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The significance of innovation similarity in the relationship between economy structure changes and economic sustainability in Europe – a spatio-temporal approach

Mateusz Jankiewicz[1, CDFMR], Elżbieta Szulc[2, CDMR]

Nicolaus Copernicus University in Toruń, Faculty of Economic Sciences and Management, Toruń, Poland, [1]e-mail: m.jankiewicz@umk.pl (*corresponding author*), [1]https://orcid.org/0000-0002-4713-778X; [2]e-mail: eszulc@umk.pl, [2]https://orcid.org/0000-0001-5636-0724

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Abstract. The aim of this paper is to assess the significance of the innovation level of countries for achieving economic sustainability in European countries, considering the context of economic structure transformations. The study focuses on 40 selected European countries from 2014 to 2021. Economic sustainability is a crucial issue for governments nowadays and depends on various factors, including ongoing changes in countries' economic structure. The investigation examines the impact of the expansion of the agricultural and services sectors on the economic pillar of Sustainable Development using a spatio-temporal sensitivity model. The level of economic sustainability, as a multidimensional phenomenon, is calculated using a composite indicator. Another determinant of economic development is the level of innovation. The research compares the significance of knowledge diffusion and geographical proximity in achieving economic sustainability. Physical proximity and innovation similarity are included in the analysis as spatial weight matrices necessary for estimating spatial models. The values of the spatial dependence parameters in the spatial autoregressive sensitivity models (SAR) indicate the superiority of one of the considered connections. Additionally, the comparison is made using the values of Moran's I statistics and the Akaike criterion.

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1. Introduction

The economic development is one of the three key issues of Sustainable Development (SD) idea. According to the Triple Bottom Line (TBL) concept presented by Elkington (1997), the justice between economic, social, and environmental development has to be ensured. Establishing a balance between all pillars of SD is hard to achieve because development in one aspect may cause a slowdown in the rest. To measure the level of achievement of Sustainable Development, the United Nations (UN) in 2015 introduced the Sustainable Development Goals (SDGs) concept, which contains 17 main goals (United Nations, 2015). Among them, the goal considered economic development occurs. This is the 8th SD goal (SDG8) entitled "Decent work and economic growth". Its aim is to assess the level of promotion of sustained, inclusive, and sustainable economic growth, employment productivity, and decent work for all. The topic considered through SDG 8 coincides with the economic pillar of Sustainable Development. Therefore, in this study, the economic pillar of SD is identified with the SDG8 achievement.

Nowadays, the modifications in the economic structure are observed (Abdullajnovich, 2022; Han et al. 2020). These transformations are observable through changes in the share of value added by agriculture, industry, and services in Gross Domestic Product (GDP). In the existing literature, the transformations towards the economy servitisation, especially in the case of developed countries, are emphasised. Moreover, the economic modifications significantly influence Sustainable Development. Mainly, the improvement of environmental conditions due to the servitisation process is highly underlined (Plepys et al., 2015; Jankiewicz, 2024). However, through the transformations of the production process by manufacturers towards the application of services, output is growing more dynamically (Opresnik & Taisch, 2015). This means that the focus on services supports economic development, measured mainly by GDP per capita. The opposite situation can be observed in less-developed countries, such as African economies. Most of them exhibit an agricultural character, so the development of this sector provides them with more benefits than economic servitisation (Barrett et al., 2017; Sheahan & Barrett, 2017). The African countries often do not develop the services sector because of their poverty.

The servitisation process is highly linked with digitalisation, which is the result of improvements in countries' innovation levels. The replacement of more and more production stages by digital services causes the acceleration of the production process. The expansion of the digital area requires significant R&D expenses, new inventions, and the expansion of knowledge. These are crucial factors for introducing innovations. Hence, the positive impact of the increase in the innovation level on economic sustainability can be investigated. A very important and increasingly discussed topic is also technological, knowledge, and innovation spillovers (Atkočiūnienė & Miroshnychenko, 2019). This phenomenon allows for the sharing of knowledge between economies to improve economic conditions. In this case, the application of similar innovative solutions can lead to achieving economic sustainability faster than by imitating the solutions of neighbouring countries, for example. Among others, this topic is discussed in this study, and it is the crucial novelty and value added of the research.

