ANALYSIS AND FORECASTING OF INTERNATIONAL TOURIST FLOWS IN ROMANIA USING THE HOLT- WINTERS METHOD

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Abstract: *Foreign tourists represent a source of external capital for the national economy, actively contributing to the formation of Gross Domestic Product and stimulating investments in tourism infrastructure. The aim of this paper is to develop a forecast for international tourist flows in Romania using the Holt Winters method, based on official data provided by the National Institute of Statistics for the period January 2015 - January 2026. The research was conducted using Microsoft Excel, with the Solver tool employed to calibrate parameters through nonlinear programming techniques. The optimization process aimed to minimize the mean squared error, resulting in a set of smoothing coefficients that confirms the dominance of the seasonal component. Due to the volatility induced by the COVID-19 pandemic, the study demonstrates the efficiency of the additive version of the algorithm in maintaining the numerical stability of the forecasting system. The final result of the research consists of the extrapolation of tourist flows for the remainder of 2026.*

Key words: *optimization, forecast, tourism, Holt Winters method.*
JEL Classification: *C61, C53, L83.*

1. Introducere

Since 1989, tourism has been considered the field in which Romania could be competitive, being conditioned by the development and improvement of the conditions offered to potential tourists. Over time, tourism began to develop, attracting tourists from both the country and abroad (Ioneci, 2010).

Tourism activity plays an essential role in economic and social development, contributing to the valorization of a country's natural and cultural resources and to the increase of the standard of living (Minciu, 2004).

For Romania, the flow of foreign tourists represents an engine of economic growth, as they are interested not only in the big cities, the coast and the Danube Delta, but also in authentic cultural experiences, from traditional crafts to local gastronomy, which encourages the preservation of traditions and heritage and contributes to the development of local communities and rural areas.

However, the success of these destinations depends on good management of visitor flows, the major challenge for operators in the field being the seasonal nature of the activity. In order to maintain a competitive advantage, they need to base their decisions on forecasts that reduce uncertainty and allow for the optimal allocation of resources before peak periods.

In this regard, the Holt-Winters method was used in the paper to transform data from January 2015 to January 2026 into useful benchmarks, providing a perspective on the evolution of foreign tourist arrivals until the end of 2026.

2. Methodology

The Holt-Winters method, also known as triple exponential smoothing, is a time series forecasting technique developed by Peter Winters and Charles C. Holt in the early 1960s. This method includes a forecast equation and three smoothing equations: an equation for the trend component, an equation for the seasonal component, and another equation for the series level.

Depending on the type of seasonality, the Holt-Winters method can have a multiplicative formulation or an additive formulation.

In the multiplicative formulation (Hanke and Reitsch, 1998) the 4 equations have the form:

Level estimation: $L_t = \alpha \frac{Y_t}{S_{t-s}} + (1-\alpha)(L_{t-1} + T_{t-1})$

Trend estimation: $T_t = \beta(L_t - L_{t-1}) + (1-\beta)T_{t-1}$

Seasonality estimation: $S_t = \gamma \frac{Y_t}{L_t} \mid (1 \quad \gamma)S_{t-s}$, unde:

L_t, T_t, S_t represent the current level estimation, the trend component estimation and the seasonal component estimation, respectively

α, β, γ are smoothing parameters for the level, trend and seasonality with values $0 \leq \alpha \leq 1$, $0 \leq \beta \leq 1$, $0 \leq \gamma \leq 1$

s = seasonality duration, Y_t = actual value at time t

The forecast made at time t for p periods in the future is:

Prognoza realizată în momentul t pentru p perioade în viitor este:

$$\widehat{Y_{t+p}} = (L_t + pT_t) \cdot S_{t-s+p}$$

In the additive formulation the 4 equations have the form:

Level estimate: $L_t = \alpha(Y_t - S_{t-s}) + (1-\alpha)(L_{t-1} + T_{t-1})$

Trend estimate: $T_t = \beta(L_t - L_{t-1}) + (1-\beta)T_{t-1}$

Seasonality estimate: $S_t = \gamma(Y_t - L_t) + (1-\gamma)S_{t-s}$

The forecast made at time t for p periods in the future is:

$$\widehat{Y_{t+p}} = L_t + pT_t + S_{t-s+p}$$

3. Economic study

Using the Holt-Winters method, this paper aims to develop a forecast for international tourist flows in Romania, for the period February 2026 - December 2026.

