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THE ECONOMIC ROLE OF TOURISM IN EUROPEAN COUNTRIES' SUSTAINABLE DEVELOPMENT

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Abstract
With the coronacrisis caused by the COVID–19 pandemic, the tourism industry in Europe suffered the most in 2020, experiencing huge losses, lay-offs of workers, mass bankruptcies of firms, etc. Undoubtedly, the tourism economy contributes to the sustainable development of European countries, but how? The answer to this question is contained in the proposed study. Algorithm method, correlation and regression analysis, and non-linear programming were used to address the economic contribution of tourism to sustainable development. The modelling of the multiple power regression equation was based on freely available official statistical data from 40 European countries for the year 2020. A multiple power regression equation modelling algorithm for the impact of tourism on the sustainable development of European countries has been proposed and validated. The challenge of maximising the Sustainable Development Goals Index is set and solved. It is justified that in order to increase the average European level of sustainable development by 1 % in the post-pandemic period, the average annual number of tourists per European country should be increased by 14 %, the tourist attractiveness of destinations should be increased to increase revenues per tourist by 17 %, and the sectoral structure of the European economy should be optimised so as to reduce dependence on tourist revenues by 0.4 percentage points.

Keywords: *algorithm, GDP, goals, modelling, multiple power regression, tourist.*
JEL Codes: *C61, L83, Q01, Z32.*

Introduction

The economic role of tourism is ever increasing in a globalising world. It is tourism that activates socio-economic processes in countries and sets trends in the use of the potential of tourism and recreational resources, which should be based on the principles of sustainable development. As services have

come to dominate material production, tourism has taken a leading place in the international division of labour, as it stimulates economic growth, solves problems of employment and poverty alleviation, promotes environmental management, serves the exchange of mental values and ensures mutual understanding between cultures.

The real challenge for sustainable development all over the world, including Europe, has been the coronation crisis starting in 2020 as a result of unprecedented quarantine measures, lockdowns, border closures, restriction of catering establishments, relocation of staff to remote jobs, etc. The tourism sector has suffered the most from the restrictive measures, but the question of its impact on sustainable development is open. Since crisis phenomena in tourism development primarily worsen the economic and social component of sustainable development, while the environmental component is significantly improved.

Through an analysis of recent published research sources, it was found that all studies related to the economics of tourism and sustainable development have followed two trends. The first group of investigations is related to the study of the conceptual foundations of tourism management in the context of sustainable development. Thus, U. Myga-Piatek (2011) developed the concept of sustainable development in tourism based on the need to strengthen regional identity and preserve natural and cultural diversity. S. Štetić, I. Trišić, A. Nedelcu (2019) prove the necessity and importance of using special nature reserves as a potential for sustainable tourism development. R. Sharpley (2020) explored the theoretical relationship between tourism and sustainable development, looking at the latest approaches and developments in understanding the concept of sustainable development. T. Pimonenko, O. Lyulyov, Y. Us (2021) analysed the relationship between economic growth, environmental performance and tourism development. C. Nguyen, T. Su, (2021) investigated the synergistic effects of tourism and institutional quality on environmental sustainability.

The second group of studies is the debate on how to ensure the sustainable development of European countries through improved tourism. investigated the impact of tourism on economic growth and carbon emissions in the EU East and West. J.-L. Navarro, M.-E. Martínez, J.-A. Jiménez (2020) proposed an integrated approach to measuring sustainable tourism development based on the indicators of the European NUTS 2 regions. A. Băndoi et al. (2020) found on the basis of cluster analysis that tourism development has a positive impact on quality of life. W. Xia et al. (2022) confirmed the existence of a positive relationship between tourism, labour, capital and GDP, indicating the hypothesis of economic growth in European countries due to tourism. investigated the resilience of the tourism industry during the COVID–19 pandemic using statistical data from 35 countries in Europe and developed potential options for post-pandemic tourism recovery harmonised with the global Sustainable Development Goals. S. Paramati, M. Shahbaz, Md. Alam (2017) substantiated the important role of tourism in accelerating economic growth and the need for regulatory policies for sustainable development in its environmental impact (using the Eastern and Western EU as an example). M. Palazzo et al. (2022) developed key scenarios for the recovery of the tourism industry in Europe under the COVID-19 pandemic, aligning them with the global Sustainable Development Goals.

Given the above, in the context of the COVID–19 pandemic, the need for scientific investigation on the impact of the tourism economy on sustainable development in Europe is relevant. The proposed study is a continuation of the authors' preliminary studies on environmental tourism for sustainable development (Oliinyk et al., 2020), regional tourism capacity building in the EU (Pasieka et al., 2021), innovation in sustainable development and geography (Braslavska et al., 2020; Trusova et al., 2021; Omelyanenko et al., 2021).

The main aim of the article is to prove the importance of the economic role of tourism in the sustainable development of European

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countries during the COVID–19 pandemic and to develop optimal post-pandemic measures.

