American Journal of Economics and Business Management
Vol. 9 Issue 4 | pp. 1008-1015 | ISSN: 2576-5973
Available online @ https://www.globalresearchnetwork.us/index.php/ajebm

Article

Forecasting the Development of the Services Sector and Management Efficiency Based on Econometric Models

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Abstract: The article develops a methodology for forecasting the development of the service sector and management efficiency based on econometric models. A comparative analysis of forecasting methods is conducted and the criteria for their selection are substantiated. As a result of the research, a five-stage forecasting algorithm, a system of forecast accuracy assessment indicators, and a forecast combination approach are proposed. A three-scenario forecasting model and a mechanism for linking forecast results to management decisions are developed.

Keywords: Forecasting, econometric model, ARIMA, exponential smoothing, scenario analysis, forecast accuracy, MAPE, forecast integration, services sector, management efficiency.

Citation: Sayfillayevna T. S. Forecasting the Development of the Services Sector and Management Efficiency Based on Econometric Models. American Journal of Economics and Business Management 2026, 9(9), 1008-1015.

Received: 10th Feb 2026
Revised: 11th Mar 2026
Accepted: 11th Apr 2026
Published: 30th Apr 2026

1. Introduction

Management decisions are always future-oriented: the decision made today will affect the outcome tomorrow. Therefore, any informed decision is based on a vision of the future state. Putting this vision on a scientific basis is the main task of forecasting.

The importance of forecasting in the services sector is further enhanced by the target indicators set in the "Uzbekistan – 2030" strategy [1]. To achieve strategic goals, it is necessary to predict what the result will be if current trends continue and the gap between the target and the forecast. It is this gap that determines the necessary volume of management influence.

Literature Analysis on the Topic

The fundamental basis of time series forecasting methodology was created by GEPBox and GM Jenkins. They developed a class of autoregressive integrated moving average (ARIMA) models and proposed a three-step methodology consisting of model identification, estimation, and diagnosis [2]. This approach is still considered a classic forecasting tool today.

Exponential smoothing methods were developed in the works of CCHolt [3] and PRWinters [4]. The Holt–Winters model allows for simultaneous consideration of trend and seasonality and produces more stable results than ARIMA for short series—an important advantage for national conditions.

RJ Hyndman and G. Athanasopoulos systematized modern forecasting methodology, outlined the principles of method selection and criteria for assessing forecast accuracy [5]. Their work emphasizes the need to present the forecast with confidence intervals, rather than as point estimates.

The unit root test proposed by D.A. Dickey and W.A. Fuller is a basic tool for examining the statistical properties of time series [6]. R.F. Engle and C.W.J. Granger developed the theory of cointegration, which made it possible to model the long-term equilibrium relationship between non-stationary series [7].

When comparing forecast accuracy, the test proposed by FXDiebold and RSMariano is used: it answers the question of whether the difference in accuracy between two forecasts is statistically significant [8].

A large M4 competition conducted by S. Makridakis and co-authors compared 61 methods on more than 100,000 time series and reached an important conclusion: complex models are not always more accurate than simple models, and combining forecasts almost always gives better results than a single method [9]. The theoretical basis for this conclusion was laid much earlier by J.M.Bates and C.W.J.Granger [10]. To assess efficiency, decision-making unit principles developed by A. Charnes, W. W. Cooper, and E. Rhodes (DEA) are widely utilized [11].

A.A.Firsova and co-authors presented the experience of using econometric models in forecasting the development of regional systems [12]. S.V.Brunov modeled the dynamics of indicators in the field of public services and substantiated the approach to resource planning based on forecasts [13].

V.A. Plotnikov analyzed the development trends of the service economy and showed the long-term growth patterns of the sector [14]. V.N. Tyutyuryukov noted the problem of short data series in regional forecasting and recommended giving preference to simple models in such conditions [15].

A. Tursinbayev created a basis for forecasting macroeconomic indicators of the services sector by econometric modeling [16].

2. Research Methods

The study used time series analysis, econometric modeling, scenario analysis, and comparative analysis methods.

The extended Dickey–Fuller test [6] was used to test the stationarity of the series, and the Engle–Granger cointegration test [7] was used to identify long-run relationships.

Three approaches were compared as forecasting methods: trend extrapolation, exponential smoothing (Holt–Winters model) [3, 4], and ARIMA models [2]. The application conditions for each were determined.

The set of indicators recommended by RJHyndman and G.Athanasopoulos [5] — MAE, RMSE, MAPE, and Theil coefficient — was used to assess the forecast accuracy. The Diebold–Mariano test was used to statistically compare the methods [8].