The calculation basis is made up of data provided by the National Institute of Statistics on the number of foreign tourist arrivals in tourist reception structures. The analyzed data set was obtained after applying a filter by "foreign tourists", monthly frequency and centralization at national level (by cumulating the values related to macroregions, development regions and counties, as follows (Table no. 1):

Table 1. Number of foreign tourists in tourist reception structures

Data	Numar Turişti (Valoare reala)
01.01.2015	103793
01.02.2015	108257
01.03.2015	143819
01.04.2015	160564
01.05.2015	218981
.....	.....
01.05.2025	239462
01.06.2025	248562
01.07.2025	261886
01.08.2025	298146
01.09.2025	273744
01.10.2025	253097
01.11.2025	190904
01.12.2025	198602
01.01.2026	144893
01.02.2026	

Source: INSSE, 2026. *Tempo Online. Turism. TUR104F* [online] Available at: <http://statistici.insse.ro/shop/index.jsp?page=tempo2&lang=ro&context=63> [Accessed 9 March 2026].

According to the literature (Hyndman and Athanasopoulos, 2018), for economic variables with seasonal variations that increase proportionally to the average level, as is the case for tourist flows, the use of the multiplicative model is recommended for forecasting.

However, applying this model to the data in Table 1 led to erroneous results and an inability of the system to generate statistically valid forecasts.

The main cause of the errors was the impact of the COVID-19 pandemic on international tourism in 2020-2021. Since the multiplicative model is based on the ratio of values in estimating the level and seasonality, the drastic decrease in the number of tourists during the lockdown periods forced the algorithm to perform divisions by values tending to zero.

This led to negative values of the level and a very large mean square error.

Given these conditions, the additive version of the Holt-Winters algorithm was chosen, which managed to integrate the atypical values from the pandemic period without compromising the long-term forecast.

Using the Microsoft Excel spreadsheet program, the structure of the additive model was established, and the corresponding calculations were performed for the columns dedicated to the estimates for level, trend, seasonality and forecast.

The corresponding values for the squared error and the mean absolute percentage error (MAPE) were calculated.

The results of these calculations are presented in Table 2.

Table 2. Values obtained by applying the additive method of the Holt-Winters algorithm

Data	Nivel (L_t)	Trend (T_t)	Sezon (S_t)	Prognoza $(\hat{y}_t)$	Eroarea patratica	Eroarea medie: MAPE (Mean Absolute Percentage Error)
01.01.2015	**103793**	0	1	0	10772986849	
01.02.2015	104239,300	44,630	402,670	103794,000	19918369,000	0,0412
01.03.2015	108197,170	435,954	3924,586	104686,600	1531344730	0,2721
01.04.2015	113433,753	916,017	8245,152	112557,710	2304603880	0,2990
01.05.2015	123988,378	1879,878	16919,899	122594,922	9290276032	0,4402

01.05.2025	186557,329	1171,667	10546,006	187167,352	2734730245	0,2184
01.06.2025	192757,696	1674,537	15071,836	198275,002	2528782148	0,2023
01.07.2025	199670,426	2198,357	19786,210	209504,069	2743866684	0,2000
01.08.2025	209517,884	2963,267	26670,400	221654,993	5850874211	0,2566
01.09.2025	215940,395	3309,191	29783,721	239151,551	1196637547	0,1264
01.10.2025	219655,956	3349,828	30149,453	249033,307	16513598,4	0,0161
01.11.2025	216780,660	2727,316	24546,842	253155,237	3875216513	0,3261
01.12.2025	214962,694	2272,788	20456,088	244054,818	2065958643	0,2289
01.01.2026	207955,625	1344,802	12104,217	237691,570	8611574589	0,6405
01.02.2026				220059,842		

Source: Created by the author

The values for the three parameters α, β, γ initially set to 0.1 led to an extremely high mean square error (4.222.839.353) for the forecast to be useful (Table 3).