Research methods

The study on the role of tourism in the sustainable development of European countries has been conducted using several main research methods, among which the classification of European countries is the first. European countries have been classified based on each country's membership of the European Union (2022). Thus, the first group of European countries are the 27 countries of the European Union: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovak Republic, Slovenia, Spain, and Sweden. The United Kingdom was part of the European Union, but it withdrew completely on 31 January 2020. The second group of European countries are non-member states that have agreements with the European Union, such as the European Economic Area and Schengen Agreement: Iceland, Liechtenstein, Norway, and Switzerland. The third group of European countries are candidates for European Union membership: Albania, Moldova, Montenegro, North Macedonia, Serbia, Turkey, and Ukraine. The fourth group of European countries are those that have applied for membership in the European Union: Bosnia and Herzegovina, and Georgia. Thus, a sample of 41 European countries was formed for the study.

Investigating the role of tourism in the sustainable development of European countries involves the application of statistical data processing methods. The most popular method is multiple correlation and regression analysis, which is based on constructing a multiple regression equation and calculating certain statistical coefficients to confirm the validity and statistical significance of the resulting model. The main purpose of multiple correlation and regression analysis is to determine the measure of one phenomenon's impact (interpreted as a factors) on another phenomenon (interpreted as an outcome). As the role of tourism in the sustainable development of European countries is investigated, the tourism phenomenon is interpreted as a factor and the sustainable development phenomenon is interpreted as an outcome. Therefore, the results of tourism activities of European countries are identified and their data sets are entered into the multiple regression model as independent variables. At the same time, the sustainable development indicator that most reliably interprets the state of sustainable development of European countries is identified and its data set is entered into the multiple regression model as the dependent variable.

Another important method is to select the type of regression. When choosing the type of regression, the principle of nonlinear economic process should be followed. The most popular nonlinear multiple regression is the power regression. It is widely used in empirical studies of sustainable development (Li, Han, 2012; Tan, Wen, Chen, 2015; Zhang et al., 2017; Soliman, et al., 2018) and tourism studies (Jin, Xu, Huang, Cao, 2014; Kronenberg et al., 2016; Wang, Huang, Luo, Xiao, 2020). Thus, the investigation of the role of tourism in the sustainable development of European countries is based on a multiple power regression modelling algorithm (Figure 1).

