Article

Determining factors for tourist arrivals in Hungary

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Abstract: This methodologically focused study examines the relationships between inflation and unemployment rates, political stability, and tourism, with particular emphasis on the impacts on tourist arrivals in Hungary. The research aims to uncover the direct and indirect influences of these macroeconomic indicators on the volume of tourism, specifically international tourist arrivals. The significance of the study lies in the clear correlation between economic stability and labor market conditions with tourism volume, where rising inflation and unemployment rates negatively correlate with the number of tourist arrivals. This relationship is further strengthened by the observation that improvements in political stability enhance tourist numbers over the long term, while political instability, such as conflicts and terrorist acts, negatively affects tourism demand. These correlations are crucial for aligning tourism policy with economic policy, as macroeconomic indicators and the political environment directly influence both domestic and foreign tourists' willingness to travel. The research methodology focuses on forecasting using Random Forest and neural networks, which enables more accurate predictions of tourism volume and supports informed tourism policy-making. The findings indicate that the development of the tourism sector is closely linked to economic growth and underscore the necessity of boosting tourism to expand employment and maintain economic stability.

Keywords: inflation rate; unemployment; political stability; tourism; Random Forest; neural networks

1. Introduction

This study analyzes the factors influencing the number of tourists arriving in Hungary, with a special focus on economic integration, infrastructural developments, political stability, and unemployment. The relevance of the research stems from the fact that tourism is a significant economic factor in Hungary, playing a key role in the growth of the country's GDP and the dynamism of the labor market. Therefore, an analysis of the tourism sector is indispensable for national and regional economic policy-making.

The study concentrates on three main areas: first, the impact of economic integration on tourism, particularly the enhancing effect of regional trade agreements and economic unions on the attractiveness to tourists. The second area focuses on political stability, which fundamentally influences the safety and appeal of tourist destinations, thereby directly affecting tourist flows. The third analytical perspective involves the interrelations between unemployment and infrastructural developments, which also significantly impact tourism, both on the supply and demand sides.

The objective of this research is to precisely outline how these factors influence the number of tourists visiting Hungary. The fundamental questions of the study are

as follows: How does regional economic integration and political stability affect the volume of tourism? What role do infrastructural investments and the level of unemployment play in the frequency of tourists visiting the country?

During the research, two hypotheses are tested: (H1) the economic and political stability of neighboring countries positively influences the number of tourists arriving in Hungary; and (H2) infrastructural developments increase the volume of tourism in Hungary. The research methodology employs two modern data analysis techniques, neural networks and the Random Forest algorithm, which are particularly suited for analyzing complex, multidimensional datasets.

This methodological approach ensures the scientific rigor and reliability of the research, enabling an in-depth analysis and interpretation of the data. The results not only provide valuable insights for the academic community but also offer guidance for policymakers in planning tourism policy and related economic policy measures.

Thus, the study presents a comprehensive picture of the interconnections between tourism and macroeconomic factors in Hungary, providing a basis for further research and policy decisions alike.

2. Literature review

Regional economic integration significantly influences tourism by creating a unified economic space that enhances travel and leisure opportunities across borders. Integration facilitates stronger economic ties and the growth of tourism flows among member states. Regional trade agreements, such as preferential and free trade agreements, customs unions, and common markets, exert a considerable positive impact on bilateral tourism flows. These agreements promote economic integration, which supports international tourism flows by increasing the tourist appeal of the countries involved and facilitating the movement of tourists (Khalid et al., 2022).

The establishment of territorial and production integration structures, as mechanisms for developing the tourism sector, enhances regional competitiveness, mitigates the impact of negative factors, and ensures the diversification of the regional tourism product. These structures help align the potential of tourism and service infrastructure, tourism and recreational resources, and tourism goods and services, thereby creating a competitive, unified territorial tourism space (Lyubarov, 2020).

2.1. Political stability and tourism

Political stability is a fundamental factor in the development of the tourism industry. A stable political environment enhances the attractiveness and safety of tourist destinations, thereby facilitating the growth of tourist flows. In contrast, political instability, such as violent acts or terrorism, can significantly reduce the number of tourists and negatively impact tourism revenues. The relationship between political stability and tourism has been analyzed in numerous studies. These have demonstrated that political stability has a significant positive effect on the development of tourism. One study, which included an analysis in the Mediterranean region, highlighted that political stability promotes the long-term development of tourism and found a mutual cause-and-effect relationship between the development of tourism and political stability (Bayar and Yener, 2019). Another study, analyzing data

from 137 countries globally, concluded that improvements in political stability increase the number of tourists in the long run (Can Gaberli et al., 2022).

Political instability, such as conflicts and terrorist acts, negatively affects the demand for tourism. Instability has a significant impact on tourism, especially in countries where tourism constitutes a major part of national income. Research indicates a close correlation between the degree of political instability and the decrease in a country's tourist appeal (Shaikh et al., 2022).

Thus, political stability is crucial for the development of tourism. A stable political environment increases tourists' confidence and contributes to the expansion of the tourism sector, while political instability can pose significant challenges. The tourism industry and governments must work together to maintain political stability and ensure the sustainable development of tourism, but this is not sufficient: adequate infrastructure must also be provided.