Table 3. The initial state of the model

Alfa	0,100
Beta	0,100
Gama	0,100
Media erorilor patratic	4222839354

Source: Created by the author

For this reason, the model was optimized, the values of the three parameters α, β, γ being automatically adjusted using Solver, an Excel add-in tool.

It determines the optimal value (in this application, a minimum value) of an objective cell by adjusting the input variables, while ensuring a series of specified restrictions.

Among the three solution methods available in Solver (Simplex LP, GRG Nonlinear and Evolutionary), the Generalized Reduced Gradient Nonlinear algorithm was selected because the Holt-Winters model is nonlinear.

The objective of the optimization process was to identify that combination of parameters α, β, γ within the interval [0,1] that minimizes the mean square error (MSE) (Figure 1).

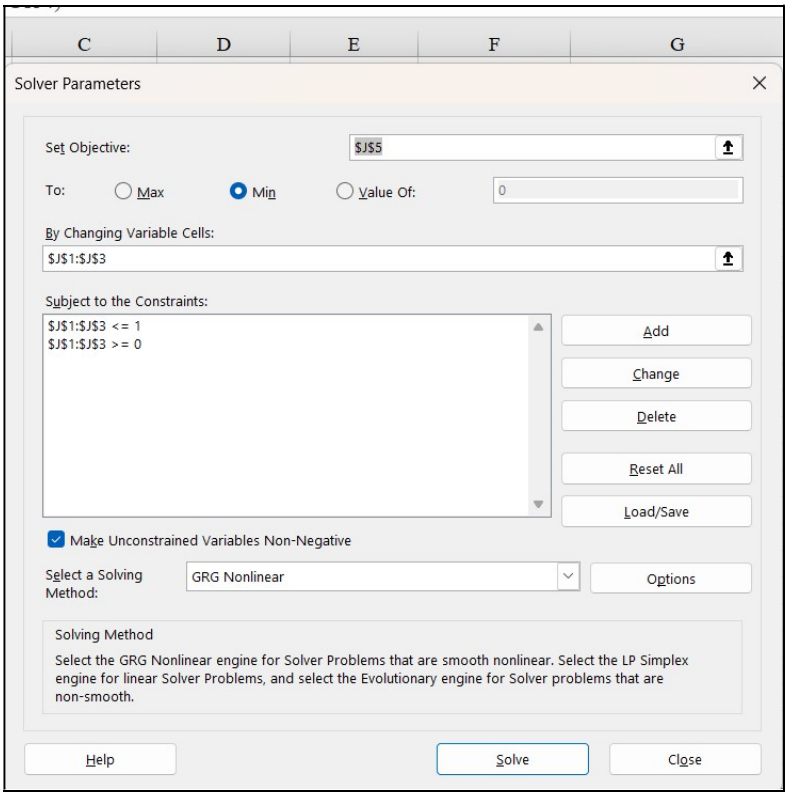

Figure 1. Solver Configuration
Source: Created by the author

As a result of the adjustments made by Solver, the values $\alpha = 0{,}817$, $\beta = 0$ and $\gamma = 1$ were obtained as shown in Table 4. With this new configuration, the mean square error decreased to the value of 1.066.192.603, representing an improvement in the model accuracy by approximately 75%.

Table 4. Results of the optimization process and final model calibration

Alfa	0,817
Beta	0,000
Gama	1,000
Media erorilor patratic	1066192604

Source: Created by the author

In the optimization process, to minimize the mean square error, the setting made by Solver on the trend parameter, $\beta = 0$, led to obtaining all values in the Trend column equal to zero (Table 5). These values signify that international tourism in Romania does not follow a linear growth, being influenced by seasonality.

According to Hyndman and Athanasopoulos (2018) the seasonality parameter γ controls the speed with which the model updates its seasonal component. The value $\gamma = 1$ indicates that the system gives maximum importance to the most recent observation (the previous year) ignoring the influence of long-term historical data.