2. Literature review

2.1. The assessment of economic sustainability

The topic of the economic issue of SD has been widely discussed so far. Zekhri et al. (2024) analysed the level of SDG8 in 61 selected countries with the division according to economic growth (26 low-income, 20 middle-income, and 15 high-income countries). Additionally, they concluded the positive impact of digitalisation and financial services on economic development. In turn, Alamsyahbana et al. (2024) emphasised the importance of the circular economy in the SDG8 achievement. Skvarciany and Astikė (2022) analysed the economic sustainability implementation in the European Union (EU) countries using multiple criteria decision-making (MCDM) approaches (CRITIC and COPRAS). They concluded about the highest level in this issue in Germany and France. On the other side of ranking were Finland, Latvia, and Slovakia. The MCDM tools were used by Skvarciany and Vidžiūnaitė (2022) to investigate the SDG8 level in BRICS countries. The COPRAS method, enriched with the cluster analysis, was applied in the analysis of the SDG8 level in the EU countries conducted by Bieszk-Stolorz and Dmytrów (2023). Simultaneously, they emphasised the difficulty of obtaining assumed targets until 2030 due to the heterogeneity of economies. The EU countries were among the interests of Vojinic (2024). In her study, the level of SDG8 in the years 2012-2022 was investigated.

She focused on the characteristics of the particular indicators of economic development. Grodzicki (2023) presented the same approach, analysing the SD in Western Balkan countries. In both articles, the indicators introduced by the United Nations were mentioned. Moreover, the progress in the economic sustainability achievement was concluded. In turn, Firlej et al. (2023) underlined the significant influence of the COVID-19 pandemic, which caused a relevant slowdown in the economic sustainability achievement.

2.2. Economy transformations vs. Sustainable Development

The transformation of the economy is one of the main drivers of reaching sustainable development. The positive impact of servitisation of the economy on environmental development is widely mentioned (Li et al., 2010; Hojnik, 2018). Moreover, the relationship between economic transformation and economic growth was analysed. For example, Isiksal and Chimezie (2016) concluded a significant linkage between GDP and agriculture, industry, and services sectors in Nigeria. They presented that an increase in the agricultural sector (by the increase of the share of the added value from agriculture in GDP) causes an improvement in the industrial and services zones, resulting in economic development. Qaiser (2020) showed the driving character of industrial expansion according to economic growth in Pakistan from 1976 to 2015. Phiri et al. (2020) noticed a significant relationship between GDP and improvement in all economic sectors in Zambia, where only the agricultural issue showed a short-run character. In turn, Zhu et al. (2023) focused on the impact of servitisation of the industrial sector on economic development in China. In their analysis, they observed that the quality of economic development is lower in countries with a low level of servitisation of industrial structure.

2.3. Innovations – relationship with economic development and cross-country similarity

Zhu et al. (2023) noted an increase in the quality of economic development due to improved innovation. The importance of the innovation level as the main determinant of economic growth is also emphasised. This aspect of economic growth is also considered by Hysa et al. (2020) conducting research for EU countries. The positive impact of innovations on economic sustainability is presented in studies carried out by Di Simone et al. (2022), Hami et al. (2015), Hofstad and Torfing (2015), Meirun et al. (2021), Omri (2020), and Wang et al. (2021).

Dachs and Pyka (2010) discussed the rising importance of cooperation between countries to explore innovations. They underlined the significance of cross-border patents between two countries. Autant-Bernard et al. (2017) analysed changes in countries' innovation levels, considering the impact of their neighbours. Mainly, they emphasised the ease of supporting the technological innovations transfer through scientific publications and patents that improve production and economic development. According to them, the transfer of knowledge expanding innovations is easy regardless of the geographical location of economies. Zamani and Tayebi (2021) proved that technological and foreign direct investment spillovers support Sustainable Economic Development. Rodríguez-Pose and Crescenzi (2008) considered innovation spillovers, recognising the neighbourhood between countries as geographical proximity. They concluded the significance of geographical location in the transfer of innovations. Nevertheless, other current studies show that the similarity of innovation levels between geographically neighbouring economies does not occur very often. For example, Noseleit (2018) also used the strength of the relationship between renewable energy production in other countries and the renewable production capacity of a given country to construct the spatial weight matrix. This shows that the transfer of innovations can be more strongly linked with similarity in other dimensions than geographical.

The aim of this study is to investigate how innovation performance between countries influences the relationship between changes in economic structure and the achievement of economic sustainability. The research is conducted for 40 selected European countries from 2014 to 2021. Firstly, the level of economic sustainability achievement is calculated using a composite indicator based on the SDG8 indicators. Next, the impact of economy transformations, specifically improvements in the agricultural and services sectors, on economic sustainability in Europe is analysed using the spatio-temporal sensitivity model. Finally, the relevance between geographical proximity and innovation level similarity is compared by applying a spatial econometrics approach (Moran's statistics and spatial models). The geographical neighbourhood and innovation level similarity are included as spatial connection matrices. The approach of considering the innovation level proximity as the spatial weights matrix in the empirical analysis of the relationship

