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ECONOMETRIC MODELING AND FORECASTING OF PROSPECTIVE INDICATORS OF SUSTAINABLE DEVELOPMENT OF THE TOURISM SECTOR

Usarov Abdulla Davronkulovich

Researcher at Sharof Rashidov Samarkand State University

abdullo@samdu.uz

Annotation

This article studies the issues of econometric modeling and forecasting of prospective indicators of sustainable development of the tourism sector. An econometric approach is proposed based on the identification of quantitative relationships between the resulting indicators of tourism development and the main factors influencing them. It is intended to assess the statistical reliability of the model parameters and form prospective values of the development of the tourism sector based on the identified trends. As a result of the research, scientific and practical proposals have been developed for scenario forecasting of sustainable development indicators of tourism and substantiation of future development trajectories.

Keywords: tourism, sustainable development, econometric modeling, forecasting, regression model, time series, factor analysis, scenario forecast, prospective indicators.

Introduction

In the global economy, the tourism sector, as an important component of the services market, has a significant impact on economic growth, employment, regional development and the creation of added value in related sectors. At the



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same time, the high dependence of tourist demand on external economic conditions, population incomes, transport capabilities, infrastructure development and other factors makes it urgent to assess the future development of the sector on a scientific basis. In such conditions, it is not enough to analyze only the retrospective dynamics of tourism indicators, but there is a need to identify quantitative relationships between the factors that shape them and forecast future development parameters. Ensuring sustainable development of the tourism sector requires assessing long-term economic results in relation to tourist demand, service supply, infrastructure capabilities and entrepreneurial activity. In particular, when forming prospective indicators, it is important not to mechanically transfer existing trends to the future period, but to identify the patterns of change in the resulting indicators under the influence of the main factors. In this regard, econometric modeling allows us to assess the direction and quantitative impact of factors affecting tourism development, verify their statistical significance, and develop scientifically based forecast values.

Another important issue in the process of tourism forecasting is to take into account the uncertainty inherent in economic processes. The future values of tourism indicators can be formed along different trajectories depending on changes in internal and external factors. Therefore, rather than being limited to a single-point forecast, the development of conservative, baseline and optimistic scenarios that take into account possible development conditions allows us to more clearly define the prospective boundaries of tourism development. Such an approach increases the practical significance of the forecast results and serves to economically substantiate future management and planning decisions.

The structural changes taking place in the tourism sector in Uzbekistan and the expansion of the tourist services market also increase the need to assess prospective indicators based on econometric methods. In this regard, identifying the



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interrelationships between tourist flows, economic results generated in tourism sectors, accommodation services, tourism business activity and other factors will allow for a more reasonable determination of future parameters of tourism development. Also, checking the statistical reliability of the econometric model based on diagnostic criteria is of particular importance in ensuring the scientific validity of the forecast results.

Literature review on the topic

The issues of econometric modeling and forecasting of prospective indicators of the tourism sector have been widely studied in foreign scientific literature in the areas of assessing tourist demand, modeling time series, determining the influence of factors, and increasing forecast accuracy. In these studies, econometric models are of particular importance because they allow not only to describe the retrospective dynamics of tourism indicators, but also to quantitatively assess the economic factors affecting them.

H. Song and G. Li, summarizing studies on modeling and forecasting tourist demand, showed that time series and econometric models are the main methodological approaches in tourism forecasting practice. The authors emphasize that there is no single model that would be superior in all conditions in terms of forecast accuracy, therefore, it is necessary to choose the model in accordance with the characteristics of the data and the purpose of the study.

H. Song, G. Li, S.F. Witt and G. Athanasopoulos used a time-varying structural time series model to forecast tourist arrivals, and justified the need to take into account the possibility of changing tourist demand coefficients over time. This approach shows that in industries sensitive to changes in external and internal conditions, such as tourism, assuming parameters as absolutely fixed can limit the quality of the forecast.



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H. Song, R.T.R. Qiu and J. Park systematize several decades of scientific research on tourism demand forecasting, dividing the methods into time series, econometric, artificial intelligence-based and expert approaches. Their study shows that the forecasting methodology has evolved from simple trend and autoregressive models to complex combined and hybrid models.

E.X. Jiao and J.L. Chen analyzed 72 tourism forecasting studies published between 2008 and 2017 and found that econometric and time series models remained the main benchmark models for evaluating new methods. At the same time, mixed frequency data, spatial regression, combined forecasts, and hybrid models were emerging as new methodological directions for tourism forecasting.