This confirms that tourism in Romania follows a repetitive seasonal pattern, where recent data is much more relevant for forecasting than the distant ones marked by the period of instability caused by the pandemic .

Table 5. Results of the optimization

Data	Nivel (L_t)	Trend (T_t)	Sezon (S_t)	Prognoza $(\hat{y}_t)$
01.01.2015	**103793**	0	1	0
01.02.2015	107440,722	0,000	816,278	103794,000
01.03.2015	136506,434	0,000	7312,566	108257,000
01.04.2015	150192,542	0,000	10371,458	143819,000
01.05.2015	197938,218	0,000	21042,782	160564,000
.....	.....			
01.05.2025	214677,852	0,000	24784,148	186744,000
01.06.2025	222115,510	0,000	26446,490	239462,000
01.07.2025	233005,549	0,000	28880,451	248562,000
01.08.2025	262641,754	0,000	35504,246	261886,000
01.09.2025	242697,389	0,000	31046,611	298146,000
01.10.2025	225822,079	0,000	27274,921	273744,000
01.11.2025	174990,183	0,000	15913,817	253097,000
01.12.2025	181281,951	0,000	17320,049	190904,000
01.01.2026	137384,241	0,000	7508,759	198602,000
01.02.2026				144893,000

Source: Created by the author

The main indicator followed was the MAPE (Mean Absolute Percentage Error), which gives us a clear picture, in percentages, of the accuracy of the model.

Calculated for the entire interval 2015 – 2025, the MAPE value obtained is 35,98.

Although this value is quite high, analyzing the column of errors obtained for each month, it was observed that the largest errors were obtained during the pandemic, with periods of lockdown and restrictions contributing to the massive decrease in the number of tourists.

In the graph below (Figure 6), one can see both the very large decrease in the number of tourists during the pandemic and the way in which the forecast closely follows the real values. This fact provides confidence that the estimated values for the rest of the current year represent a useful support for planning activities in the coming months.

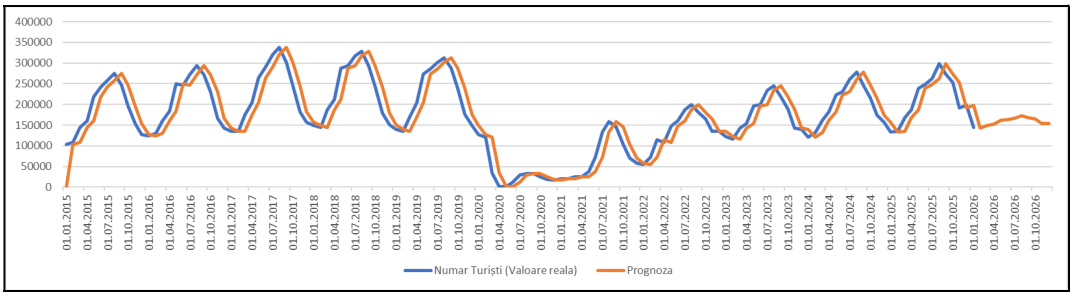

Figure 6. Comparative analysis between actual tourist flows and estimated values during the period 01.01.2015 – 01.01.2026

Source: Created by the author

Without the extremely low values during the pandemic, the MAPE would have been much lower, as demonstrated by the subsequent analysis carried out for the period 2023 – 2025, when the obtained MAPE value was 13,04.

According to Lewis (1982), a MAPE value between 10% and 20% indicates a good forecast, which demonstrates that the additive Holt–Winters method is sufficiently accurate to be used in anticipating foreign tourist flows (Figure 7).

This aspect allows tourism managers to establish their pricing strategies and reception capacities in advance, thus having a competitive advantage in the market.