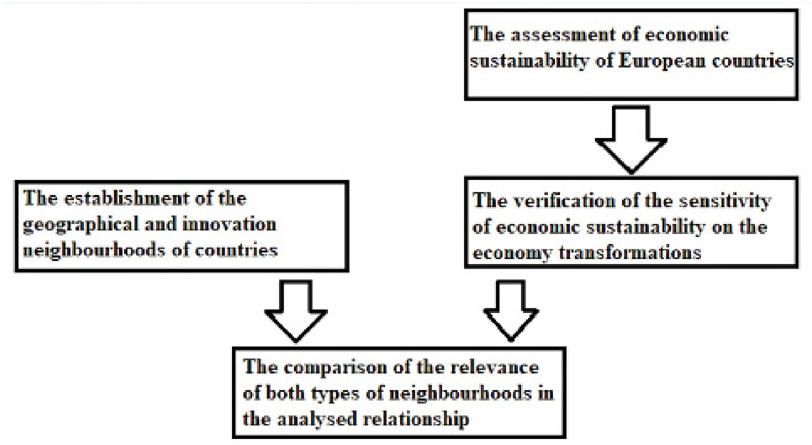

Fig. 1. The research scheme
Source: authors own elaboration

between economic structure modifications and Sustainable Development constitutes the novelty of the research.

Figure 1 presents the research scheme. This study verifies the following hypotheses: (1) Economy servitisation positively influences economic sustainability in Europe, in contrast to agricultural improvement; (2) Connections between countries, calculated based on innovation performance, are more significant for achieving the economic sustainability than geographical proximity. .

3. Research methodology

Because economic development is a multidimensional phenomenon, its level is calculated using a composite indicator (CI). The classical algorithm for establishing CIs requires determining diagnostic variables, aggregating them within the pillar, and calculating the final holistic CI (Kuc-Czarnecka et al., 2020).

In the first stage, the variables are divided into stimulants (phenomena that positively affect economic development) and destimulants (phenomena with the opposite impact of stimulants). Next, the destimulants are transformed into stimulants by inverting their values:

$$x_{pi,t}^{s} = \frac{1}{x_{pi,t}}, \tag{1}$$

where $x^{s}_{pi,t}$ and $x_{pi,t}$ are values of transformed and primary pth variable in ith territorial unit in time t, respectively. When all variables have the same character, values are normalized to provide the comparability of units:

$$z_{pi,t}^{s} = \frac{x_{pi,t}^{s} - \min_i x_{pi,t}^{s}}{\max_i x_{pi,t}^{s} - \min_i x_{pi,t}^{s}}, \tag{2}$$

where $\max_i x^{s}_{pi,t}$ and $\min_i x^{s}_{pi,t}$ are the maximum and minimum values of the p^{th} variable in the whole analysed period, respectively. Normalisation using the same parameters for the whole period allows for comparing the values over time because the relation between variables values does not change. After normalisation the final value of composite indicator of economic sustainability is calculated using the following formula:

$$ES_{i,t} = \frac{\sum_{p=1}^{k} z_{pi,t}^{s}}{k}, \tag{3}$$

where $ES_{i,t}$ constitutes the final value of the economic conditions measure that has values between zero and one. All variables included in the measure are assigned equal weights. Higher values of ES denote better conditions of economic sustainability in European countries.

In the next part of the research, the relationship between economy structure modifications and economic sustainability is verified using the spatio-temporal sensitivity model characterised as follows (Jankiewicz, 2022):

$$\ln(ES_{i,t}) = \xi_1 \ln(SV_{i,t}) + \sum_{k=0}^{p}\sum_{m=0}^{p}\sum_{l=0}^{p} \theta_{kml} x_i^k y_i^m t^l + \varepsilon_{i,t}. \tag{4}$$

where $\ln(ES_{i,t})$ and $\ln(SV_{i,t})$ are the natural logarithms of the economic sustainability level and the share of value added by services in GDP (despite the services' value added, the agricultural value added is also considered). In turn, $\sum_{k=0}^{p}\sum_{m=0}^{p}\sum_{l=0}^{p}\theta_{kml}x_i^k y_i^m t^l$ denotes the spatio-temporal trend component (Schabenberger & Gotway, 2005; Szulc, 2007; Szulc & Jankiewicz, 2018) whereas x_i and y_i are longitude and latitude of *i*th territorial unit, respectively. The role of parameter ξ_1 is to assess the sensitivity of the considered dependence. It measures the percentage change of *ES* value caused by the 1% change in service (agriculture) value added.

$$\ln(ES_{i,t}) = \xi_1 \ln(SV_{i,t}) + \sum_{k=0}^{p}\sum_{m=0}^{p}\sum_{l=0}^{p}\theta_{kml}x_i^k y_i^m t^l + \rho \boldsymbol{W}^* \ln(SC_{i,t}) + \varepsilon_{i,t}, \quad (5)$$

$$\ln(ES_{i,t}) = \xi_1 \ln(SV_{i,t}) + \sum_{k=0}^{p}\sum_{m=0}^{p}\sum_{l=0}^{p}\theta_{kml}x_i^k y_i^m t^l + \rho \boldsymbol{D}^* \ln(SC_{i,t}) + \varepsilon_{i,t}. \quad (6)$$