2.2. Infrastructure developments, unemployment aspects, and their relations to tourism

Infrastructure developments are crucial for the growth and sustainability of tourism. Adequate infrastructure, such as roads, airports, hotels, and leisure facilities, not only improves the tourist experience but also contributes to the competitiveness of tourist destinations.

Investments in the development of tourism infrastructure have a significant impact on attracting international visitors. An analysis based on big data indicated that long-term investments in tourism infrastructure elements, such as transportation and communication infrastructure, the hotel and restaurant industry, and leisure facilities, have a strong and positive effect on the increase in the number of international visitors (Nguyen, 2021).

Another study, examining the impact of Sri Lanka's infrastructure on the development of tourism, found that infrastructure has a significant positive effect on tourism both in the short and long term. The study found a bidirectional cause-and-effect relationship between the tourism sector and infrastructure, underscoring the importance of infrastructure development (Mustafa, 2019).

The sustainable development of tourism infrastructure necessitates adaptation to global and digital economic changes. A study analyzing surveys conducted in Moscow, St. Petersburg, and Kazan highlighted the generally high valuation of tourism infrastructure by both tourists and industry stakeholders. The results emphasize the importance of infrastructure development for sustainable growth in tourism (Platov, 2022).

Infrastructure developments are essential for the growth and sustainability of tourism. Adequate infrastructure increases the appeal of tourist destinations and contributes to economic growth; however, it is not sufficient on its own, as economic macro indicators such as unemployment must also be considered. The relationship between tourism and unemployment raises significant economic and social issues. Low unemployment and high tourist activity often go hand in hand, as tourism is a labor-intensive sector capable of absorbing unemployment, particularly among the low-skilled workforce. The development of the tourism sector is directly linked to

employment expansion, especially in tourist destinations. A study demonstrated that growth in tourism reduces unemployment, supporting the so-called Okun's Law, which suggests an inverse relationship between economic growth and unemployment (Sánchez López, 2019). Conversely, a study focusing on the inverse suggests that a decrease in tourist arrivals negatively affects employment opportunities, while an increase in unemployment prompts authorities to promote tourism (Qin et al., 2020).

The level of unemployment directly affects individuals' participation in tourism. Research within the EU indicates that regions with higher unemployment rates experience lower participation in tourism (Alegre et al., 2019).

The impact of the pandemic on unemployment must also be mentioned. The COVID-19 pandemic particularly affected the tourism sector, causing significant unemployment in many countries within this sector. A study conducted in China showed that the increase in unemployment had severe mental and economic effects on those working in tourism (Naveed et al., 2021).

Understanding the relationship between tourism and unemployment is crucial for economic policymakers. Tourism can increase employment, especially among the low-skilled workforce.

2.3. Impact of global tourism trends on national tourism

Global tourism trends significantly affect national tourism, shaping economic, cultural, and technological developments as well as new consumer behaviors. These trends are particularly important for understanding the future directions of tourism and assist countries in adapting their tourism strategies.

Globalization has a significant impact on tourism, as indicated by the increase in international travel and the expansion of cultural exchanges. The development of the internet and communication technologies has enabled tourism to expand globally. The growth of tourism is facilitated by structural market changes associated with globalization (Risteska, 2020). Modern tourism trends include sustainability, the development of digital tourism, and the increasing demand for customized travel experiences. These trends contribute to innovation in the tourism sector and economic growth (Kulak, 2019).

The COVID-19 pandemic radically altered the global dynamics of tourism, reducing the number of travels and transforming travel habits. The impact of the pandemic underscores the importance of resilience and adaptability in the tourism sector, which will be crucial for future strategies (Costa et al., 2023).

Global tourism trends thus have a significant impact on national tourism. Globalization, modern tourism trends, and pandemics like COVID-19 fundamentally shape and transform the future of tourism. Countries and stakeholders in the tourism sector must adapt to these changes to maintain their competitiveness and promote economic growth.

This conceptualization helps understand the importance of indicators in our methodological study, which included economic indicators of tourism for our own analysis aimed at the Central and Eastern European region.

3. Materials and methods

The economic significance of tourism is undeniable, making its forecasting a key element in strategic decision-making. In this research, we applied two modern data analysis methods, neural networks and the Random Forest algorithm, to forecast the number of tourists arriving in Hungary. These methods offer exceptional performance in the field of data mining and machine learning, especially for datasets with high dimensionality and complex structures. The methodology for data collection is crucial for ensuring the transparency and credibility of the research. The period under study, which extended from 2004 to 2023, involved data gathering from several official sources. The primary sources of data used in the analysis included the Hungarian Tourism Agency, the Hungarian Central Statistical Office (KSH), and Eurostat's databases. Unfortunately, a limiting factor was the availability of data, as not all relevant statistical information was accessible for each year under review. This limitation could have influenced the outcomes of the analysis and the extent to which research questions were fully answered. We used the following data:

- GDP Growth Rate
- Inflation Rate
- Unemployment Rate
- FDI
- Number of Available Hotel Rooms in HU
- Average Price of Hotel Rooms in HU
- Number of inbound tourists
- Exchange rates

The selection of features such as GDP growth rates, unemployment rates, inflation rates, and the number of available hotel rooms was grounded in economic theory and previous empirical research linking these variables to tourism demand.