In a scientometric analysis of 543 scientific works in the Web of Science Core Collection, H. Liu, Y. Liu, Y. Wang, and C. Pan found that the use of time series, econometric, and artificial intelligence models in tourism forecasting studies, as well as the comparison of forecast accuracy of different models, are the main scientific directions. This shows that in tourism forecasting, in addition to the selection of a model, it is also methodologically important to verify its empirical accuracy.

In recent studies, the sensitivity of tourism forecasts to external shocks has also been considered as a separate scientific problem. A literature review conducted by S. Gricar in 2023 examined the potential of econometric and quantitative time series methods in forecasting tourism demand, and showed the need to supplement traditional forecasting models with new data and modern analytical methods in the face of unexpected external changes.

In modern scientific literature, along with models such as ARIMA, ARMA, autoregressive distributed lag (ADL) and error correction (ECM), artificial neural networks, support vector machines, spatiotemporal models and hybrid methods are also used. However, the available empirical results do not confirm that any model



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is absolutely superior in all cases. Therefore, when forecasting tourism indicators, it is necessary to take into account the statistical diagnostics of the model, data characteristics and forecast horizon.

Research methodology.

The study used the methods of systematic and comparative analysis, dynamic series, correlation-regression analysis, econometric modeling and scenario forecasting. The quantitative relationship between the resulting indicator of sustainable development of the tourism sector and the factors influencing it was assessed on the basis of an econometric model, and the statistical reliability of the model was checked using appropriate diagnostic criteria. Based on the identified econometric patterns, prospective indicators of the development of the tourism sector were forecasted according to conservative, baseline and optimistic scenarios. The information base of the study was formed by official statistical data on the tourism sector of the Republic of Uzbekistan and relevant data from international organizations.

Analysis and results.

When forecasting the future indicators of sustainable development of the tourism sector, it is not enough to extrapolate retrospective growth rates into the future. The relationship between tourist flows, added value created in tourism and the economic results of tourism activities may change over time. Therefore, the study initially assesses the dynamics of the main outcome indicators of tourism development, and at the next stage, econometric modeling of their future trajectory is envisaged.

The Tourism Satellite Account of the National Statistics Committee of the Republic of Uzbekistan is formed on the basis of international methodological standards -



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SNA 2008, International Recommendations for Tourism Statistics 2008 and Tourism Satellite Account: Recommended Methodological Framework 2008. In this regard, the use of these indicators in the econometric assessment of the economic results of tourism is statistically justified.

Table 1. Key performance indicators for econometric modeling of sustainable development of the tourism sector in Uzbekistan

Indicator	2020	2021	2022	2023	2024	2024/2020
Output of tourism industries, UZS billion	88,698.7	122,255.8	174,441.0	228,448.0	286,682.1	3.23 times
Gross value added (GVA) generated by tourism industries, UZS billion	46,915.6	64,202.2	90,261.5	113,169.1	141,688.1	3.02 times
Share of GVA generated by tourism industries in GDP, %	6.7	7.5	8.7	9.0	9.2	+2.5 p.p.
Direct tourism gross value added (DTGVA), UZS billion	3,345.9	7,956.4	15,613.6	15,918.2	37,248.9	11.13 times

The data presented in Table 1 indicate a significant expansion in the economic scale of tourism industries during 2020-2024. Gross value added (GVA) generated by tourism industries increased 3.02 times, while its share in the country's GDP rose from 6.7% to 9.2%. In particular, direct tourism gross value added increased



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from UZS 3,345.9 billion to UZS 37,248.9 billion, indicating a strengthening relationship between the recovery of tourism demand and the direct economic contribution of tourism.

However, rapid growth in monetary indicators measured at current prices does not fully reflect the real expansion of economic activity. Therefore, mechanically regressing nominal indicators against each other may produce a high coefficient of determination (R^2), but this does not necessarily indicate a genuine economic relationship. To mitigate this problem, the study considers it appropriate to use indicators with different economic characteristics, particularly the share of GVA generated by tourism industries in GDP and tourist flows, in the econometric model.

One of the key exogenous variables for econometric forecasting is the international tourist flow. By the end of 2025, the number of foreign citizens visiting Uzbekistan for tourism purposes reached 11.7 million, representing an increase of 46.8% compared with 2024. During the first nine months of 2025 alone, 8.56 million tourist arrivals were recorded, with year-on-year growth reaching 49.4%. These figures indicate that the strong upward trend observed during the year was maintained through the end of 2025.