In models (5) and (6), parameter ρ shows the strength of the similarity in the economic sustainability level between neighbouring countries using matrices $\boldsymbol{W}^*$ and $\boldsymbol{D}^*$. Matrices $\boldsymbol{D}^*$ and $\boldsymbol{W}^*$ are the spatio-temporal connection matrices given as equations (7) and (8). Matrix $\boldsymbol{D}^*$ is built based on the similarity of the innovation levels, and $\boldsymbol{W}^*$ is the neighbourhood matrix defined according to the common land border criterion.

$$\boldsymbol{D}^* = [d_{ij,t}]_{NT\times NT} = \begin{bmatrix} \boldsymbol{D_1} & \boldsymbol{0} & \cdots & \boldsymbol{0} \\ \boldsymbol{0} & \boldsymbol{D_2} & \cdots & \boldsymbol{0} \\ \vdots & \vdots & \ddots & \vdots \\ \boldsymbol{0} & \boldsymbol{0} & \cdots & \boldsymbol{D_T} \end{bmatrix}, \quad (7)$$

$$\boldsymbol{W}^* = [w_{ij,t}]_{NT\times NT} = \begin{bmatrix} \boldsymbol{W_1} & \boldsymbol{0} & \cdots & \boldsymbol{0} \\ \boldsymbol{0} & \boldsymbol{W_2} & \cdots & \boldsymbol{0} \\ \vdots & \vdots & \ddots & \vdots \\ \boldsymbol{0} & \boldsymbol{0} & \cdots & \boldsymbol{W_T} \end{bmatrix}. \quad (8)$$

Matrices $\boldsymbol{D}^*$ and $\boldsymbol{W}^*$ are constant over time, so $\boldsymbol{D}_1 = \boldsymbol{D}_2 = \ldots = \boldsymbol{D}_T$ and $\boldsymbol{W}_1 = \boldsymbol{W}_2 = \ldots = \boldsymbol{W}_T$, where *T* represents the number of years of the study. The calculation of $\boldsymbol{D}^*$ matrix begins with the assessment of Manhattan distance in innovation level values (measured with the Global Innovation Index from 2022) between all pairs of countries. Next, the threshold of similarity is chosen to determine neighbours (the maximum distance allowed). In this study, the 12th percentile of all distances is used. This value is selected to ensure comparability of the densities of matrices $\boldsymbol{D}^*$ and $\boldsymbol{W}^*$. Only in this case, the comparison of connection strengths is most reliable. Simultaneously, the calculated distance for the chosen neighbours is inverted, and the values for non-neighbours are set to zero. Finally, the values in the matrix are standardised by rows to one (Jankiewicz, 2021; Jankiewicz & Szulc, 2021; Grodzicki & Jankiewicz, 2022).

The connections between countries obtained for both matrices are presented in Figure 2. The $\boldsymbol{W}$ matrix contains 136 connections in each year, which corresponds to 8.5% of all available connections. On the other hand, the matrix $\boldsymbol{D}$ contains 156 connections every year, accounting for 9.75% of all available connections. Thus, the densities of both matrices are almost the same. Additionally, the matrices do not show similar connections, which is an advantage in the research. This neighbourhood structure allows for assessing which of the two determinants - geographical location or innovation similarity - is more significant in the analysis of economic sustainability. The appropriate connection structure is chosen using the values of Moran's I statistics and the values of Akaike criterion (AIC) calculated for SAR models (Kubara & Kopczewska, 2024).

4. Data description

The study is conducted using data characterising 40 selected European countries. The selection of this research area allows for a comparison of the differences between European Union economies and non-EU countries in terms of economic sustainability and innovation levels. The time range of the research is from 2014 to 2021. The beginning of the time range is 2014 due to stabilisation after the financial crisis and economic slowdown. Table 1 presents the diagnostic variables that describe the economic sustainability assessment. Due to the lack of data, only a few indicators concerning SDG8 achievement are considered. Among the diagnostic variables are the GDP per capita and the share of R&D expenditures in GDP, which are phenomena that positively affect economic sustainability (stimulants – S). Additionally, the unemployment rate, which has higher values that make economic development worse, is considered a destimulant (D).

In the sensitivity analysis, the shares of added value in GDP coming from the agriculture and services sectors are used. All the mentioned data come from the World Bank Indicators database (2024) and these data were taken directly without modifications.

The values of the Global Innovation Index, which allow for the establishment of connections between countries, also come (directly) from the Global Economy database (2024).