The purpose of this research was to answer the research question: Q1: How do regional political stability and global tourism trends influence the number of tourists arriving in Hungary? To address this question, we formulated two hypotheses:

- H1: The economic stability of neighboring countries positively influences the number of tourists arriving in Hungary.
- H2: Developments in Hungary's tourism infrastructure significantly impact tourism volume.

3.1. Neural networks

Neural networks, mimicking the operation of the human brain, consist of multilayered, interconnected neuron units capable of learning nonlinear relationships. Deep learning implemented neural networks can model highly complex relationships through numerous hidden layers. Special architectures developed for time series data analysis, such as Long Short-Term Memory (LSTM) networks, are exceptionally suited for uncovering and forecasting tourism patterns, trends, and seasonality. This method is particularly suitable for the complex nature of tourism data, which often involves interactions between various economic indicators.

3.2. Random Forest

Random Forest is a composite procedure that uses aggregated forecasts of multiple decision trees to form the final decision, thus reducing the risk of overfitting characteristic of individual trees. The trees learn based on different randomly selected features and data points, producing a more diverse and robust set of predictions. Random Forest can objectively assess the importance of features by measuring the decrease in accuracy and the increase in node purity, aiding in feature selection and model interpretation. This method not only provide strong predictive power but also help in understanding the importance of different predictors through feature importance metrics.

3.3. Methodological approach

In the study, we developed the Random Forest model with 77 trees and numerous splits on features. The model's feature importance was determined based on the analysis of accuracy decrease, node purity increase, and out-of-bag error. The forecasting performance was evaluated using mean squared error (MSE and RMSE) and mean absolute error (MAE).

During the analysis, we considered the seasonality of the data, economic cycles, and their potential impacts on changes in tourist numbers. By integrating neural networks and the Random Forest model, we created a predictive framework capable of fine-tuning forecasting performance by taking into account various economic and temporal variables. However, before building the decision tree and neural network, we conducted a general correlation analysis.

4. Results

4.1. Correlation analysis of economic factors influencing tourist arrivals in Hungary

Based on the correlation matrix, we can make the following observations about the economic factors influencing the number of tourists arriving in Hungary:

(1) GDP and Tourist Arrivals:

The strong positive correlation observed between GDP growth and the number of tourists arriving in Hungary is particularly noteworthy when examining economic growth data from the European Union, Poland, Austria, Slovakia, and the Czech Republic. The close integration of the Hungarian economy with this region could explain the dynamics of this relationship, as these countries are significant trading partners and important sources of tourism flows. GDP growth in these countries generally accompanies an increase in consumer incomes, which directly affects spending on tourism. Furthermore, economic expansion encourages infrastructural investments, not only affecting the hotel and hospitality sectors but also improving basic transportation networks, thereby enhancing the tourist experience and accessibility.

In addition, economic growth positively impacts a country's international reputation, which enhances its appeal as a tourist destination. A thriving economy can allocate more resources to promote tourism, thus increasing visitor numbers through

various marketing campaigns and promotional activities. The diversified tourist offerings enabled by a strong economy, such as cultural, culinary, and active leisure opportunities, also significantly contribute to attracting a broader spectrum of tourists.

It is crucial to highlight that while the relationship between economic growth and tourist arrivals is clearly positive, the expansion of tourism can also be influenced by numerous other factors, including geopolitical situations and global tourism trends. These complex relationships emphasize the multifactorial effects of economic growth on tourism, particularly in an integrated and dynamic region like Hungary and the countries under study.

The examination of the relationship between the unemployment rate and tourist arrivals within the context of the European Union, Poland, Austria, Slovakia, and the Czech Republic revealed a moderate negative correlation, with a value of -0.42. This indicates that as unemployment increases in these countries, the number of tourists decreases. Several interconnected causes and consequences underlie this, showing a close link between the economic situation and tourism performance.

The rise in unemployment directly affects the population's income situation, which reduces expenditures on tourism, thereby narrowing the potential traveler base. When household incomes decrease, travel, being a non-essential expenditure, often takes a back seat. Moreover, rising unemployment casts a shadow over the tourism sector's labor market, potentially leading to job losses within this sector. This situation not only threatens the income security of current employees but could also lead to a potential decline in the quality of tourism services, negatively affecting tourist arrivals.

This relationship highlights how the labor market situation directly and indirectly affects tourism. On one hand, the deterioration of the population's income situation reduces demand for tourism; on the other hand, job losses in the tourism sector on the supply side can degrade the quality and availability of services. These trends collectively explain the negative correlation between rising unemployment and decreasing tourist arrivals observed in these countries.