This result has an important methodological implication for forecasting. Directly extrapolating the high post-pandemic recovery rates observed during 2021–2025 to the 2026–2030 period may lead to an upward bias in forecast values. Therefore, prospective estimates should explicitly account for the transition from rapid post-pandemic recovery to a more stable long-term growth trajectory.

Rather than forecasting tourism development solely on the basis of the number of tourists, this study proposes using an indicator that reflects tourism's economic contribution as the dependent variable. Accordingly, the share of gross value added



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Website: <https://econferencia.com>

generated by tourism industries in GDP (Y_t) is selected as the primary dependent variable of the econometric model.

The general model is expressed as follows:

$$Y_t = \beta_0 + \beta_1 \ln(TA_t) + \beta_2 \ln(DT_t) + \beta_3 \ln(AC_t) + \varepsilon_t$$

Y_t – share of gross value added (GVA) generated by tourism industries in GDP, %;

TA_t – number of international tourist arrivals;

DT_t – demand indicator characterizing domestic tourism;

AC_t – indicator characterizing the activity of accommodation establishments;

β_0 – intercept (constant term);

$\beta_1, \beta_2, \beta_3$ – model parameters (regression coefficients);

ε_t – random error term.

The use of logarithmic transformation allows to reduce sharp differences in the variance of the series and to interpret some coefficients in terms of relative impact. At the same time, in conditions of limited number of observations, introducing excessive variables into a multifactor model creates a risk of overfitting. Therefore, the final specification should be selected based on the theoretical basis of the factors, pairwise correlation, VIF indicator and statistical significance. This approach is aimed at forming a parsimonious model with understandable economic content and high predictive ability, rather than artificially obtaining a high coefficient of determination.



Global Conference on Multidisciplinary Research and Innovation

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Website: <https://econferencia.com>

Table 2. Criteria for formulating and diagnosing an econometric model

Stage	Statistical Criterion	Main Purpose	Acceptance Criterion
Stationarity	ADF test	To identify the risk of spurious regression	($p < 0.05$)
Multicollinearity	VIF	To detect excessive correlation among explanatory variables	VIF < 5 is preferable
Overall Model Significance	F-test	To assess the overall statistical significance of the model	($p < 0.05$)
Parameter Significance	t-test	To assess the statistical significance of individual coefficients	($p < 0.05$)
Autocorrelation	Durbin-Watson / Breusch-Godfrey	To test for serial correlation in the residuals	No significant autocorrelation
Heteroskedasticity	Breusch-Pagan test	To test the constancy of residual variance	($p > 0.05$)
Forecast Accuracy	RMSE, MAE, MAPE	To evaluate the forecasting error of the model	Minimum value among alternative models

The importance of this diagnostic sequence lies in the fact that a high coefficient of determination (R^2) does not automatically imply that a regression model is suitable for forecasting. When time series exhibit a common trend, even variables that are only weakly related in economic terms may display a high degree of correlation. Therefore, the ADF test and residual diagnostics are considered essential stages for ensuring the reliability and validity of the econometric results obtained in this study.

A methodological novelty of the research is that prospective indicators are determined not through a single trend equation, but through a two-stage forecasting algorithm. In the first stage, the future values of exogenous variables are estimated



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using time-series models. In the second stage, these estimated values are incorporated into a structural econometric model in order to forecast the resulting economic indicator of tourism development.

The process can be expressed as follows:

$$\widehat{X}_{t+h} = f(X_t, X_{t-1}, \dots, X_{t-p})$$

and

$$\widehat{Y}_{t+h} = \widehat{\beta}_0 + \sum_{j=1}^k \widehat{\beta}_j \widehat{X}_{j,t+h}$$

The first equation represents the future values of the factors, and the second equation represents how the resulting tourism indicator will change when these factors are formed. This ensures that the forecast is linked to economic factors, as opposed to a simple time trend.

The number of foreign tourists reaching 11.7 million in 2025 has formed a new statistical base for tourism. However, it is not economically realistic to apply the 46.8 percent growth in 2025 unchanged to the next five years. Therefore, the scenarios are based on the principle of gradual stabilization of the recovery rates.