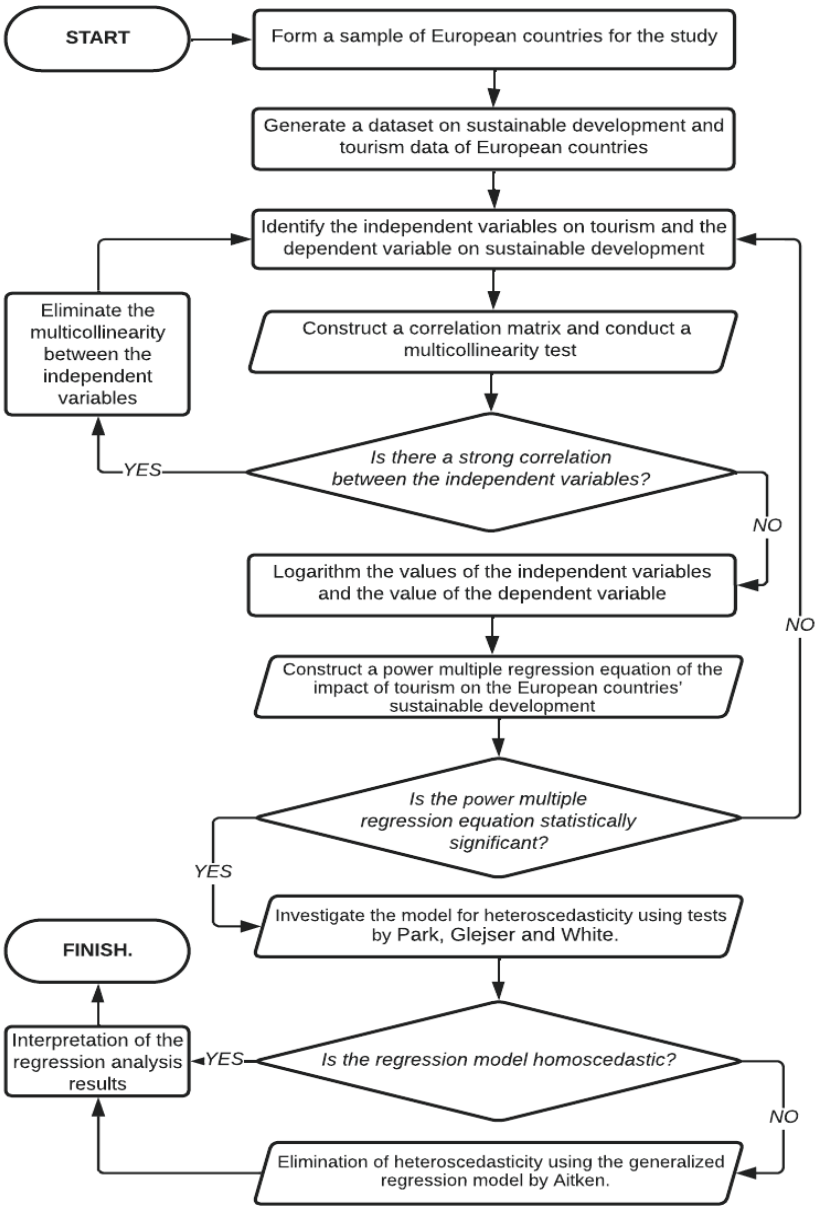

Figure 1. Modelling algorithm for a multiple power regression equation of the tourism impact on sustainable development in European countries

Source: Author's elaboration.

The proposed algorithm fully reveals the methodology for modelling the impact of economic performance of tourism activities on the sustainable development of European countries based on multiple correlation and regression analysis. At the same time, correlation analysis is used to investigate the density of stochastic connection between variables, testing multicollinearity and heteroscedasticity. Regression analysis is used to construct a multiple power regression equation, obtain numerical parameter values, elasticity coefficients and residuals. The parameter of the power function shows by how many percent the numerical value of the corresponding independent variable will change when the numerical value of the dependent variable increases by 1 percent. The regression model residuals are used to account for heteroscedasticity testing by Park, Glejser and White.

Based on the proposed algorithm, data sets of sustainable development and tourism characteristics should be generated. In our view, the most comprehensive indicator of sustainable development is the Sustainable

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Development Goals Index compiled for 165 countries (Sachs et al., 2021), which is an aggregation of 17 equally weighted sub-indices calculated for each Sustainable Development Goal (United Nations, 2022). European countries are ranked according to the Sustainable Development Goals Index (Figure 2).

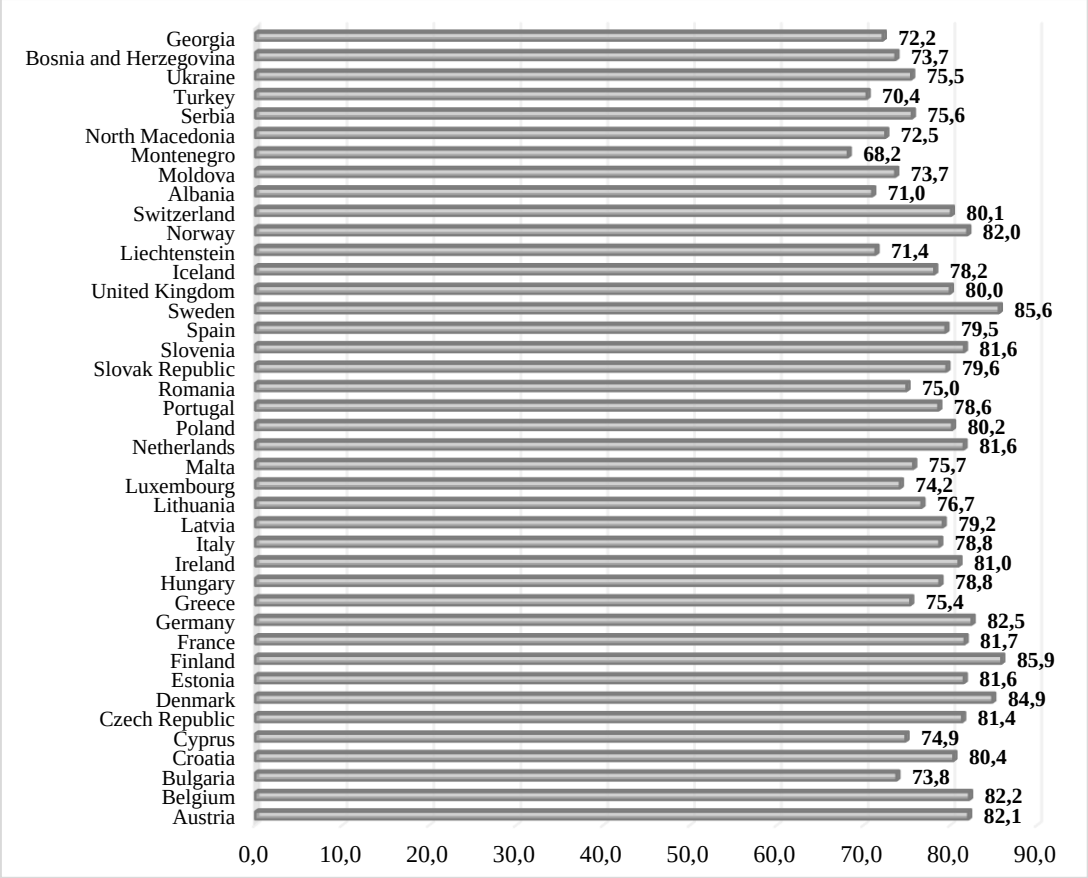

Figure 2. Sustainable Development Goals Index of European countries 2020, score
Source: Formed to the data given in (Sachs et al., 2021, p. 10–11).

