RevistaEconomică
Journal of economic-financial theory and practice

Vol. 75, issue 2 Year 2023
DOI: 10.56043/reveco-2023-0021

# THE INTERCONNECTIONS BETWEEN ECONOMIC, SOCIAL AND ENVIRONMENT RELATED INDIDCATORS AND THEIR RELATIONSHIP WITH ECONOMIC GROWTH

**Radu RUSU**[1]

*Lucian Blaga University of Sibiu, Romania, 0000-0002-6356-0449*

***Abstract:***
*This study examines the principal components that are characteristic to a varied number of indicators specific to the economic, social and environmental interconnectivity. The data are drawn primarily from the World Bank's WDI, the UNDP's HDI and Our World in Data's Indicators. Using cross-section panel data from 2000 to 2021, for a number of 32 European countries, a considerable number of factors are generated by conducting the principal component analysis. The results of the analysis depict an image where the three-dimensional interconnectivity is described to a greater extent by components such as: the agricultural sector's value added as a percentage of the GDP, the total quantity of primary energy consumed per capita, the percentage of the population that has access to internet, the percentage of individuals that are unemployed, the population density, the total dependency ratio, the industrial sector's value added as a percentage of the GDP and the percentage of the female population that has attained at least secondary education. Together with the GDP, the obtained factors are statistically analysed in order to observe the existing correlations between economic growth and the economic, social and environmental interconnectivity. According to the results of the Pearson correlation, both positive and negative relationships of moderate intensities exist between economic growth and the factors that address the three-dimensional interconnectivity. Furthermore, recommendations are made for future research regarding the creation of an index based on the components that form the factors previously obtained.*

***Keywords:*** *Gross Domestic Product, Primary Energy Consumption, Unemployment, Three-Dimensional Interconnectivity, Principal Components*

***JEL classification:*** *O10, O11, O20, O44, O52*

## 1. Introduction

Given the current global state of every nation, in the previous three years European countries had to face new challenges, such as the COVID-19 pandemic, the Russo-Ukrainian war, overall rising temperatures and pollution related issues (Razzaq et al., 2023). In case no immediate and effective actions are taken by governments worldwide, the average global temperature is expected to increase by more than four degrees Celsius by the end of the 21st century (Wang et al., 2022). As a potential consequence, the world risks to face even greater disasters such as rising seas and oceans' levels due to the melting of glaciers, diminishing capabilities of the food production industry, the extinction of both flora and fauna species, the possible pandemics created by new viruses or diseases and various threats related to pollution and rising global temperatures (SDR 2021; Wang et al.,2021; Zheng et al.,2022).

The COVID-19 pandemic placed countries all over the world at a setback regarding their sustainable development (SDR 2021). This is primarily due to the rising rates of poverty and unemployment alike. Military conflicts generate additional aspects that hinder sustainable development through their negative effects on exacerbating poverty, the lack of food security and the affordable access to energy (SDR, 2022). The world's overall progression toward sustainable development was hindered both in 2021 and 2022, the lower income countries being those that require the largest amount of time to be back on track (SDR, 2021; SDR, 2022).

[1] *raduav.rusu@ulbsibiu.ro*

Vol. 75, issue 2 Year 2023
DOI: 10.56043/reveco-2023-0021

As a solution to these issues caused by the rapid industrial development, among others, governments' focus transitions from economic growth to sustainable development through the means of low-carbon and climate-resilient policies (OECD, 2017). The achievement of sustainable development through the means of environment friendly related policies implies the production and consumption of green energy (Ghouse et al., 2022). Given that the primary and major role of fossil fuels in generating energy will be replaced by green and renewable resources, future economic growth represents an objective that will have accomplished the environment related aspect of sustainable development (Khan et al., 2023). In a spectrum that is characterised by the existence of efficient and regulatory governance mechanisms, green energy is relevant and impactful toward sustainable and inclusive development (Ofori et al., 2022).

The social aspect of sustainability is of equal importance to that of the environment. Therefore, in order to achieve an effective transitions from economic growth to sustainable development, it is imperative that social issues such as unemployment, inequality, education attained and governance are taken into account (Moriña, 2017; Pickett & Wilkinson, 2010; Rodríguez-Martínez et al., 2019; Wasseling, 2021). The interconnectivity between the previously mentioned issues and sustainability also resides in the relationship that these elements, components of inclusiveness, have with digitalization (Ofori et al., 2022). Therefore, it is only fitting to assume that in order to achieve sustainability through the means of digitalization, there is need of people with the appropriate skills and knowledge (Aksin-Sivrikaya, & Bhattacharya, 2017; Colás Bravo et al., 2021).

