high value of 27.26% was identified for the second quarter of 2020 (2020-Q2). This outlier is attributed to lockdown policies and government subsidies during the COVID-19 pandemic. To mitigate its disproportionate impact on model training, smoothing treatment was applied, replacing the value with the arithmetic means of the saving rates from the first and third quarters of 2020. The basic statistical characteristics of the data are presented in Table 1.

Table 1. Descriptive statistics of the UK household saving rate, 2007Q1–2025Q1

	mean	SD	max	min	kurtosis	skewness
SP500	8.67	3	21.82	4.27	3.87	1.45

Note: The saving rate is presented as a percentage.

As shown in Table 1, the UK saving rate exhibited considerable volatility over the sample period. The positive skewness and high kurtosis indicate a right-skewed distribution with heavy tails, suggesting the presence of extreme values and asymmetry in the data.

To better illustrate the evolution of the UK household saving rate, the processed time series is plotted in Figure 1 below.

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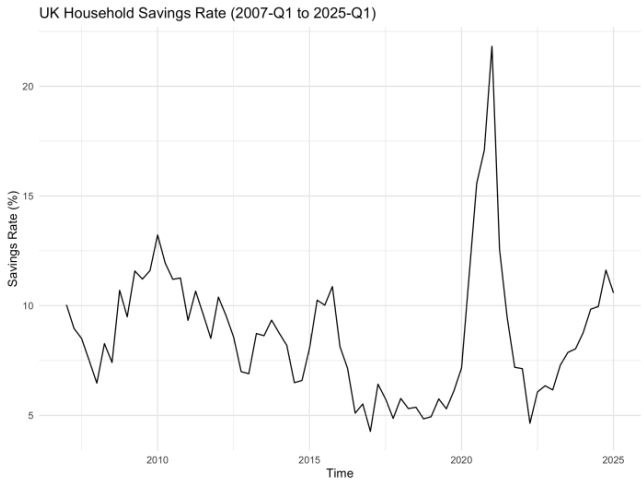


Figure 1. UK Household saving rate, 2007Q1–2025Q1

3. Method

To provide a sound assessment of the future trajectory of the UK household saving rate, reliable forecasting models are essential. Within the domain of time series forecasting, the ARIMA and ETS models have become standard tools in economics and related fields due to their solid statistical foundations and demonstrated predictive performance [9-10]. Such models are widely used not only for economic series, but also often compared in academic studies to show their competitiveness. Therefore, this paper employs ARIMA and ETS models to build the forecast and comparison of the two models in the UK household saving rate is carried out in detail.

3.1. ARIMA

A popular forecasting model for univariate time series called Autoregressive Integrated Moving Average (ARIMA) model. ARIMA model is popular for univariate time series because it is able to model autocorrelation and trend in economic data well. Also, ARIMA model is able to work with non-stationary series, so it is widely used for macroeconomic time series. The general form of an ARIMA (p, d, q) model is expressed as:

$$\left(1-\phi_1 B-\cdots-\phi_p B^p\right)(1-B)^d y_t=c+\left(1+\theta_1 B+\cdots+\theta_p B^p\right)\epsilon_t \tag{1}$$

Where y_t denotes the observation at time t, B represents the lag operator, $By_t = y_{t-1}$, $\phi_1, , , \phi_p$ are the autoregressive parameters, $\theta_1, , , \theta_p$ are the moving average parameters, d is the order of differencing, ε_t is the white noise error term, and c is a constant.

3.2. ETS

Error, Trend, Seasonal (ETS) model is built upon the idea of exponential smoothing. It separately smooths and weights level, trend and seasonal components of a time series. It is very flexible: it is able to detect multiple time series characteristics in data and in practice often performs well for highly seasonal data. The general form of the ETS model is presented below.

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$$\hat{y}_{t+1} = l_t + b_t + s_{t+1-m} \tag{2}$$

Where l_t denotes the level component, b_t the trend, s_t the seasonal term, and m the seasonal cycle length.

4. Results

4.1. Data split and model estimation

The time series was partitioned into a training set and a test set. The training set, used for model parameter estimation, includes data from Q1 2007 to Q4 2021 (60 observations). The test set, reserved for evaluating out-of-sample forecast accuracy, contains data from Q1 2022 to Q3 2024 (11 observations). To determine the optimal model parameters, the auto.arima() and ets() functions from the R forecast package were employed. These functions automate model selection by traversing the possible parameter space and identifying the best model structure based on minimizing the corrected Akaike Information Criterion (AIC). The estimated parameters for the selected models are reported in Table 2.