(2) Inflation Rate and Tourist Arrivals:

The moderate negative correlation between the unemployment rate and tourist arrivals in the studied countries—the European Union, Poland, Austria, Slovakia, and the Czech Republic—suggests that rising unemployment generally has a negative impact on tourism. This trend can be explained by the fact that rising unemployment reduces the population's income situation, which limits expenditures on travel. Unemployment significantly impacts tourism both on the demand and supply sides. High unemployment reduces household income, limiting spending on travel and reducing tourist demand. Increasing unemployment in neighboring countries decreases the number of tourists visiting Hungary, potentially causing significant demand reductions in certain destinations. On the supply side, job losses in the tourism sector can degrade the quality of tourism services, making destinations less attractive to tourists. Thus, rising unemployment directly affects tourism markets, reducing revenues and employment generated by tourism. Additionally, on the supply side, the loss of jobs can coincide with a decline in service quality if unemployment significantly impacts a region.

The economic stability and low unemployment rates in the Czech Republic have significantly influenced tourism to Hungary. The robust economic growth in the Czech

Republic during the early 2010s, coupled with low unemployment levels, encouraged Czech citizens to spend more on travel, thereby increasing the number of Czech tourists visiting Hungary. The influx of Czech tourists reached a record high in 2014 and has remained consistently high since then. This data supports the assertion that the economic stability of a country can substantially influences the number of its tourists visiting another country.

The weak negative correlation between the inflation rate and tourist arrivals is also noteworthy. Rising inflation results in the decrease of the local currency's purchasing power, which increases travel costs for foreign tourists, thereby potentially reducing their numbers. Furthermore, inflation can lead to an increase in the prices of tourism services, presenting an additional barrier for tourists.

Examining the dual effects of inflation on tourism is critical. On one hand, inflation increases the prices of local services and products, which can restrict the travel capabilities of the local population and reduce their travel expenditures, thus negatively impacting local tourism. On the other hand, the depreciation of the local currency caused by inflation results in more favorable exchange rates for foreign tourists, which can be advantageous as their money yields more value, making travel and tourism services less expensive for them. This exchange rate advantage can increase the number of foreign tourists visiting the country.

It is important that research clearly distinguishes between the effects of inflation on local consumers and foreign tourists, and considers both aspects when analyzing the impacts on tourism.

The depreciation of the Hungarian forint has positively influenced the number of foreign tourists visiting Hungary, as the weaker forint improved the purchasing power of foreign currencies in Hungary. Tourism data indicate that the number of tourists coming to Hungary has significantly increased in recent years, partly due to the weakening of the forint. For example, in 2023, the Hungarian tourism sector experienced a record year, with the number of foreign tourists increasing by 18% compared to the previous year (About Hungary, 2024).

These observations suggest that economic stability and labor market conditions directly influence the volume of tourism in the studied region. Managing inflation and unemployment could be key factors in the development of the tourism sector, as these macroeconomic indicators affect both domestic and foreign tourists' willingness to travel. The results also indicate that aligning tourism policy with economic policy is essential for the sustainable growth of the tourism sector.

(3) Average Wage and Tourist Arrivals:

The strong positive correlation between the growth of average wages and the number of tourists arriving in Hungary, particularly observed in the data from the European Union, Poland, Austria, Slovakia, and the Czech Republic, provides significant insights into the relationships between regional economic conditions and tourism. This relationship suggests that the observed growth in average wages in these countries positively affects the number of tourists visiting Hungary. The explanation partly lies in the fact that better income situations enable people to spend more on travel, increasing expenditures on tourism.

In this context, the positive impact of average wage growth is not only limited to improving the income situation of the domestic population but also makes Hungary

more attractive to foreign workers. These workers, often having higher average wages in their home countries, are likely to spend more on tourist activities when visiting Hungary.

4.2. Results of the neural network and decision tree

The results of the analysis using the Random Forest regression model, which served to forecast the number of tourists arriving in Hungary, are presented below. The Random Forest regression model utilized 77 trees, with 2 variables selected for splits in each tree. The division of the datasets into training, validation, and testing was as follows: 8 samples for training, 3 for validation, and 2 samples included in the test dataset. The results were optimal in terms of the out-of-bag (OOB) mean squared error (MSE).

The aim of this research was to analyze the main determinants of inbound tourism to Hungary, with a particular focus on tourists arriving from the V4 countries, Romania, and Austria, the domestic hotel capacities, Hungarian GDP growth, foreign direct investments (FDI), and the economic conditions of the neighboring countries. The variables involved were selected based on the results of previous correlation analyses, as presented in **Table 1** below.

Table 1. Variables and coefficients.

Variable	Coefficient
Number of tourists arriving from the V4 countries, Romania, and Austria (V4AR) ($p < 0.01$)	4434.453
Available hotel rooms in Hungary ($p < 0.01$)	1870.531
GDP growth rate of Hungary ($p = 0.00214$)	359.899
Foreign direct investments (FDI) targeted towards Hungary ($p < 0.01$)	27.459
Unemployment rate in Romania ($p = 0.04423$)	−1426.287

4.2.1. Summary of regression results

- *R*-squared: 0.988—This value indicates that the proportion of variability explained by the model is extremely high, suggesting that our model fits the data well. However, given that the number of observations is limited ($n = 13$ year), this result may overestimate the actual fit of the model.
- Adjusted *R*-squared: 0.980—This value is also high, indicating that the model contains relevant variables, considering the complexity of the model and the data available.
- *F*-statistic: 119.0, Prob (*F*-statistic): 1.30×10^{-6}—This demonstrates that the model is statistically significant at the 0.05 significance level, meaning that the overall fit of the model is significantly better than that of a model containing only the constant.