Figure 2 shows that EU members Denmark (84.9), Sweden (85.6) and Finland (85.9), also ranked in the top 3 world ranking on Sustainable Development Goals among 165 countries, have the highest level of achievement of the sustainable development goals in Europe. EU candidates Albania (71.0, 64th place in the world ranking), Turkey (70.4, 70th place in the world ranking) and Montenegro (68.2, 85th place in the world ranking) had the lowest Sustainable Development Goals Index in Europe.

Several circumstances have been taken into account in the compilation of indicators reflecting the economic performance of tourism. Firstly, the indicators selected are the same for all European countries. Secondly, the data set presenting the tourism economic performance in European countries has been compiled from open sources (Eurostat, 2022; UNWTO, 2022; WorldData, 2022). Thirdly, data sets have been generated for the year 2020, so far, the last reporting year of the statistical authorities.

The main quantitative economic indicators of tourism activity should be considered the number of tourists and tourist receipts for the year under study. It is clear that the number of tourists is a definite indicator of the tourist attractiveness and tourist competitiveness of a country. The importance of tourism receipts lies in the fact that the funds

spent by tourists in the host country form part of GDP by stimulating sales of tourism, hotel and catering services, and also form part of budgetary revenues through the volume of taxes paid. That is why the study of the economic role of tourism in the sustainable development of European countries is based on the number of tourists and tourism receipts. The derived qualitative economic indicators are revenue per tourist (ratio of tourism receipts to number of tourists) and receipts in % of GDP (percentage ratio of tourism receipts to GDP). Statistics on the given economic indicators of tourism activity for the year are presented in Table 1.

Table 1. Economic performance of European tourism in 2020

European country	Number of tourists, mln persons	Tourism receipts:		
		volume, bln USD	per tourist, USD	% of GDP
	NT	***VR***	R_T	R_{GDP}
Austria	15.09	15.36	1018	3.58
Belgium	2.58	7.45	2888	1.45
Bulgaria	4.97	1.79	360	2.59
Croatia	21.61	5.63	261	10.05
Cyprus	0.63	0.66	1048	2.77
Czech Republic	2.80	3.89	1389	1.60
Denmark	15.60	16.26	1042	4.58
Estonia	1.70	0.87	512	2.81
Finland	0.90	1.76	1956	0.65
France	117.11	35.96	307	1.38
Germany	12.45	58.37	4688	1.53
Greece	7.41	6.19	835	3.27
Hungary	31.64	4.22	133	2.72
Ireland	4.30	4.16	967	0.99
Italy	38.42	20.46	533	1.10
Latvia	3.20	0.80	250	2.39
Lithuania	2.28	0.47	206	0.84
Luxembourg	0.53	4.45	8396	6.10
Malta	0.72	0.42	583	2.88
Netherlands	7.27	10.93	1503	1.20
Poland	8.40	8.38	998	1.41
Portugal	4.21	10.52	2499	4.60
Romania	5.02	1.61	321	0.60
Slovak Republic	0.83	1.30	1566	1.24
Slovenia	1.22	1.42	1164	2.68
Spain	36.41	18.35	504	1.43
Sweden	1.96	4.37	2230	0.81
United Kingdom	11.10	19.10	1721	0.71
Iceland	0.49	0.65	1327	3.00
Liechtenstein	0.06	no data	no data	no data
Norway	1.40	2.20	1571	0.61
Switzerland	10.30	9.99	970	1.34
Albania	2.66	1.24	466	8.38
Montenegro	0.35	0.18	514	3.75
North Macedonia	0.12	0.25	2083	2.03
Serbia	0.45	1.42	3156	2.68
Turkey	15.97	13.77	862	1.91
Bosnia and Herzegovina	0.20	0.44	2200	2.22
Georgia	1.51	0.59	391	3.71
Moldova	0.03	0.35	11667	2.94
Ukraine	3.40	0.69	203	0.44

Source: Formed to the data given in (Eurostat, 2022; UNWTO, 2022; WorldData, 2022).

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Table 1 shows that the leaders in the number of tourists are Spain (36.4 million), Italy (38.4 million) and France (117.1 million), while Italy and France are also leaders in terms of tourist receipts (respectively, Italy received USD 20.5 billion, showing a third result, France received USD 36 billion, showing a second result). Germany received the largest volume of tourism receipts, with USD 58.4 billion. In 2020, the least visited countries were Montenegro (350,000), Bosnia and Herzegovina (200,000), North Macedonia (120,000) and Moldova (30,000). The outsiders in terms of tourism receipts were Moldova (USD 350 million), North Macedonia (USD 250 million) and Montenegro (USD 180 million). Staying in European countries was most expensive in Germany (USD 4,688), Luxembourg (USD 8,396) and Moldova (USD 11,667), and the cheapest in Lithuania (USD 206), Ukraine (USD 203) and Hungary (USD 133). To assess the dependence of national economies on tourism, the share of tourism receipts in GDP should be used. Analysing the value of this indicator, one can understand that such European countries as Finland (0.65 %), Norway (0.61 %), Serbia (0.6 %) and Ukraine (0.44 %) are the least dependent on tourism activity. The highest dependence of national economies on tourism is characteristic of Portugal (4.6 %), Luxembourg (6.1 %), Albania (8.38 %) and Croatia (10.1 %). It is not possible to include Liechtenstein in the modelling, as most of the official statistics are missing.