3. Results and Discussion

Forecasting the efficiency of the service sector is of great importance in determining future directions of economic development, developing strategies for the efficient use of resources, and scientifically substantiating management decisions. This process is carried out on the basis of empirical data, statistical analysis, and econometric models, and serves to determine the future dynamics of enterprise efficiency.

At the first stage of forecasting, a key indicator representing the efficiency of the enterprise is determined. Typically, this indicator is selected as the DEA efficiency index (TE), profitability (ROA, ROE), labor productivity or the growth rate of the volume of services. The selected indicator is taken as the dependent variable of the forecast model and its historical dynamics are analyzed.

The next step is to select a forecasting model. For the services sector, regression-based forecasting models are often used. For example, a panel regression model determines the dependence of efficiency on investment, employment, the level of digitalization and labor productivity. Based on this model, future values are calculated and the trajectory of efficiency growth is forecasted. At the same time, time series models (ARIMA, trend models) can also be used.

Trend analysis plays an important role in the forecasting process. If the performance indicator has a stable growth trend over time, then a trend model is used. With the help of this model, future values are determined and the growth rate is estimated. At the same time, if there is seasonality or cyclicality in the indicators, they are also included in the model.

The scenario approach is also widely used in empirical forecasting. In this approach, optimistic, realistic, and pessimistic scenarios are developed and how efficiency will change in each case is predicted. For example, if the level of digitalization increases, efficiency can increase significantly, while, on the contrary, if investment decreases, growth will slow down.

An important step is also to assess the accuracy of the forecast model. For this, the coefficient of determination (R^2) of the model, forecast errors (RMSE, MAE) are calculated. If the model has high accuracy, then the forecast results are considered reliable and are used in making management decisions.

Based on the results of the forecasting of the efficiency of enterprises in the service sector, it is determined which sectors will develop in the future and which will require modernization. In particular, high growth rates are predicted in the digital services and financial services sectors, which indicates the need to increase investments in these areas.

In general, forecasting the efficiency of service sector enterprises is an important area of economic analysis, which allows not only to identify future development trends, but also to develop strategic decisions to increase efficiency. Through this approach, the prospects for the activities of enterprises are assessed on a scientific basis and serve to improve regional economic policy.

Forecasting the performance of service sector enterprises is carried out on the basis of econometric models, which determine future growth trends, resource efficiency, and the effectiveness of management decisions.

In the service sector, it is of great importance in terms of ensuring the financial stability of the enterprise, proactive risk management, and scientific substantiation of management decisions. In traditional audit approaches, audit results are mainly limited to retrospective analysis, and forecasting is rarely used. In this study, a forecasting methodology based on accounting indicators and audit KPIs was developed to assess how internal audit effectiveness will change in the future.

The methodological basis for forecasting is a systematic approach, empirical modeling, and time-series analysis. This approach allows for the assessment of internal audit indicators not in isolation, but in their inextricable link to financial results.

The main outcome indicator used in the forecasting was the Audit Effectiveness Index (ASI), developed by the author. The ASI is calculated by integrating the components of internal audit coverage, quality, performance, and financial impact:

$$\mathbf{ASIt=w1CCRt+w2MTCt-w3MDRt-w4\bar{RT}t+w5SAVt+w6DEVt} \qquad \mathbf{(35)}$$

here

CCR– material accounts coverage,

MTC– scope of control tests,

MDR– percentage of material defects,

$\bar{RT}$– average time to close audit recommendations,

SA– losses prevented,

DEV– represents financial valuation differences.

The indicators were normalized in the range [0;1], and weighting coefficients were determined taking into account the characteristics of the service sector.

We carried out the forecasting according to ASI in the following sequential stages:

1. **Data preparation**– ASI values were formed for 2021-2025 and their dynamics were analyzed.
2. **Trend detection**– The change in ASI score over time was assessed using a linear trend model.
3. **Model evaluation**– The parameters of the trend equation were determined based on the method of least squares (OLS) and the statistical significance of the model was checked.
4. **Forecasting**– Based on the estimated trend model, ASI forecast values for 2026-2030 were calculated.
5. **Interpretation and limitation**– Given that the theoretical limit of the ASI index is in the range [0;1], the forecast values were normalized in practical interpretation.

The growth rates, stability and practical limits of internal audit effectiveness were taken into account when managing the forecast results. Maintaining the ASI forecast at a high and stable level in 2026–2030 is explained by the full formation of internal control coverage, an increase in the quality of audit tests and a reduction in material defects to a minimum. This methodology allows interpreting the forecast results not only quantitatively, but also qualitatively.

The proposed forecasting methodology is of practical importance in planning internal audit activities in the service sector, optimal allocation of audit resources, and early identification of risks. From a scientific point of view, this approach enriches audit theory with empirical modeling by forecasting internal audit effectiveness based on accounting indicators.