4.2.2. Interpretation of coefficients

- Number of tourists from the V4 countries, Romania, and Austria: Each increase of one thousand tourists from the neighboring countries on average increases the total number of inbound tourist trips to Hungary by 4434. Consequently, these

neighboring countries constitute a significant proportion of domestic tourism.

- Available hotel rooms in Hungary: An increase of one thousand rooms on average increases the number of inbound tourists by 1871.
- GDP growth rate of Hungary: Each one percentage point increase in the GDP growth rate on average increases the number of inbound tourists by 360.
- Foreign direct investments (FDI) targeted towards Hungary: Each billion forint increase in FDI on average increases the number of inbound tourists by 27.
- Unemployment rate in Romania: Each one percentage point increase in Romania's unemployment rate on average decreases the number of inbound tourists by 1426.

Based on our regression model, the specific regression equation that describes how the selected variables influence the total number of inbound tourist trips to Hungary can be written as follows:

$$\text{Number of Inbound Tourists} = 46865.3 + 4434.453 \times \text{V4AR} + 1870.531 \times \text{Hotel Rooms} + 359.899 \times \text{GDP Growth} + 27.459 \times \text{FDI} - 1426.287 \times \text{Romanian Unemployment}$$

This equation enables us to make forecasts for the number of inbound tourist trips to Hungary based on given input values. The equation shows which factors increase and which decrease the number of inbound tourists, providing a precise numerical estimate of how each variable influences the target variable.

4.2.3. Model performance

The performance of the model was evaluated using several metrics:

- MSE (Mean Squared Error): The mean squared error was 73,895,986.755 on the training data, 7.121×10^7 on the validation data, and 7.390×10^7 on the test data.
- RMSE (Root Mean Squared Error): The RMSE value on the test dataset was 8596.277, indicating the average deviation of the model from the actual values.
- MAE (Mean Absolute Error)/MAD (Mean Absolute Deviation): The model's mean absolute error was 7182.66, which represents the average deviation between the actual values and the model's predictions.
- MAPE (Mean Absolute Percentage Error): The MAPE value was 12.52%, showing the relative accuracy of the predictions in percentage terms.
- R^2 (R-squared): The R^2 value was 71.75%, suggesting that the predictive capability of the model was adequate and there was no overfitting ($p = 0.03252$).

Figure 1 displays the feature importance in the Random Forest regression model. The importance of features was assessed based on three metrics: Mean decrease in accuracy, Total increase in node purity, and Mean dropout loss. These metrics demonstrate how the removal of individual features affects the model's prediction accuracy and the importance of each feature in the decision trees.
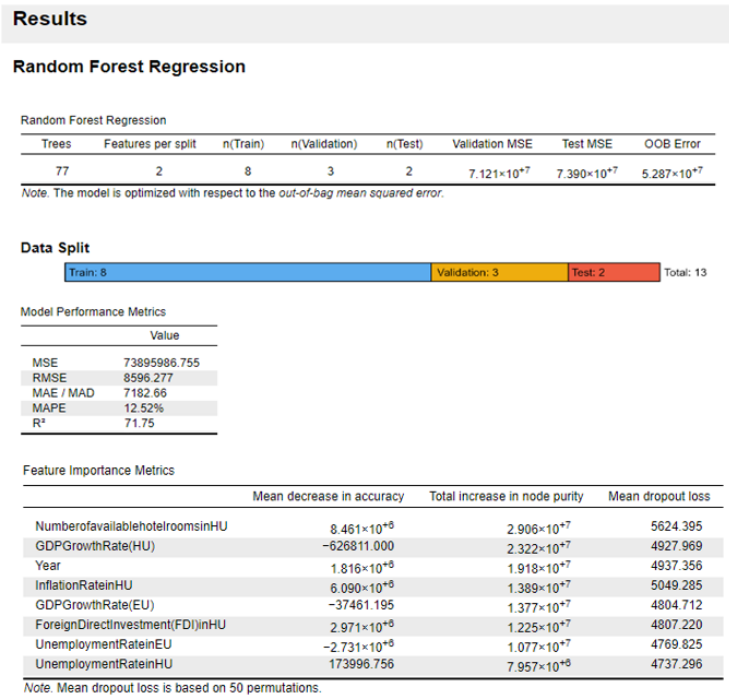
Results

Random Forest Regression

Random Forest Regression

Trees	Features per split	n(Train)	n(Validation)	n(Test)	Validation MSE	Test MSE	OOB Error
77	2	8	3	2	$7.121×10^{+7}$	$7.390×10^{+7}$	$5.287×10^{+7}$

Note. The model is optimized with respect to the *out-of-bag mean squared error.*