A dataset on sustainable development indicators and economic performance of tourism activities in European countries was generated (see Figure 2 and Table 1). The identification of the independent variables was then carried out:

1) Number of tourists, mln persons – *NT*;
2) Volume of Receipts, USD bln – *VR*;
3) Receipts per tourist, USD – R_T;
4) Receipts in % of GDP – R_{GDP}.

The dependent variable is defined as the Sustainable Development Goals Index, score – I_{SDG}.

Exactly these variables are introduced in multiple power regression equation of the tourism impact on sustainable development in European countries.

Constructing a correlation matrix by "Data Analysis ⇨ Correlation" in Excel and conducting a multicollinearity test is the next step in the modelling algorithm for a multiple power regression equation of the tourism impact on sustainable development in European countries (see Figure 1). A correlation matrix combines all possible pairwise correlation coefficients (r) between independent variables, calculated according to the formula:

$$r = \frac{n\sum x_{ij} \cdot x_{ij-1} - \sum x_{ij} \sum x_{ij-1}}{\sqrt{n\sum x_{ij}^2 - \left(\sum x_{ij}\right)^2} \cdot \sqrt{n\sum x_{ij-1}^2 - \left(\sum x_{ij-1}\right)^2}}, \quad (1)$$

where x_{ij} is the i-th value of j-th independent variable, $i = \overline{1,2,...,n}$, $j = \overline{1,2,...,m}$;

m is the number of independent variables in the model;

n is the number of values j-th independent variable.

The need for a multicollinearity test is due to the fact that the model will only be statistically valid if the stochastic relationship between the independent variables is low. That is, if a strong stochastic relationship is found between the independent variables, then, according to the algorithm (see Figure 1), one of the independent variables should be removed, or the other one identified and entered.

The test for multicollinearity is conducted according to the methodology (Braslavska et al., 2020), where initially the critical value of the F-test for the paired model is determined and the value of the pairwise correlation coefficient (r_M) from the formula is obtained:

$$F = \frac{r_M^2}{1-r_M^2} \cdot \frac{n-m-1}{m}. \quad (2)$$

The calculated values r_M and $-r_M$ represent the critical values against which each pairwise correlation coefficient from the correlation matrix is compared. If there is a direct stochastic relationship between the independent variables, multicollinearity is fixed if the value of the even correlation coefficient is: $r > r_M$. If there is an inverse stochastic relationship between the independent variables, multicollinearity is fixed if the value of the pairwise correlation coefficient is: $-r < -r_M$.

Thus, according to the proposed algorithm in Figure 1, the investigation of the economic role of tourism in the sustainable development of European countries is based on a multiple power regression formalised by the following general equation:

$$\hat{y}_x = \alpha_0 \cdot x_1^{\alpha_1} \cdot x_2^{\alpha_2} \cdot \ldots \cdot x_m^{\alpha_m}, \quad (3)$$

where $\hat{y}_x$ is the dependent variable;

$x_1, x_2, \ldots, x_m$ are independent variables;

$\alpha_1, \alpha_2, \ldots, \alpha_m$ are the model parameters, showing the percentage change in the dependent variable when the corresponding independent variable increases by 1 %;

α_0 is a constant that indicates the value of the dependent variable when all independent variables acquire the value of 1 or all parameters $\alpha_1, \alpha_2, \ldots, \alpha_m$ are equal to 0.

In order to construct a multiple power regression equation, formula (1) must be converted to logarithmic form:

$$\ln \hat{y}_x = \ln \alpha_0 + \alpha_1 \ln x_1 + \alpha_2 \ln x_2 + \ldots + \alpha_m \ln x_m. \quad (4)$$

The next step is to construct a power multiple regression equation of the impact of tourism on the European countries' sustainable development by "Data Analysis ⇨ Regression" in Excel. The Excel function allows to obtain all necessary statistical indicators to evaluate statistical validity and adequacy of the model, in particular the multiple correlation coefficient R, determination coefficient R^2, F-statistics, t-statistics. No Durbin-Watson statistics are required, as the model does not contain a time series. Therefore, it is sufficient to assume that in our case there can be no residuals autocorrelation.