The economic dimension of the addressed interconnectivity resides in the importance that effective governance has toward the achievement of sustainable development, through the means of the control of corruption, the rule of law, the government effectiveness, the regulatory quality, the political stability and the citizens' freedoms (Ding et al., 2023; Ofori et al., 2022; Wang et al., 2022). Inflation, as an economic related indicator, intersects with the social aspect of inclusiveness and sustainability, to the extent that it has a rather accentuated negative impact on those individuals that are less wealthy (Ofori et al., 2022; Ofori & Asongu, 2021). Therefore, in order for economic growth to be sustainable it must be inclusive; as a consequence, effective governance is needed in order to maintain the stability of these macroeconomic indicators. (Güney, 2017).

In addition to effective governance mechanisms, education and innovation dictate a country's ability to develop in a sustainable manner (Little & Green, 2009; Silvestre & Ţîrcă, 2019). Given the current global issues related to pollution and rising global temperatures, innovative ways for generating and consuming energy are needed. Therefore, through the means of investments in education and later on in research, can a country develop technologies needed to address issues such as the mitigation of the negative effects generated by climate change, and the predominant consumption of green energy (Razzaq et al., 2023; van der Waal et al., 2021; Wang et al., 2019).

## 2. Literature review and hypotheses

### 2.1. Research on the economic dimension of sustainable development

From a practical perspective, this paper analyses the interconnection between aspects related to the economic, environment and social dimensions of sustainability (Alsayegh et al., 2020). The economic dimension addresses subjects such as: inflation, trade openness, globalization, industrial upgrading and the government final consumption expenditure. The choice of indicators is similar to that of Ofori et al., 2022 and Wang et al., 2022. To present day, existing economic growth was made possible largely due to the consumption of natural resources, resources that were not entirely regenerable. Therefore, in order to make economic growth prolonged in the future and for countries to be able to sustainably develop, there is need of new economic growth patterns that have at their core the consumption of renewable resources (Cerdeira Bento & Moutinho, 2016; Pao & Fu, 2013).

The relevance of the relationship between the economic dimension and sustainability is given by the fact that: trade openness positively influences both inclusiveness and economic growth (Ofori et al.,

Vol. 75, issue 2 Year 2023
DOI: 10.56043/reveco-2023-0021

2022) ; the degree of government intervention has a beneficial impact toward sustainable development through the means of green growth (Razzaq et al., 2023; Wang et al., 2022); inflation negatively influences sustainability by hindering economic development (Ozturk & Ullah, 2022); foreign direct investments are shown to both positively influence economic growth and negatively influence the amount of CO2 emissions, thus proving determinant toward sustainable development (Ghouse et al., 2022; Ofori & Asongu, 2021; Ozturk & Ullah, 2022).

The economic, social and environment's interconnectivity are further accentuated by the fact that a country's level of economic development is statistically related to its degree of inclusiveness and sustainability (Ofori et al., 2022). This is due to the fact that a nation's wealth ( its degree of economic development ) should be directly proportional with its investments in education and research (Little & Green, 2009). As a consequence of such investments, the overall level of existing human capital is subject to quantitative increases and qualitative enhancements (Colás Bravo et al., 2021; Moriña, 2017). With regard to the objective of achieving sustainable development, human capital is shown to positively influence inclusiveness, sustainability, and green economic growth (Khan et al., 2023; Lee et al., 2022; Ofori & Asongu, 2021; Wang et al., 2022).

With regard to the work of the above researchers and the chosen indicators reflecting the economic aspect of sustainable development, the following hypothesis is proposed:

*Hypothesis 1: Economic related indicators are primary determinants of the three-dimensional interconnectivity's principal factors.*

2.2. Research on the environment dimension of sustainable development

Within the structure of sustainable development, the transition from the economic aspects to those related to the environment is dictated by the degree by which renewable resources have replaced non-renewable and pollutant resources (OECD 2017; OECD 2022; Zheng et al.,2022). The reduction of the CO2 emissions is a global objective targeted by every country (Ding et al. 2023). However, countries that experience a more advanced level of economic development must take immediate action toward lowering their negative spill-over effects and pollutant emissions, with respect both to the environment and their neighbouring countries (Cerdeira Bento & Moutinho, 2016; SDR 2021).