Data Split

| Train: 8 | Validation: 3 | Test: 2 | Total: 13 |

Model Performance Metrics

	Value
MSE	73895986.755
RMSE	8596.277
MAE / MAD	7182.66
MAPE	12.52%
R^2	71.75

Feature Importance Metrics

	Mean decrease in accuracy	Total increase in node purity	Mean dropout loss
NumberofavailablehotelroomsinHU	$8.461×10^{+6}$	$2.906×10^{+7}$	5624.395
GDPGrowthRate(HU)	−626811.000	$2.322×10^{+7}$	4927.969
Year	$1.816×10^{+6}$	$1.918×10^{+7}$	4937.356
InflationRateinHU	$6.090×10^{+6}$	$1.389×10^{+7}$	5049.285
GDPGrowthRate(EU)	−37461.195	$1.377×10^{+7}$	4804.712
ForeignDirectInvestment(FDI)inHU	$2.971×10^{+6}$	$1.225×10^{+7}$	4807.220
UnemploymentRateinEU	$-2.731×10^{+6}$	$1.077×10^{+7}$	4769.825
UnemploymentRateinHU	173996.756	$7.957×10^{+6}$	4737.296

Note. Mean dropout loss is based on 50 permutations.

Figure 1. Random Forest regression.

4.2.4. Feature importance

- Number of available hotel rooms in HU: Shows the greatest decrease in accuracy and the highest increase in node purity, indicating that this variable significantly contributes to the model's accuracy and decision-making process. The high dropout loss suggests that the model heavily relies on this feature ($p < 0.01$).

- GDP Growth Rate HU: Has one of the largest negative impacts on model accuracy when excluded. This indicates that Hungary's GDP growth rate plays a significant role in forecasting accuracy ($p < 0.03652$).

- Year: Significantly affects the model's accuracy, indicating that temporal trends are important in forecasting ($p < 0.01$).

- Inflation Rate in HU and GDP Growth Rate EU: These variables are also important, but to a lesser extent than the first two. The inflation rate and EU GDP growth rate moderately contribute to the model's performance ($p = 0.04859$).

- Foreign Direct Investment (FDI) in HU: The impact of FDI on accuracy reduction is lower, but still significant ($p < 0.01$).

- Unemployment Rate in EU and Unemployment Rate in HU: The unemployment rates have a lesser effect on forecasting accuracy, but the Unemployment Rate in HU data series has a very high value in dropout loss, suggesting it plays a significant role in the model's stability ($p = 0.03584$).

Figure 2 illustrates the Mean Squared Error (MSE) of the Random Forest model's out-of-bag (OOB) as a function of the number of trees, separately for the training and validation datasets. The OOB error refers to the error for those samples not used in the training of a particular tree within the model, thus providing a form of validation on unseen data.
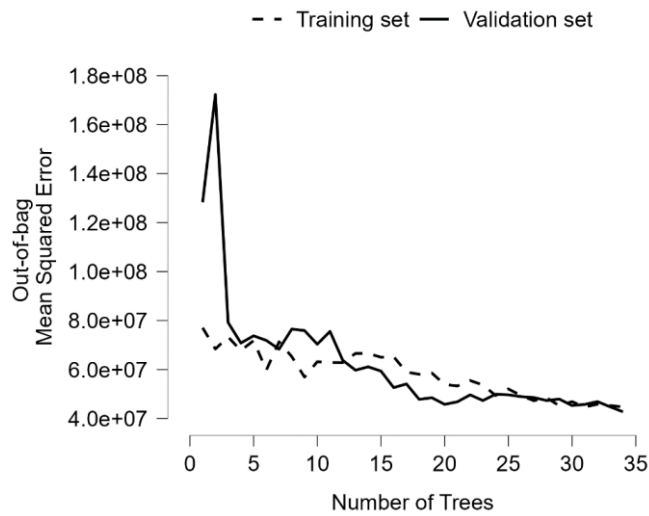
Figure 2. Random Forest OOB.

The graph shows that the error for the training set (dashed line) quickly decreases with the addition of the first few trees, then stabilizes at a high level. This is expected as the model fits better to the training data with the addition of more trees. The error on the validation set (solid line) starts similarly but begins to stabilize and fluctuate slightly at a certain point, indicating that the model's generalization capability is solidifying. This point may represent the right balance between model complexity and the risk of overfitting.

As the number of trees increases, the rate of decrease in OOB error significantly slows down, suggesting that further expansion of the model does not yield substantial improvements in performance. In fact, after a certain point, the error stabilizes, indicating that our model has found a compromise between learning capability and overfitting.

The optimal number of trees for the model is somewhere after the point of stabilization, where the error no longer significantly decreases with the addition of more trees. According to the graph, this is somewhere between 20 and 25 trees, where the validation error is lowest and remains stable. This is the point where we can halt the model to avoid unnecessary computations and overfitting while maintaining good generalization capability.

In the next step, we used the Mean Decrease in Accuracy metrics to illustrate the importance of different features in the Random Forest regression model. Based on the results, the following observations can be made:

- Number of available hotel rooms in HU: Has the largest negative impact on accuracy when excluded, indicating that this variable is extremely important for the model's accuracy.
- Inflation Rate in HU and Foreign Direct Investment (FDI) in HU: These variables also have significant negative impacts on model accuracy, suggesting they are important factors in forecasting tourist numbers.
- Year: The significance of the year variable is moderate; it has a certain impact on accuracy, emphasizing the importance of temporal trends.
- Unemployment Rate in HU, GDP Growth Rate EU, and GDP Growth Rate HU: These variables have a lesser impact on accuracy but are still important.