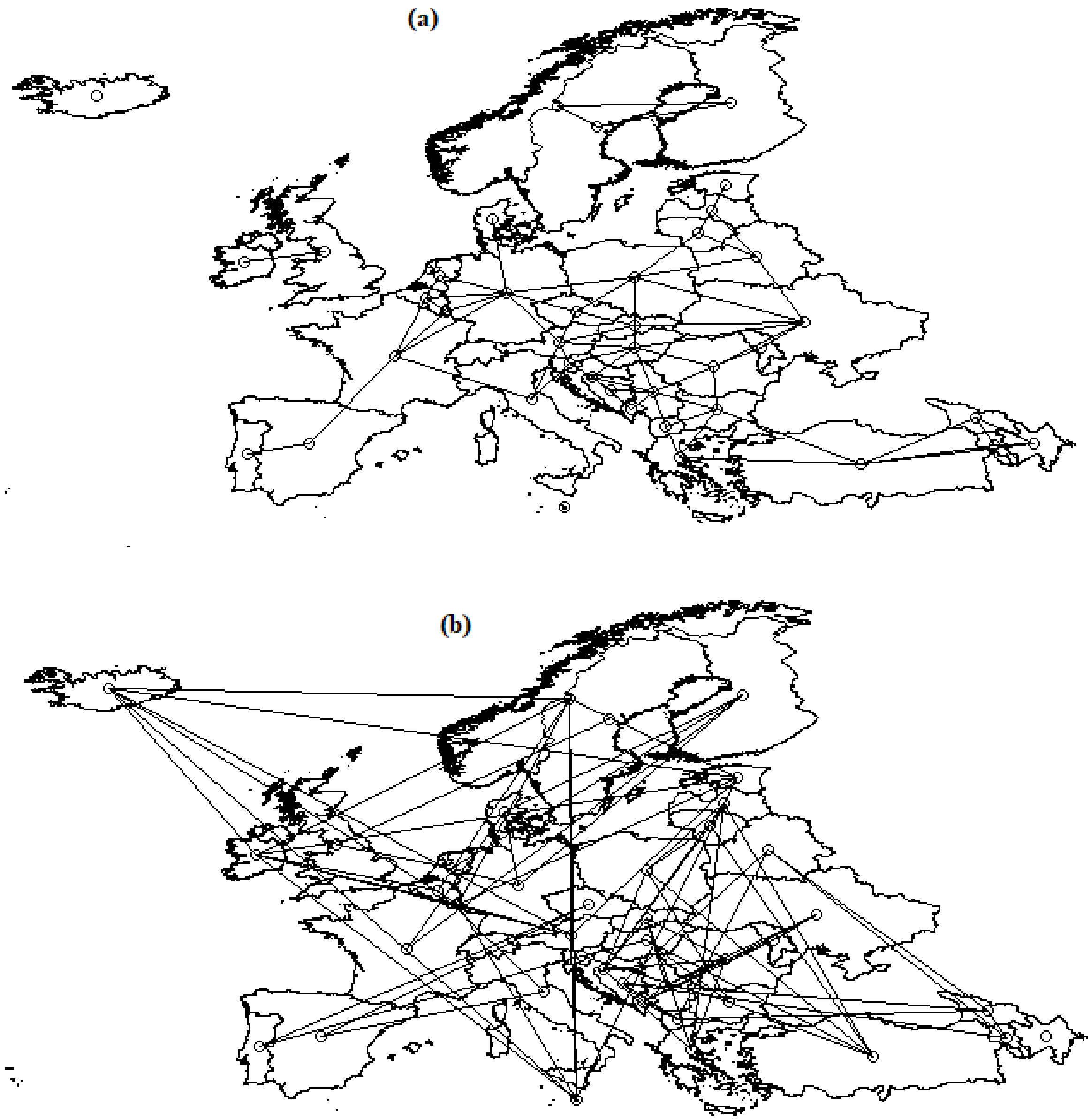

Fig. 2. The connections between countries arising from the common land border criterion (a), and the innovation level similarity (b)
Source: authors own elaboration.

Table 1. The list of diagnostic variables characterizing economic sustainability

Symbol	Description	Character
X_1	Research and Development expenditures (% of GDP)	**S**
X_2	GDP per capita (purchasing power parity – PPP)	**S**
X_3	Unemployment rate (% of total labour force)	**D**

Source: authors own elaboration

5. Empirical results

At the first step of the investigation the level of economic sustainability using the composite indicator is determined. Figure 3 presents the spatial distributions of the economic sustainability measure in the years 2014 – part (a) of Figure 3 and 2021 – (part (b). Countries are divided into four groups using positional measures of descriptive statistics. As we can see, the northern and western parts of Europe are dominated by units belonging to the set with the highest values of considered measure. In both years, only Spain and Portugal showed relatively lower economic development than their geographical neighbours. In 2021 Ireland moved to the group of the best developed states at the expense of France. Countries located in Central Europe were more diversified according to the economic sustainability. In this part of Europe were countries with values of considered measure above median (Czechia, Hungary) and also relatively the worst developed such as Balkan states (Bosnia and Herzegovina, Montenegro, North Macedonia). The eastern part of studied area was dominated by countries with the economic sustainability below the median value of calculated indicator.