In the aftermath of economic growth due to the consumption of renewable and non-renewable resources, a country extends its degree of urbanization, its infrastructure capabilities and it has lower stocks of natural resource (Khan et al., 2023). As a solution to this sustainability related issues, investments in green technologies research prove beneficial (Wang et al., 2021; Wang et al., 2022). Therefore, investments in green growth that imply the creation of patents related to green technologies are responsible for lowering the emissions of CO2 as well as for the transition toward the production of electricity from renewable resources (Pao & Fu, 2013; Razzaq et al., 2023).

Green research expenditure leads to technological innovation that accentuates the energetical efficiency (Ofori et al.,2022). The environment dimension of the three-dimensional interconnectivity includes issues related to those of natural resources besides those related to energy or pollutant emissions (Cerdeira Bento & Moutinho, 2016; Khan et al., 2023). Therefore, elements such as agricultural area and forest area, among others, are valid determinants that describe the end goal of sustainable development (Lee et al., 2022).

Sustainable development, seen through the environment friendly actions, implies an adjacent focus on inclusiveness. Various studies that address inclusiveness include in its sphere of reference elements that represent the materialization of pollution's negative effects on the population (Ofori et al.,2022). These types of elements refer to the fine particles (PM2.5) that have a diameter of 2.5 μm or less and are generally created in the aftermath of combustion activities. Their negative effects on human welfare, premature deaths, welfare costs and the degree of exposure to such particles are components that are included in various studies regarding inclusiveness and sustainability (Lee et al., 2022; Ofori et al., 2022; Wang et al., 2022).

Vol. 75, issue 2 Year 2023
DOI: 10.56043/reveco-2023-0021

In the light of the above-mentioned aspects that reflect the environmental dimension of the studied interconnectivity, the following hypothesis is proposed:

*Hypothesis 2: The elements reflecting the environment dimension account for a distinctive principal factor.*

2.3. Research on the social dimension of sustainable development

The social dimension strongly reflects the expected positive effects that sustainable development has on the population (Güney, 2017; Little & Green, 2009). The population's level of education reflected through the mean or expected years of schooling, the employment rate, the total unemployment rate ( and the advanced unemployment rate) are indicators that reflect both the social dimension and the intersection between social and economic (Dong et al., 2022; Ghouse et al., 2022). These all reflect quantitative and qualitative dimension of the human capital, which is show to positively influence inclusiveness, green innovation, energy consumption and development (Ofori & Asongu 2021; Khan et al., 2023).

Apart from human capital, the social dimension of sustainability is characterised by aspects related to the population's overall welfare, which in turn are components of inclusiveness (Ofori et al., 2022). Such components refer to the population's access to safely managed water services, safely managed sanitation services, clean cooking oils and technologies, the total dependency ration, life expectancy at birth, child mortality rate, and the list may continue (SDR, 2022). Through statistical analyses, these indicators have been proven to be relevant in depicting the image of inclusiveness. Consequently, from the point of view of creating a composite index, inflation and vulnerable employment have negative influences on sustainable development (Ofori & Asongu, 2021; Ofori et al., 2022).

At the opposite pole, between the interactions of elements specific to the three-dimensional interconnectivity, governance, trade openness and digitalization appear to be positively influencing sustainable development through the means of inclusiveness (Alsayegh et al, 2020; Razzaq et al., 2023; Wang et al., 2022). The efficiency of governments, primarily reflected by the six dimensions of the World Governance Indicators as well as by the governments final consumption expenditure, is a major determinant of sustainable development, given its positive influences on inclusiveness, digitalization and energy efficiency (Aksin-Sivrikaya, & Bhattacharya, 2017; Güney, 2017; Ofori et al., 2022).