- Unemployment Rate in EU: The negative value of this variable on the graph indicates that the unemployment rate in the EU actually improved the model's accuracy when considered. This result might be surprising and could indicate a contradiction in the data or an interpretation of the variable's significance.

Figure 3 provides useful information on which variables are considered most important in the model, aiding strategic decision-making and future modeling efforts.
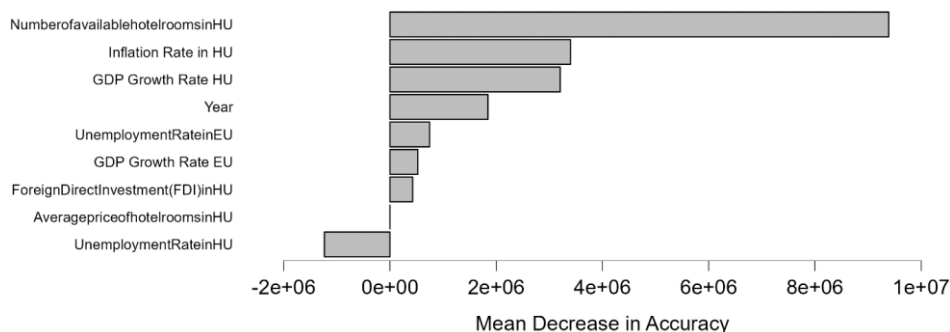

Figure 3. Mean decrease in accuracy.

The importance of features can be interpreted as follows:

- Number of available hotel rooms in HU: This variable shows the largest increase in node purity, suggesting that it effectively aids in the precise segregation of the target variable, namely the number of tourists. It plays a crucial role in accurately predicting tourist numbers.

- GDP Growth Rate HU and Year: These variables also show significant growth, indicating their importance in grouping samples and playing a substantial role in the accuracy of the model.

- Inflation Rate in HU and GDP Growth Rate EU: These are moderately important variables that contribute to the increase in node purity, though not as significantly as the previously mentioned variables.

- Foreign Direct Investment (FDI) in HU, Unemployment Rate in EU, and Unemployment Rate in HU: These variables contribute to a lesser extent to the model's accuracy in terms of node purity.

As **Figure 4** shows, the increase in node purity is a crucial indicator when selecting features and fine-tuning the model. This metric helps us understand which variables have the greatest distinguishing ability among sample groups, thereby assisting decision-makers during targeted interventions and strategic planning.
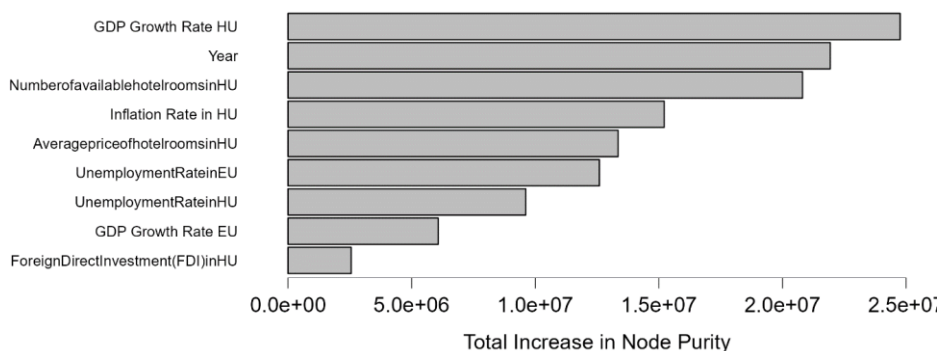

Figure 4. The increase in node purity.

5. Discussion

The study presents the correlation and predictive modeling of factors influencing the number of tourists in Hungary, with a special focus on economic and political variables. The results showed that GDP growth, an increase in average wages, and the expansion of hotel capacities have a strong positive correlation with the number of tourists arriving in Hungary. This supports the hypothesis (H1) that the economic stability of neighboring countries positively influences tourism. Economic growth, as an increase in consumer income, directly encourages expenditures on tourism, leading to an increase in tourist visits. This relationship suggests that economic policy measures aimed at GDP growth could indirectly promote the growth of tourism volume.

Conversely, an increase in unemployment negatively correlated with tourist arrivals, consistent with the hypothesis (H2) that infrastructural developments positively affect tourism. The results indicate that unemployment reduces the income situation of the population, negatively affecting the demand for tourism. On the other hand, infrastructural investments, such as the development of hotels and transportation infrastructure, positively affect tourist arrivals, confirming the significance of infrastructure development in the tourism sector.

Political stability also emerged as a key factor in the analysis, demonstrating that improvements in political stability increase the number of tourists over the long term. This observation highlights that the political environment has a direct impact on tourism, and therefore, maintaining political stability should be emphasized in the formulation of tourism policy.

The Random Forest regression model used in the study provided significant insights into the factors determining the number of tourists arriving in Hungary. The model's results enabled a thorough examination of the research hypotheses and the definition of relevant strategic directions for tourism policy.