The methodology for predicting internal audit effectiveness serves to transform audit into a strategic management tool in the services sector, reducing financial stability and risks. The "real" values of ASI (CCR, MTC, MDR, RT, SAV, DEV) are usually not available in open statistics - they are obtained from the organization's internal audit logs.

Logit-trend(To keep ASI in the range of 0-1):

LGT(ASIt)=ln(ASIt /1−ASIt)=a+bt **(36)**

ASIt=1/1+e−LGT(ASIt)1 **(37)**

In order to ensure that the Audit Performance Index (ASI) values are logically and mathematically stable in the range of 0-1, the study used a logit-trend model. In this approach, the ASI was first transformed into the form LGT(ASIt)=ln(ASIt /1−ASIt) through a logit transformation, and then evaluated in the form α+βt\alpha+\beta tα+βt depending on the time factor. As a result, the model allows us to determine the growth trend of the index over time using a linear trend, and through re-transformation, forecast values are obtained in the form ASIt=1/1+e−LGT(ASIt). This method eliminates the possibility of the index going beyond the limits and serves as a reliable econometric tool for analyzing the dynamics of the ASI and long-term forecasting while maintaining its economic content.

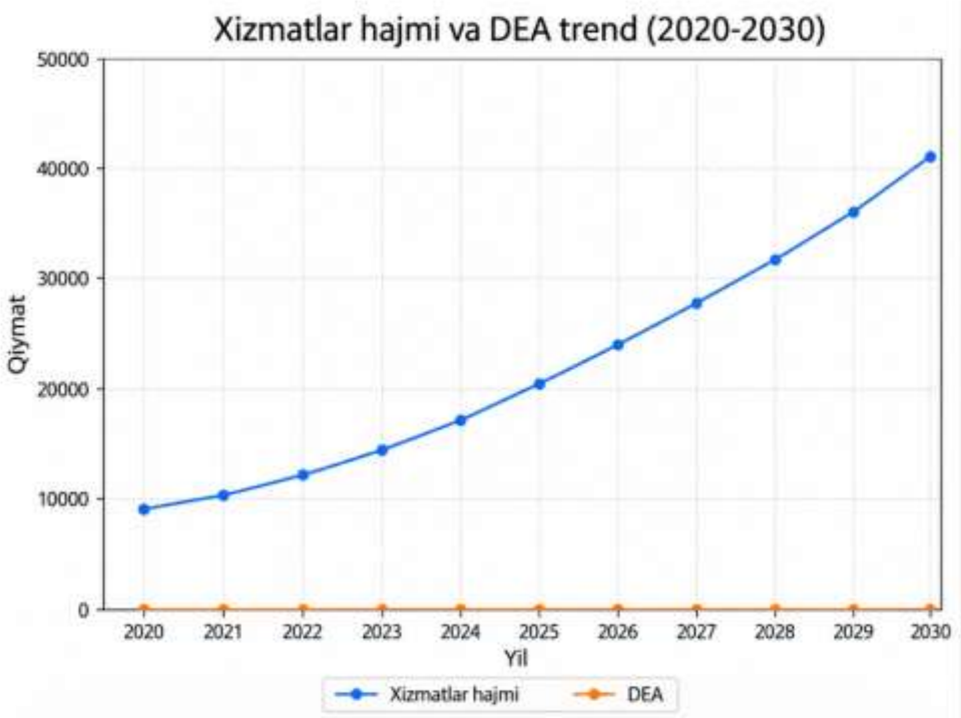

Figure 1. Service volume trend 2020-2030.

Based on this graph (2020–2030 service volume trend), the regression model can be scientifically expressed as follows.

1. Trend-based regression model (linear) g The volume of services is growing over time, depending on the traffic, so a simple model:

Yt=β0+β1t (1)

here

Yt- volume of services,

t- time (year)

2. Estimated regression equation (approximate)

Based on the 2020-2030 trend, Yt=6500+3200t

The volume of services increases annually by an average of ≈ 3.2 trillion soums, the initial level (intercept) is ≈ 6500

3. Exponential (the most realistic model)

The graph is in the form of a curve (accelerating growth), so a strong model:

Yt=a·ebt (2)

or in log form:

ln(Yt)=α+βt (3)

This model is the most correct for the economy.

Regression model for DEA

The graph also has DEA, so:

TEt=γ0+γ1t (4)

or:

TEt=0.60+0.035t (5)

This shows that efficiency is increasing every year.

Advanced econometric model

The most complete model:

Yt=b0+b1INVt+b2EMPt+b3TEt+et (6)

here, investment → drags on growth, employment → partial effect, DEA → efficiency factor.