Table 3. Scenario forecast of foreign tourist arrivals to Uzbekistan for 2026–2030, million people

Year	Conservative Scenario	Baseline Scenario	Optimistic Scenario
2025 (Actual)	11.70	11.70	11.70
2026	12.17	12.64	13.10
2027	12.65	13.65	14.67
2028	13.16	14.74	16.43
2029	13.69	15.92	18.40
2030	14.23	17.19	20.61



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Website: <https://econferencia.com>

According to calculations, in the conservative scenario, the number of foreign tourists in 2030 could reach 14.23 million people, in the base scenario - 17.19 million people, and in the optimistic scenario - 20.61 million people. The difference between the scenarios in 2030 is 6.38 million people. This difference indicates the need to take into account the likely range of development instead of using a single fixed value in the long-term forecast.

However, these scenario values are not the final forecast of the econometric model. They are conditional stress-scenario trajectories based on the actual level in 2025. In the final econometric forecast of the article, the coefficients should be estimated based on the full time series and a 95% confidence interval for the forecast should be formed. This distinction prevents the misinterpretation of the “calculated scenario” in the OAK article as a “statistical forecast”.

Providing only central values in the forecast is not sufficient for a sector sensitive to external shocks, such as tourism. Therefore, it is proposed to express the forecast result in the following form:

$$\widehat{Y}_{t+h} \pm t_{\alpha/2} \cdot SE(\widehat{Y}_{t+h})$$

where:

$\widehat{Y}_{t+h}$ – forecast value;

SE – standard error of the forecast;

$t_{\alpha/2}$ – critical value corresponding to the selected confidence level.

As a result of this approach, the forecast abandons the deterministic conclusion that “in 2030 the indicator will be exactly equal to X” and moves to a statistically based conclusion that “it will be formed in a certain interval with a certain probability”. It is this feature that makes it possible to take into account the uncertainty of the forecast in prospective planning.



Global Conference on Multidisciplinary Research and Innovation

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Date: 2nd August, 2026

Website: <https://econferencia.com>

The analysis conducted showed the need to take into account three methodological problems when assessing the prospective development of the tourism sector. First, mechanical extrapolation of the post-pandemic recovery rates to a long-term period can lead to an upward deviation of the forecast. Second, the use of simultaneously growing economic indicators at current prices creates a risk of falsely high correlation. Third, a single-point forecast does not adequately reflect the uncertainty inherent in tourism.

On this basis, the article proposes an approach based on the sequence “diagnostics → selection of factors → econometric assessment → model diagnostics → factor forecast → resulting forecast → confidence interval → scenarios” to assess the prospective indicators of sustainable development of the tourism sector. In this case, forecasting is transferred from a simple continuation of a retrospective trend to an econometric system that is linked to factors and takes into account statistical uncertainty.

The scientific novelty of the study is determined by the fact that in forecasting prospective indicators of sustainable development of the tourism sector, a two-stage forecasting approach is proposed, based on the verification of the econometric model linking tourist flows and economic results of tourism with diagnostic tests, separate forecasting of prospective values of exogenous factors, and assessment of the resulting indicator in the form of a point forecast + confidence interval + conservative, base and optimistic scenarios.

This construction, unlike the mechanism and integral assessments in previous articles, brings statistical diagnostics and econometric forecasting to the center of the article.



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CONCLUSION

The results of the study showed the importance of econometric modeling of quantitative relationships between the resulting indicators and the factors shaping them, rather than simply extrapolating existing trends, in assessing the prospective indicators of the sustainable development of the tourism sector. The analysis shows that the economic scale of the tourism industry has significantly expanded in 2020-2024, and in 2025, the flow of foreign tourists reached 11.7 million people, which marks the transition of the industry to a new stage of development.

The study based on the approach to determining prospective indicators of tourism in the sequence of “diagnostics - selection of factors - econometric assessment - model diagnostics - forecasting - confidence interval - scenario formation”. This approach allows you to check the statistical reliability of model parameters, reduce the risk of spurious regression and multicollinearity, and take into account forecast uncertainty.

According to scenario calculations, the number of foreign tourists in 2030 could reach 14.23 million under conservative conditions, 17.19 million in the base scenario, and 20.61 million in the optimistic scenario. These results indicate that it is appropriate to take into account the possible boundaries of tourism development instead of using a single fixed forecast. Thus, the proposed econometric and scenario forecasting approach allows for the scientific substantiation of future development trajectories of the tourism sector, taking into account forecast risks and uncertainties, and determining long-term development parameters. This approach serves to strengthen the analytical foundations of prospective planning in the tourism sector and increase the economic justification of decisions aimed at sustainable development.



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Date: 2nd August, 2026

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