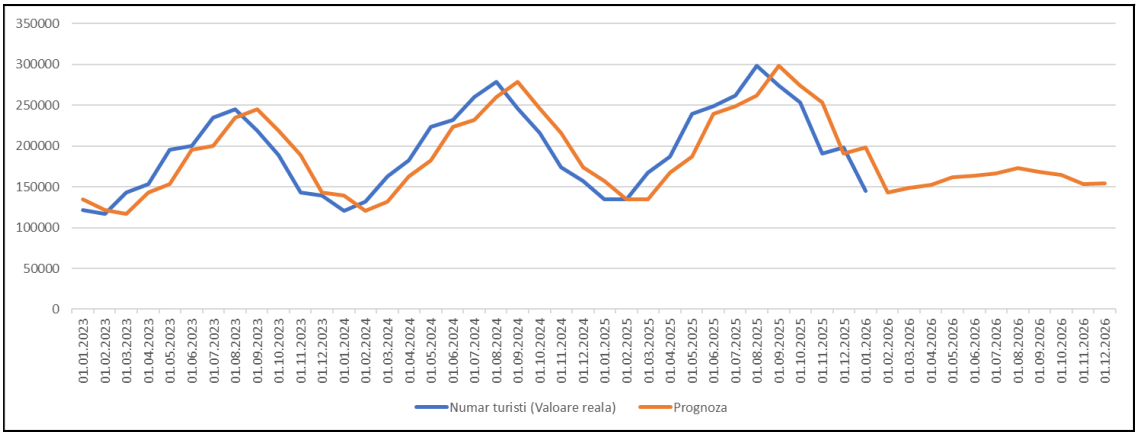

Figure 7. Comparative analysis between actual tourist flows and estimated values during the period 01.01.2023 – 01.01.2026.

Source: Created by the author

The forecast regarding the number of foreign tourists who will visit Romania between 01.02.2026 and 01.12.2026 is presented in Figure 8. The results indicate a stable evolution, with a minimum value for February of 142.981 arrivals and a maximum value of 172.888 arrivals forecast for August.

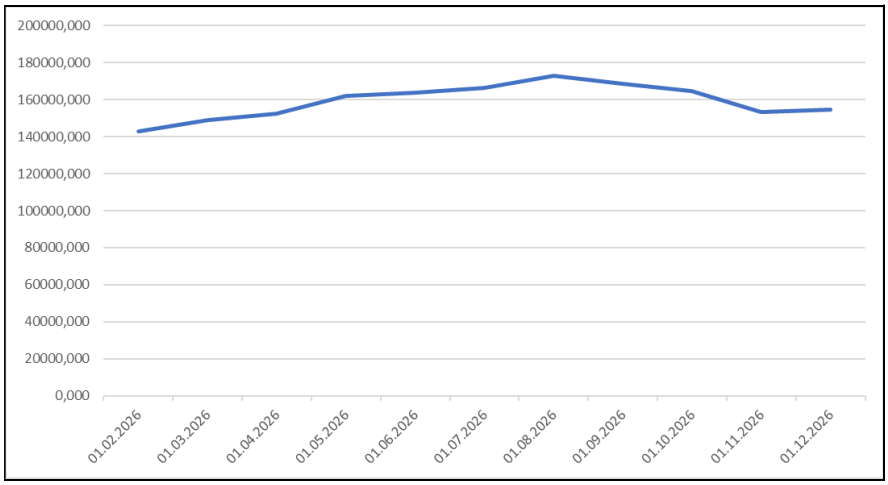

Figure 8. Forecast for the period 01.02.2026 – 01.12.2026.
Source: Created by the author

The fact that the level of forecasted values for 2026 is lower compared to previous years is due to the optimization of the parameters with Solver, which set the trend value $\beta - 0$. This means that the model did not force a continuous increase from one year to the next, but chose to rely on how last year's season looked.

For those who run tourism businesses, this way of calculating is extremely useful, as it provides a safety limit below which the number of tourists is unlikely to fall.

Thus, they can organize their staff and services based on some conservative estimates, avoiding unnecessary expenses when the market is difficult to predict.

3. Conclusions

Tourism is an important factor for a country's economy, representing a way to better capitalize on all categories of resources (Minciu, 2004).

To maintain their competitive advantage, tourism managers need an estimate of the number of visitors, which will allow them to better organize resources and services. The study presented in this paper has demonstrated that the Holt-Winters additive method is a tool capable of generating estimates of future values with high accuracy, thus providing support in planning activities according to demand fluctuations.

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