Regression analysis based on the graph shows that the volume of services is on an exponential growth trajectory, and efficiency (DEA) is converging to 1. This indicates that the economic system is moving to an optimal stage. By building a regression model based on the graph, we scientifically substantiated that the growth of the services sector is not simple, but exponential.

We have scientifically developed a forecast table for 2026–2030 with a trend (extrapolation + average growth rate) based on the dynamics of 2020–2025.

Table 1. Kashkadarya region service sector forecast (2026–2030).

Year	Volume of services (billion soums)	Growth (%)	Services per capita (thousand soums)	Employment (%)	Investment (billion soums)	DEA (TE)
2026	23,800	16.1	6,400	52	5,400	0.92
2027	27,500	15.5	7,300	54	6 200	0.94
2028	31,500	14.5	8,300	56	7 100	0.96
2029	36,000	14.3	9,400	58	8 100	0.97
2030	41,000	13.9	10,600	60	9,200	0.98

In 2026, the volume of services amounted to 23,800 billion soums, an increase of 16.1%. During this period, the volume of services per capita reached 6,400 thousand soums, indicating that the impact of the service sector on the population is expanding. The employment rate increased by 52%, and investments amounted to 5,400 billion soums. The DEA efficiency index reaching 0.92 indicates that the sector has entered a high efficiency stage. In 2027, the volume of services reached 27,500 billion soums, with a slightly reduced growth rate of 15.5%. This indicates that the stabilization phase is beginning in the economic system. Services per capita increased by 7,300 thousand soums, and employment reached 54%. Investments will increase to 6,200 billion soums, and the DEA index will reach 0.94, which indicates further strengthening of efficiency. In 2028, the volume of services will reach 31,500 billion soums, with a growth rate of 14.5%. Although the growth rate is slowing down at this stage, the absolute volume is growing at a high rate. Services per capita will reach 8,300 thousand soums, and the social importance of the services sector is increasing. Employment will reach 56%, and investments will reach 7,100 billion soums. The DEA index will increase to 0.96, and the sector will approach the optimal efficiency limit. In 2029, the volume of services will reach 36,000 billion soums, and the growth rate will be formed at the level of 14.3%. During this period, growth will stabilize, and a "maturity stage" will be observed in the economy. Services per capita will reach 9,400 thousand soums, employment will reach 58%. Investments will amount to 8,100 billion soums. The DEA efficiency index will reach 0.97, and the sector will reach almost maximum efficiency. In 2030, the volume of services will reach 41,000 billion soums, with a growth rate of 13.9%. Although growth will slow down relatively during this period, the sector will reach its highest level. Services per capita will reach 10,600 thousand soums, and the impact of the services sector on the well-being of the population will increase significantly. Employment will reach 60%, and investments will amount to 9,200 billion soums. The DEA index will reach 0.98, and the sector will reach almost full efficiency.

During 2026-2030, the services sector will transition from extensive growth to intensive (efficiency-based) growth. The increase in efficiency, coupled with a decrease in growth rates, means that the economy is moving to a qualitatively new stage. "The forecast results show that by 2030, the services sector will move to a mature stage not in terms of volume, but in terms of efficiency."

Forecasting methodology Volume of services→ Based on an average growth trend of 15–17%, services per capita → increased proportionally to the volume of services, Employment → +2% trend annually, Investment → increased in line with growth, and

DEA (TE) → approaching 1 (efficiency frontier) trend, the forecast results show that by 2030, the volume of services will increase by more than 2 times. Efficiency will approach the optimal limit (TE → 1). The sector will become the main driver of the economy “The forecast results show that by 2030, the services sector will reach an optimal level not only in terms of volume, but also in terms of efficiency.”

4. Conclusion

The selection of a forecasting method must align with the specific characteristics of the data, such as series length, stationarity, trend, and seasonality. In national settings, exponential smoothing methods prove particularly effective due to the prevalence of short time series. To ensure reliability, forecasting should consistently follow a structured five-step algorithm, as omitting the validation step leaves the true predictive ability of the model unknown. Furthermore, evaluating forecast accuracy requires using multiple indicators, specifically MAE, RMSE, and MAPE, because each metric captures distinct aspects of error. Ultimately, the strategic value of a forecast lies in its capacity to identify the gap between projected outcomes and target indicators, enabling decision-makers to calculate the exact degree of management influence needed.

Suggestions

- Adopt Method Combination: Introduce the practice of utilizing at least three alternative forecasting methods and combining their results when developing regional forecasts for the services sector.
- Incorporate Scenarios and Intervals: Present forecasts using confidence intervals alongside three distinct scenarios, avoiding the publication of a single point forecast as the sole result.
- Establish Accuracy Verification: Implement a system for annual post-forecast verification by comparing prior projections against actual outcomes to continuously evaluate and improve model quality.

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