The spatial differentiation of economic sustainability did not change significantly between 2014 and 2021. There the certain tendency can be observed. When we move from west to east and from north to south the economic sustainability averagely decrease. Moreover, we can suppose that the neighbouring countries are similar according to the considered process.

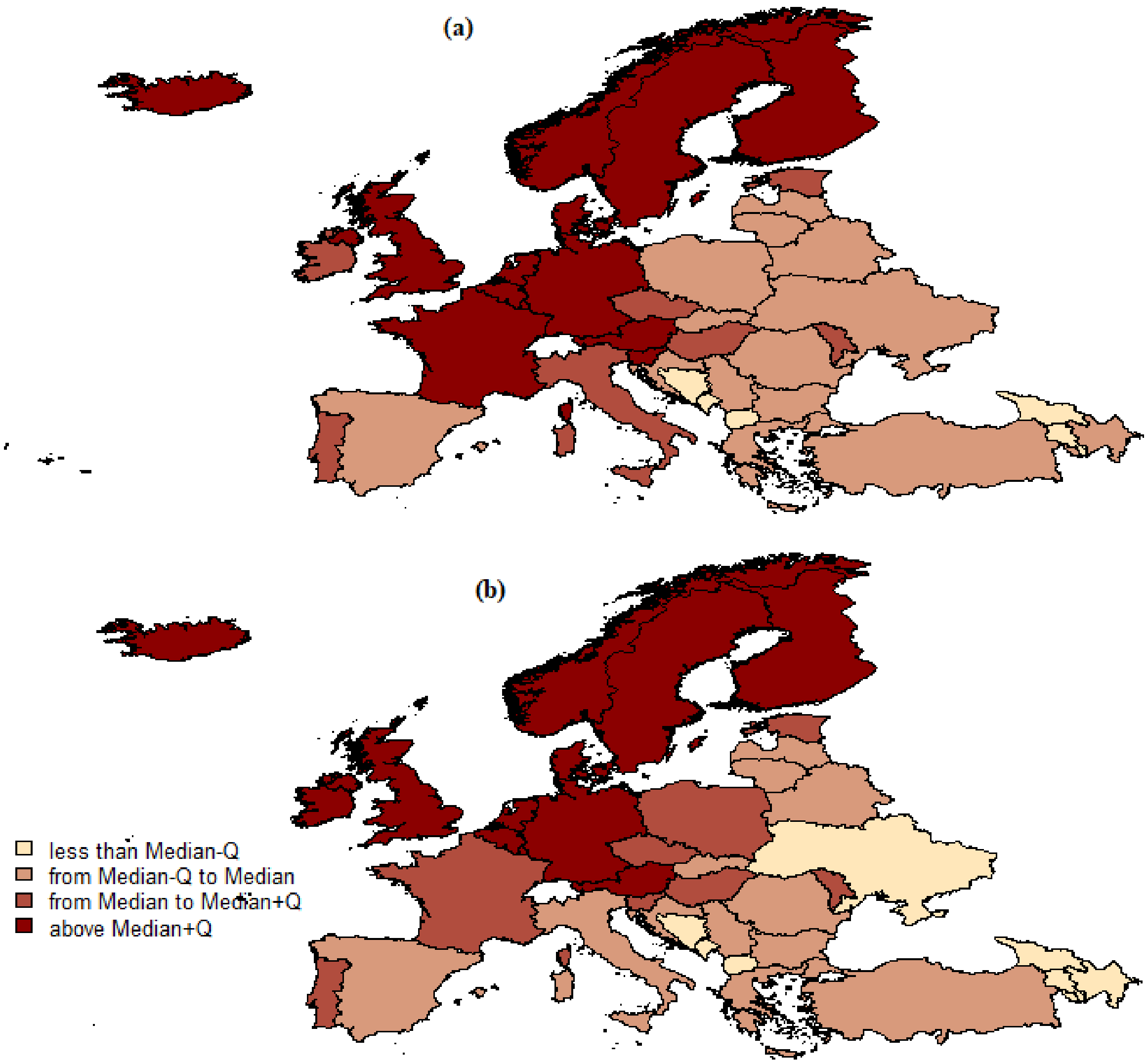

Fig. 3. The spatial differentiation of the economic sustainability level in Europe in 2014 (a) and 2021 (b)
Source: authors own elaboration.

To verify presumptions about the spatial distribution of economic sustainability, the spatio-temporal trend model was estimated and validated. The results are presented in Table 2. Parameters θ_{100} and θ_{010} are statistically significant because the p-value corresponding to the t-statistics is lower than the given significance level (0.05). The negative sign of the parameter θ_{100} indicates a decrease in average economic sustainability indicator values towards the east. In turn, the positive estimate of the parameter θ_{010} denotes the opposite trend (an increase in average values of economic sustainability) towards the north. Therefore, the supposition made based on the Figure 3 was confirmed.