Table 2. Parameter estimation results

Model	Parameter Estimation
ARIMA(1,0,0)	AR1 = 0.585, Mean = 9.054
ETS(M,N,M)	Alpha = 0.999, Gamma = 0.001

For the ARIMA (1,0,0) model, the autoregressive coefficient (AR1) is 0.585, indicating a moderate positive correlation between the current saving rate and the rate from the previous period. The ETS (M, N, M) model yielded a level smoothing parameter (Alpha) very close to 1 (0.999), suggesting the model relies almost exclusively on the most recent observation and assigns very low weight to historical values. The seasonal smoothing parameter (Gamma) is 0.001, indicating a relatively stable seasonal pattern in the data.

4.2. Model comparison and forecast evaluation

Based on the training set fit, the AICc values were 315.12 for the ARIMA model and 379.32 for the ETS model. A lower AICc value indicates a better fit to the training data, suggesting the ARIMA (1,0,0) model performed superiorly in-sample.

The forecast results, including the predicted values and confidence intervals from both models plotted against the actual observations in the test set, are visually compared in Figure 2 and Figure 3.

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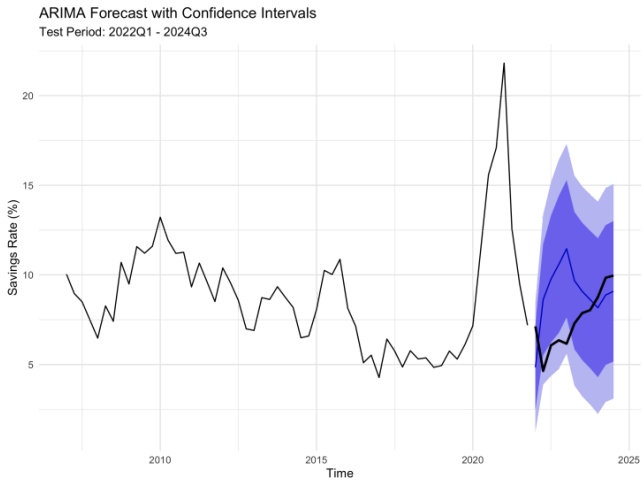


Figure 2. ARIMA model fit

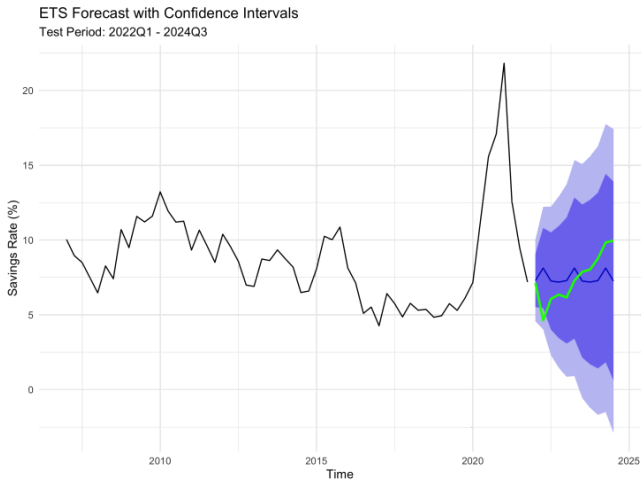


Figure 3. ETS model fit

The forecasting accuracy metrics on the test set, presented in Table 3, tell a different story. The ETS model demonstrated lower error values across all reported metrics-Root Mean Square Error (RMSE), Mean Absolute Error (MAE), and Mean Absolute Percentage Error (MAPE)-indicating significantly better out-of-sample forecast accuracy compared to the ARIMA model.

Table 3. Forecast accuracy comparison

Model	RMSE	MAE	MAPE
ARIMA(1,0,0)	2.866	2.375	37.5%
ETS(M,N,M)	1.644	1.361	19.95%

This discrepancy between in-sample fit and out-of-sample forecast performance is a classic indicator of overfitting by the ARIMA model. The ARIMA model may have captured specific noises or short-term fluctuations in the training data (2007-2021), which did not persist in the test period (2022-2024). Consequently, its predictions deteriorated when faced with the new data regime. In contrast, the smoothing mechanism of the ETS model provided greater robustness against such structural changes, leading to more stable and accurate forecasts during the volatile post-2022

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period. Therefore, for the purpose of forecasting, the ETS model is deemed more reliable for this dataset.

5. Conclusion

Using quarterly data from 2007 to 2025, this study models and forecasts the UK household saving rate. By applying both ARIMA and ETS models and comparing their performance on training and testing datasets, the core objective has been to evaluate the effectiveness of these two approaches in this forecasting task. The empirical results indicate that ETS model obtains lower error measures in out-of-sample forecasts than the ARIMA model, which provides evidence towards the robustness of the model and its practical value in UK household saving rate.

Nevertheless, this paper is subject to some limitations. The analysis is based on historical time series without using explanatory variables which are known to have a large impact, for example, consumer confidence or monetary policy shocks. Additionally, demographic pressures in the marriage market or the impact of technological innovation at play are not within the scope of macro-level models considered in this paper, which provide potential directions for future research to make the saving rate data more comprehensive.

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