The final step is to evaluate the model for homoscedasticity, i.e., to prove that the random errors of the model are uncorrelated and have constant dispersion. Otherwise, it is concluded that the model is heteroscedastic, which should be eliminated using the Aitken method (Joreskog, Goldberger, 1972). The test for heteroscedasticity is implemented using methods:

1) Park test involves assessing dependency (Park, 1966):

$$\ln e_i^2 = a + b \ln x_j + v_i, \quad (5)$$

where e_i is i-th residual of model;

v_i is a random remainder;

a and b are parameters whose statistical significance needs to be assessed;

2) Use the Glejser test to find the parameters a and b of a series of equations given by the function (Glejser, 1969):

$$|e_i| = a + bx_j^k + v_i, \quad (6)$$

where k is some number.

3) White test consists in constructing a quadratic function including all factors and their pair products, e.g., for a three-factor model this function is (White, 1980):

$$e_i^2 = a + b_{11}x_1 + b_{12}x_1^2 + b_{21}x_2 + b_{22}x_2^2 + b_{31}x_3 + b_{32}x_3^2 + c_{11}x_1x_2 + c_{12}x_1x_3 + c_{13}x_2x_3 + v_i. \quad (7)$$

In each of the above formulas (5)–(7) the statistical significance parameters are estimated by a t-test. If at least one parameter is statistically significant, then the null hypothesis of homoscedasticity is rejected and heteroscedasticity is concluded. If all parameters turn out to be statistically insignificant, the null hypothesis of homoscedasticity is accepted and the multiple regression equation is used in further research. The White test is carried out if the Park and Glejser tests show opposite results. It is decisive for establishing the absence or presence of heteroscedasticity in a multiple regression model.

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Research results and discussion

According to the modelling algorithm for a multiple power regression equation of the tourism impact on sustainable development in European countries, we construct a correlation matrix (Table 2).

Table 2. Correlation matrix of economic characteristics of tourism and sustainable development of European countries

	NT	***VR***	R_T	R_{GDP}	I_{SDG}
NT	1				
VR	0.5778	1			
R_T	–0.2052	0.0712	1		
R_{GDP}	–0.0584	–0.1384	0.0919	1	
I_{SDG}	0.2093	0.3480	–0.0809	–0.2742	1

Source: Formed and calculated according to the data given in Figure 1 and Table 1 (Sachs et al., 2021, p. 10–11; Eurostat, 2022; UNWTO, 2022; WorldData, 2022).

Table 2 summarises all pairwise correlation coefficients between the independent variables of a multiple power regression model of the economic impact of tourism on sustainable development in European countries. The data from the matrix presented in Table 2 is used to detect multicollinearity between the independent variables according to the algorithm (Braslavska et al., 2020, pp. 634–635):

$$F = 4.0982 = \frac{r_M^2}{1-r_M^2} \cdot \frac{40-1-1}{1} = \frac{38r_M^2}{1-r_M^2};$$
$$38r_M^2 = 4.0982 \cdot (1-r_M^2);$$
$$38r_M^2 = 4.0982 - 4.0982r_M^2;$$
$$42.0982r_M^2 = 4.0982;$$
$$r_M^2 = 0.0973;$$
$$r_M = \sqrt{0.0973} = \pm 0.312, \quad (8)$$

where r is a pairwise correlation coefficient;

4.0982 = FINV(0,05;1;40-1-1) in Excel is the F-test critical value.

From formula (8), there is no multicollinearity between the independent variables if the value of the pairwise correlation coefficient between them is in the range of values:

$$r_M \in [-0.312; 0.312]. \quad (9)$$

If, however, the value of the pairwise correlation coefficient does not fit into the area represented by formula (9), there is multicollinearity between the independent variables and it must be eliminated. Thus, analysing the data in Table 2, we can see that among the six pairwise correlation coefficients only one, between the number of tourists and the volume of receipts, does not belong to the area given in formula (9). Therefore, it is revealed that there is a strong correlation dependence between tourist arrivals and tourism receipts, called multicollinearity, which is eliminated by removing the independent variable *VR* (volume of receipts) from the model.

So, after removing the multicollinearity, the dependent variable Sustainable Development Goals Index (ISDG) and the 3 independent variables: Number of Tourists (*NT*), Receipts per Tourist (R_T), Receipts in % of GDP (R_{GDP}) are entered into a multiple power regression model. The data sets in Figure 2 and Table 1 were converted to logarithms before modelling. This process was the completion of all necessary measures before econometric modelling the economic impact of tourism on the sustainable development of European countries. Next, "Data Analysis ⇨ Regression" in Excel is used to populate the data sets of the independent variables ($\ln NT$, $\ln R_T$, $\ln R_{GDP}$) and the

dependent variable ($\ln I_{SDG}$). Figure 3 shows the simulation results.