Additionally, the statistically significant parameter θ_{001} with a positive estimate shows an average increase in economic sustainability indicator values between 2014 and 2021. Based on the Moran test and Moran's I statistics, we can conclude that there is spatial autocorrelation in the residuals of the model. The positive value of the I statistics corresponding to the W neighbourhood matrix indicates the similarity of economic sustainability levels in countries that share a common land border. However, when comparing this value with the higher value of Moran statistics calculated with using the D matrix, we can observe that the connections between countries resulting from the similarity of innovation levels are stronger than the connections between neighbouring units in the geographical area. Therefore, while geographical proximity is important in economic development, there are other factors that can have a greater influence on economic sustainability.

Table 3 presents the results of estimation and verification of the spatio-temporal sensitivity models. It shows the relationships between economic sustainability and modifications of the economy structure in the case of expanding the agricultural and services sectors. The most important parameter ξ_1, is statistically significant in both situations. The negative estimate for the link between agricultural expansion and economic sustainability indicates that a 1% increase in the added value in GDP from agriculture leads to a 0.4954% decrease in economic development indicator. Conversely, the positive estimate of this parameter in the second relationship suggests that increasing the value-added in services (economy servitisation) favours economic sustainability.

Regardless of the connections matrix used, the model residuals exhibit spatial autocorrelation. However, the strength of connections between countries with similar levels of innovation (matrix D) is higher than the strength of connections resulting from geographical proximity (matrix W). Based on the LM statistics and their significance, we can conclude that the spatial autoregressive (SAR) model is better than the spatial error (SE) model. This indicates that the economic sustainability level in neighbouring countries is more important to the economic sustainability of a given country than the random phenomena or phenomena omitted in the models. Whenever the LM_{lag} statistics are higher than LM_{err} statistics, and additionally in the relationship between agricultural expansion and economic sustainability considering the matrix D, the RLM_{lag} is statistically significant, contrary to RLM_{err}. Based on these results, it will be possible to compare the importance of geographical and innovation proximities. The same type of spatial model is chosen.

Table 4 presents the results of estimation and verification of spatial autoregressive sensitivity models. The parameter ξ_1 remains statistically significant, but the linkage between economic sustainability and economy structure transformation is weaker than

Table 2. The results of estimation and verification of the spatio-temporal trend model for the economic sustainability

Parameter	Estimate	Standard error	t statistics	p-value
$\boldsymbol{\theta_{000}}$	-2.8839	0.2450	-11.7690	0.0000***
$\boldsymbol{\theta_{100}}$	-0.0302	0.0024	-12.5330	0.0000***
$\boldsymbol{\theta_{010}}$	0.0436	0.0045	9.6850	0.0000***
$\boldsymbol{\theta_{001}}$	0.0512	0.0141	3.6230	0.0003***
		$R^2 = 0.5300$		
Matrix:	$\boldsymbol{W}$		$\boldsymbol{D}$	
Moran's I	0.2410***		0.3264***	
(p-value)	(0.0000)		(0.0000)	

Source: authors own elaboration

Table 3. The results of estimation and verification of the spatio-temporal sensitivity model in case of agricultural and services expansion

Parameter	Agriculture		Services	
	Estimate	**p-value**	**Estimate**	**p-value**
$\boldsymbol{\theta_{000}}$	-2.3167	0.0000***	-9.0316	0.0000***
$\boldsymbol{\theta_{100}}$	-0.0121	0.0000***	-0.0213	0.0000***
$\boldsymbol{\theta_{010}}$	0.0364	0.0000***	0.0450	0.0000***
$\boldsymbol{\theta_{001}}$	0.0434	0.0001***	0.0472	0.0006***
$\boldsymbol{\xi_1}$	-0.4954	0.0000***	1.4532	0.0000***
R^2	0.7045		0.5653	
Matrix:	***W***	***D***	***W***	***D***
Moran's *I*	0.0987**	0.2144***	0.1688***	0.2972***
(p-value)	(0.0166)	(0.0000)	(0.0002)	(0.0000)
LM_{err}	4.6073**	19.3336***	13.4677***	37.1364***
	(0.0318)	(0.0000)	(0.0002)	(0.0000)
LM_{lag}	5.6630**	47.2642**	29.7543***	114.6137***
	(0.0173)	(0.0000)*	(0.0000)	(0.0000)
RLM_{err}	0.0949	0.2495	4.4663**	9.7834***
	(0.7580)	(0.6174)	(0.0346)	(0.0018)
RLM_{lag}	1.1506	28.1801***	20.753***	87.2607***
	(0.2834)	(0.0000)	(0.0000)	(0.0000)

Source: authors own elaboration

Table 4. The results of estimation and verification of the SAR sensitivity model in case of agricultural and services expansion