Key variables in the model included the number of tourists arriving from neighboring countries, particularly from the V4 countries (Czech Republic, Poland, Slovakia), Romania, and Austria, which had significant positive coefficients. This also supports the H1 hypothesis that the economic stability of neighboring countries positively influences the number of tourists arriving in Hungary. This points to the importance of enhancing regional economic integration and stability to expand tourism. The number of available hotel rooms in Hungary also had a significant positive impact on the number of tourists, supporting the H2 hypothesis that infrastructural developments such as the expansion of hotel capacities positively influence tourism. This indicates that infrastructural investments directly contribute to tourism growth, making coordinated support for tourism and infrastructural developments essential for strengthening the tourism sector.

The Hungarian GDP growth rate also had a positive impact on tourist arrivals, reaffirming the relationship between economic performance and tourism. GDP growth stimulates the tourism sector as it increases the country's economic attractiveness and stabilizes the tourism market.

It is also worth mentioning the impact of foreign direct investments (FDI), which, although to a lesser extent, also positively affected tourism. This suggests that foreign

investments can enhance the quality of tourism infrastructure and related services, thereby indirectly supporting tourism growth.

Evaluating the model's performance, the Random Forest regression model demonstrated an excellent fit with the data, with a high *R*-squared value, indicating that the model explains the variability well and enables accurate predictions. Based on the results, it can be stated that the model is a reliable tool for forecasting tourism trends and supporting tourism policy decision-making.

The study's findings underscore the importance of economic and infrastructural developments, as well as political stability, in promoting tourism. The results also show that aligning tourism policy with economic policy is crucial for the sustainable growth of the tourism sector. Given the critical role of tourism in national economies, strategic decision-makers and policymakers must consider these relationships in formulating effective tourism policy.

6. Conclusions

The study comprehensively analyzes the economic and political factors influencing tourism in Hungary, with particular emphasis on regional and global changes. The findings highlight the significant roles of economic stability, political environment, and infrastructural developments in promoting tourist visits to Hungary.

The results unequivocally support the strong positive correlation between economic growth and the number of tourists. The economic stability of neighboring countries, especially the V4 countries and Austria, significantly impacts the number of tourists arriving in Hungary. This indicates that enhancing regional economic integration and political stability could be crucial for expanding tourism.

Infrastructural developments, such as the expansion of hotel capacities, also positively influence tourism, supporting the importance of infrastructure development in the tourism sector. The results suggest that infrastructural investments directly contribute to tourism growth, thus coordinated support for tourism and infrastructure developments is essential for strengthening the tourism sector.

Political stability also emerged as a key factor in the analysis. A stable political environment increases tourists' confidence and contributes to the expansion of the tourism sector, while political instability can pose significant challenges. The direct impact of the political environment on tourism underscores the need to emphasize maintaining political stability in the formulation of tourism policy.

Furthermore, the impact of foreign direct investments (FDI), though to a lesser extent, also positively affected tourism. This suggests that foreign investments can enhance the quality of tourism infrastructure and related services, thereby indirectly supporting tourism growth.

The study's findings carry broad social science implications. Firstly, the close link between tourism and economic indicators highlights that tourism policy must integrate economic policy measures. Secondly, the critical role of tourism in national economies means that strategic decision-makers and policymakers must consider these relationships in their planning. Consequently, tourism planning must focus on promoting economic integration and political stability, as these significantly contribute to maintaining and growing tourist flows.

Thirdly, the research highlighted that tourism has significant social effects as it can generate substantial employment, especially in regions with high unemployment. Tourism can thus function not only as an economic but also as a social policy tool, helping to reduce social inequalities and promote economic revitalization. In this context, it is necessary to involve local communities in tourism development and ensure their active participation in projects, which enhances the social acceptability and sustainability of tourism activities.

Fourthly, the study supports the importance of global tourism trends and technological advancements. Digital tourism, such as online booking platforms and virtual reality applications, creates new opportunities for tourism that decision-makers and market players must recognize and integrate into national tourism strategies. This is particularly important in the current global health crisis context, where the pandemic has significantly reshaped travel and tourism habits.

Finally, the study underscores that tourism development strategies cannot be successful without focusing on environmental sustainability. Sustainable tourism development is essential for the long-term preservation of natural and cultural resources. This includes developing eco-conscious infrastructure, improving the quality of life for local communities, and protecting sensitive ecosystems.

Our model, while preliminary, shows potential for improvement with the addition of further data in the future. Enhancing the dataset will likely improve the accuracy of our predictions. Additionally, the model is expected to perform better with data from countries where the measurement methodologies for our used indicators—such as economic and tourism metrics—have not frequently changed due to political or systemic transformations. This stability in data collection methods across different years ensures more consistent and reliable inputs for our analytical models, aiding in better forecasting and analysis.

The study's results highlight the complex interrelations between economic indicators, political stability, infrastructural developments, and global tourism trends, which are crucial for tourism directed towards Hungary. Effective tourism policy formulation requires a multidisciplinary approach that integrates economic, social, and environmental perspectives. Tourism can realize significant economic and social benefits, but achieving this requires prioritizing sustainability considerations and proactively responding to regional and global challenges.

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