SUMMARY OUTPUT

Regression statistics	
Multiple R	0.612255
R Square	0.374856
Adjusted R Square	0.322761
Standard Error	0.045592
Observations	40

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*	*t*
Regression	3	0.044872	0.014957	7.195587*	0.000663	4.646155**
Residual	36	0.074832	0.002079			
Total	39	0.119704				

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	4.193005	0.061470	68.211965***	0.000000	4.068338	4.317672
lnNT	0.018434	0.004939	3.732630***	0.000653	0.008418	0.028449
lnR_T	0.023101	0.008387	2.754453***	0.009161	0.006092	0.040110
lnR_{GDP}	–0.021703	0.010072	–2.154729***	0.037948	–0.042131	–0.001276

** > 4.0982, so the R square is statistically significant;*
*** > 2.0281, so the multiple R is statistically significant;*
**** $t \notin [-2.0244; 2.0244]$, so the regression coefficients are statistically significant.*

Figure 3. Regression analysis results on the economic impact of tourism activities on the European countries' sustainable development levels

Source: Calculated according to the data given in Figure 2, Table 1 and formula (4).

Figure 3 presents the parameters of the three-factor power regression model and the actual values of its statistical estimates. The resulting model of the economic impact of tourism on the sustainable development of European countries is presented in Figure 2 and is statistically significant and credible, as it is described by high values of statistical coefficients and criteria. Thus, the multiple correlation coefficient R = 0.612 confirms the existence of an average correlation between model variables. The multiple determination coefficient $R^2 = 0.375$ means that the dynamics of sustainable development of European countries by 37.5 % is determined by changes in the number of tourists, receipts per tourist, the share of receipts from tourism in GDP. The influence of other factors is 62.5 %, which is fair, because in addition to economic factors, environmental and social factors also influence the sustainable development of the country. It is therefore important to prove the statistical significance of the model using statistical criteria.

The resulting F-test value is 1.8 times its critical value (4.1) and the t-test value is 2.3 times its critical value (2.03), demonstrating the overall statistical significance and validity of Multiple R and R Square. The validity of the model parameters is confirmed by the actual values of the t-test, each of which is greater than 2.02 (critical value). Consequently, the resulting model is statistically significant and valid.

Based on the data in Figure 2, a regression equation in logarithmic form was generated:

$$\ln I_{SDG} = \ln 4.193 + 0.018 \ln NT + 0.023 \ln R_T - 0.022 \ln R_{GDP}. \quad (10)$$

After the necessary algebraic transformations of formula (10), the final three-factor power regression equation for the economic role of tourism in the sustainable

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development of European countries is as follows:

$$I_{SDG} = 66.221 \cdot NT^{0.018} \cdot R_T^{0.023} \cdot R_{GDP}^{-0.022}. \quad (11)$$

The formula (11) shows that a 1 % increase in tourist arrivals leads to a 0.018 % increase in the Sustainable Development Goals Index. A 1 % increase in tourist receipts is accompanied by a 0.023 % increase in the Sustainable Development Goals Index. As the share of tourism receipts in GDP increases by 1 %, the Sustainable Development Goals Index decreases by 0.022 %. The combined growth of all three tourism economic indicators by 1 % is accompanied by the growth of Sustainable Development Goals Index by 0.019 %.

The last step is to test the model for heteroscedasticity, that is, to investigate whether there is a significant dependence of the variance of the random components on the independent variables. For this purpose, the necessary data sets were generated according to formulas (5)–(7), and all necessary operations were carried out to obtain the parameters of the residuals dependence of the regression equation represented by formula (11) on the independent variables NT, R_T, and R_{GDP} (Table 3).

Table 3. Results of a heteroscedasticity investigation of the model

Parameter	Value	t-test
Park test by formula (5)		
b_1	–0.207	–1.021*
b_2	–0.085	–0.242*
b_3	0.413	0.860*
Glejser test by formula (6)		
b_1	–0.0001	–0.057*
b_2	–0.002	–0.489*
b_3	0.005	0.849*
White test by formula (7)		
b_{11}	–0.0003	–0.055*
b_{12}	$2.772 \cdot 10^{-5}$	0.098*
b_{21}	0.006	0.609*
b_{22}	–0.0004	–0.629*
b_{31}	–0.001	–0.149*
b_{32}	0.0002	0.214*
c_{11}	$1.71 \cdot 10^{-6}$	0.003*
c_{12}	0.0004	0.497*
c_{13}	$8.812 \cdot 10^{-5}$	0.099*

* $t \in [-2.028; 2.028]$, *so the regression coefficients that reflect the dependence of the independent variables on the residuals are statistically insignificant.*
Source: Calculated according to the data of Figure 2, Table 1 and formulas (5)–(7).

The data in Table 3 show that the multiple power regression model represented by formula (11) was tested for heteroscedasticity using the Park, Glejser and White tests. All 3 test results confirmed the homoscedasticity of the model of the economic role of tourism in the sustainable development of European countries. Therefore, the resulting model should be considered statistically adequate, valid and does not contradict economic logic.