Parameter	Agriculture		Services	
	SAR_**W**	SAR_**D**	SAR_**W**	SAR_**D**
	Estimate (p-value)	**Estimate (p-value)**	**Estimate (p-value)**	**Estimate (p-value)**
$\boldsymbol{\theta_{000}}$	-2.0203***	-1.9398***	-5.7362***	-5.9525***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
$\boldsymbol{\theta_{100}}$	-0.0093***	-0.0113***	-0.0134***	-0.0154***
	(0.0002)	(0.0000)	(0.0000)	(0.0000)
$\boldsymbol{\theta_{010}}$	0.0320***	0.0321***	0.0323***	0.0348***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
$\boldsymbol{\theta_{001}}$	0.0366***	0.0312***	0.0309**	0.0270**
	(0.0011)	(0.0025)	(0.0148)	(0.0152)
$\boldsymbol{\xi_1}$	-0.4389***	-0.3470***	0.8738***	0.9186***
	(0.0000)	(0.0000)	(0.0010)	(0.0001)
$\boldsymbol{\rho}$	0.1596***	0.2799***	0.3732***	0.4186***
	(0.0088)	(0.0000)	(0.0000)	(0.0000)
Log-lik	-199.8059	-179.7454	-246.2611	-209.9497
AIC	413.6100	373.4900	506.5200	433.9000

Source: authors own elaboration

in the models without spatial dependence. Therefore, the inclusion of connections between neighbouring countries weakens the direct impact of the economy transformations. The greater decrease in the absolute value of the estimation of parameter ξ_1 in the case of agricultural expansion concerns the application of innovation level similarity (SAR_**D**). The opposite situation is in the case of economy servitisation, where the relationship weakens more including the geographical neighbourhood (SAR_**W**). This can be the result of the increasing importance of innovations diffusion in the introduction of services.

The statistical significance of the parameter ρ denotes that the linkages between neighbouring countries are relevant. Nevertheless, the strength of connections is lower when considering the impact of agricultural expansion on economic sustainability. Regardless of the character of the economy transformations, the estimation of parameter ρ is higher when including innovation level similarity than geographical proximity (the value of the parameter is higher for the SAR_**D** model than for the SAR_**W** model). Hence, we can conclude that innovations diffusion is more important for achieving economic sustainability than the geographical neighbourhood. Moreover, the higher values of logarithms of likelihood (Log-lik) and significantly lower values of Akaike criterion (AIC) confirm the superiority of SAR_**D** models over SAR_**W** models.

6. Conclusions

Achievement of economic sustainability is a crucial issue for governments of countries nowadays. One of the goals is to provide decent work and economic growth, which are included in the 8th goal of Sustainable Development. Economic development is characterised by various factors. Hence, this study establishes the level of economic sustainability of European countries using a few indicators presented by the United Nations in 2015. Based on this study, the highest values of economic sustainability were noted in the northern and western parts of the continent. The spatial tendencies showed that the values of calculated indicators decreased towards the east and the south. Importantly, progress in economic sustainability was observed in the considered period. Economic sustainability can be achieved through economy transformation with a focus on the services sector. This linkage was confirmed by the estimation of sensitivity models.

One of the crucial factors influencing economic development is the level of innovation. The question was whether knowledge diffusion between countries with similar levels of innovation is more important than connections between geographical neighbours for economic sustainability. The estimations of spatial models allow for the verification of this question by building spatial weights matrices based on the similarity of Global Innovation Index values and based on the common land border criterion, respectively. The highest values of the spatial parameter in the spatial autoregressive (SAR) models, which include innovation similarity, compared to the models considering geographical neighbourhood, indicate the superiority of the innovation factor over geographical location in the analysis of economic sustainability. The entire investigation positively verifies the formulated research hypotheses. This research answers the question of which is better for economic sustainability: geographical proximity or innovation level similarity. This is the first paper conducting such an analysis. Existing studies consider spatial neighbourhood and economic similarity in the analysis of innovations and sustainable development but do not combine these elements.

From the analysis conducted, we can formulate some implications for policymakers. Firstly, governments formulating innovation policy should take into account the significance of innovation spillovers that highly support sustainable economic development. Moreover, they should expand knowledge about similarities and differences in spatial patterns of knowledge generation and use to adjust the most suitable pattern of innovation development for their country. Finally, policymakers should strive to converge innovation levels with other countries, as achieving common goals in subgroups of countries will be easier, and that is a goal related to sustainable economic growth.

Our further research will focus on testing the simultaneous inclusion of innovation and space - two significant factors in improving economic sustainability. Moreover, the analysis will be carried out in separate regimes, considering the division into developed and developing countries. Additionally, other characteristics that can significantly influence economic sustainability will be considered, such as the poverty rate or Human Development Index (HDI). The impact of the level of industrialisation on economic sustainability will also be added.

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