From the data in formula (11), it can be seen that the greatest impact in percentage terms on the sustainable development of a country comes from the average receipts per tourist. That is, the highest Sustainable Development Goals Index level was enjoyed by those countries with the highest receipts per

tourist. Here it should be understood that the revenue per tourist is related both to expensive tourist costs and to the tourist attractiveness of the destinations and their number in the country, which forces the tourist to stay for longer periods and spend more money. Destination attractiveness is the main driver of tourist growth, i.e., the first independent variable in the model. And rather surprisingly, a third pattern emerged, that the higher the share of tourism receipts in GDP, the lower the level of sustainable development of the country. In other words, countries whose national economies were more dependent on tourism had lower levels of sustainable development. This phenomenon can be explained by the impact of the COVID–19 pandemic, which caused all countries in Europe and the world to close their borders for a long time in 2020, banning restaurants and other catering establishments. Due to quarantine measures and sending employees to work remotely, hotels have also lost a large number of visitors. As a consequence of this, loss in international tourism receipts USD 1.3 trillion; estimated loss in global GDP over USD 2 trillion; loss of international tourist arrivals –74%; 100–120 million direct tourism jobs at risk (World Tourism Organisation, 2020). The consequences of the coronacrisis undermined the economic and social components of sustainable development, while objective improvements in the environmental component failed to mitigate the decline. Therefore, countries where tourism did not play a significant role in the economy had the higher rankings for sustainable development.

Another important aspect of the resulting multiple power regression model is its full suitability for setting and solving optimization problems. The optimisation objective can refer to a short period or a long period. In the short period, the target function is maximised or minimised by changing only one independent variable, while in the long period, all independent variables are maximised or minimised. Setting the optimization challenge: Determine what changes will make it possible to achieve the one per cent average European Sustainable Development Goals Index level over the long period. The solution to the maximisation challenge is to construct an optimisation function, which in our case is of the form:

$$66.221 \cdot NT^{0.018} \cdot R_T^{0.023} \cdot R_{GDP}^{-0.022} \xrightarrow[NT, R_T, R_{GDP}]{} 1.01 I_{SGD}, \quad (12)$$

where $\xrightarrow[NT, R_T, R_{GDP}]{}$ means that optimisation is carried out on all variables.

The results of solving the objective function represented by formula (12) are summarised in Table 4.

Table 4. Results of the average annual level of European countries' sustainable development maximisation over the long period

Indicator	Value in 2020	Optimised value	Difference (+ / –)	
			units of measure	%
Number of tourists, mln persons	9.931	11.306	+1.375	+13.85
Receipts per tourist, USD	1632.2	1915.5	+283.3	+17.35
Receipts in % of GDP	2.524	2.112	–0.412	–0.412
Sustainable Development Goals Index, scores	78.0* 80.3**	81.1	+3.1* +0.8**	+4.0* +1.0**

** Actual value.*

*** Theoretical value calculated from formula (11).*

Source: Calculated according to the data of Table 1, Figure 2 and formula (12) by "Solver" in Excel.

The data in Table 4 show that an average increase of 1.4 million tourists (+13.9 % compared to 2020) is needed to increase the average level of the Sustainable Development Goals Index for European countries by 1 %. Another direction could be to increase the average revenue per tourist by USD 283 (+17.4 % compared to 2020). It is also necessary to ensure that other sectors of the national economy outpace tourism so that tourism's share of GDP declines by 0.4 percentage points. It should be clarified that

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EU real GDP fell by 6.1 % in 2020 (Monks, Verwey, 2021), which has certainly changed the sectoral structure of the national economy. Optimistic projections of post-consolidation growth allow optimising the sectoral structure with the necessary changes in the share of tourism. During a coronacrisis, the proposed measures will minimise risks and ensure that European countries improve their level of sustainable development.

Conclusions

Thus, the study has achieved the main objective of the article to identify the economic role of tourism in the sustainable development of European countries during the COVID–19 pandemic. As a result, the following scientific results were obtained.

Firstly, a sample of European countries has been implemented, in particular 27 countries of the European Union and the United Kingdom, 3 countries which have European Economic Area Agreement and Schengen Agreement with EU, 7 candidates for EU membership, and 2 countries which have applied for membership in the EU.

Secondly, a modelling algorithm for a multiple power regression equation of the tourism impact on sustainable development in European countries is proposed. This algorithm contains a logical sequence of steps from identifying the independent variables of the model variables as economic indicators of tourism and the dependent variable as an indicator of sustainable development, conversion of data sets to logarithms, and testing for multicollinearity and heteroscedasticity.

Thirdly, a long-term optimization challenge is posed and solved using a multiple power regression model of the tourism economy impact on the sustainable development of European countries in the first year of the coronacrisis. It is proved that to increase by 1 % the average European level of Sustainable Development Goals Index in the long-run it is necessary to achieve a 14 % increase in the average annual number of tourists, to increase the average receipts per tourist by 17 % and to optimise the sectoral structure of the economy by reducing the average European dependence on tourism by 0.4 percentage points.

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