Digitalization is the result of the intersection between economic, environment and social related factors (Ofori & Asongu, 2021; Wang et al., 2022). It is positively influencing sustainable development through the means of inclusiveness (Ofori & Asongu, 2021; Ozturk & Ullah, 2022). Its implications for environment friendly policies are relevant, given the fact that it is negatively correlated with the level of carbon intensity and positively correlated with the carbon sequestration capacity (Ding et al., 2023; Lee et al., 2022). Furthermore, component factors specific to digitalization such as internet usage, mobile and fixed broadband subscriptions, technology's availability to households are relevant indicators that are applied in the construction of various indexes that reflect either inclusiveness, or digital development (Dong et al., 2022; Wang et al., 2022).

By outlining the vast implications and interconnections that the social dimension has with the objective of sustainable development, as a whole, the following hypotheses are set to be tested:

*Hypothesis 3: The elements reflecting the social dimension are characteristic to each and every principal factor generated.*

*Hypothesis 4: Digitalization related indicators form a distinctive principal factor.*

## 3. Methodology

Beginning from a theoretical point of view, the current study sets to analyse the contribution and relevance of elements representative to each of the planes that form the three-dimensional interconnectivity characterised by economic, environmental and social aspects (Hosseini & Kaneko,

Vol. 75, issue 2 Year 2023
DOI: 10.56043/reveco-2023-0021

2011; Lamichhane et al., 2021). Given that sustainable development is an objective composed of various subobjectives, which in part reflect aspects related to the three dimensions previously mentioned, principal component analysis is the primary method of analysis implemented within this paper (Tan & Lu, 2016).

On the other hand, sustainable development has been addressed through the means of inclusiveness or energy internet, which in turn represent indexes that are not available in databases, thus they are required to be generated by using methods such as PCA (Ofori et al., 2022; Wang et al., 2022). Although the main objective of this study is not the creation of a sustainable development index, the results of the conducted PCA will prove beneficial for future research that focuses in the previously mentioned task.

In addition, PCA is a method appropriate not only for the creation of indexes, but also for the reduction of large volumes of data without diminishing the quality of the data they contain (Hansmann et al.,2012; Hosseini & Kaneko, 2011). Therefore, with regard to the present study, PCA will prove useful in retaining the variation of the elements characteristic to the three-dimensional interconnectivity (Ofori & Asongu, 2021).

A close follow up to the PCA is the Pearson Correlation test that will be conducted between the economic growth, represented by gross domestic product per capita, and the primary principal factors obtained by running the PCA. As a consequence, the transition from economic growth to sustainable development will be further justified by the degree by which principal factors, that contain elements related to sustainable development, correlate to raw economic growth.

Data-wise, this study employs macro data that covers a range of 22 years, from 2000 to 2021, and a number of 32 European countries. The number of indicators used for the two analysis, PCA and Pearson Correlation, counts up to 32. To the author's knowledge, there are no studies that address the relationship between components of sustainable development and economic growth through the means of principal component analysis for European countries for a broad span of years.

Lamichhane et al. (2021) set to study sustainability through the means of the Sustainable Development Goals by conducting a principal component analysis for the years 2017 and 2018 for a number of 35 OECD countries. Their findings have shown differences when it comes to the index generated by conducting PCA and the SDGs' Index for low performing countries, whereas, little to no differences were observed for top tier countries. Sustainable development, as seen through the importance of inclusiveness, was addressed in various research that applied PCA in order to study influences on inclusive growth (Ofori & Asongu, 2021; Ofori et al., 2022). Their findings, for a number of 23 African countries from 2000 to 2020, have shown that inclusiveness is positively influenced by digitalization and governance. In addition, a similar method of research was conducted in order to obtain an energy internet index that was later used in regressing for green economic growth (Wang et al.,2022). The results, for a number of 30 Chinese provinces from 2006 to 2018, show that foreign direct investment and the generated index positively influence green economic growth. Furthermore, regarding the Bohai Region, China, from 2001-2010 the authors Tan & Lu (2016) conducted a principal component analysis in order to study sustainable development. Their results point at the importance that the environment dimension plays toward sustainability.

**Table 1: Indicators' data sources and definitions**

| Variable | Symbol | Definition | Source |
|---|---|---|---|
| Economic growth | GDP | GDP per capita (constant 2015 USD) | WDI |
| ***Economic dimension*** | | | |
| Agriculture value added | AGR | Proportion of the value added by the agriculture sector to GDP | WDI |
| Foreign direct investment | FDI | Net foreign direct inflow (% GDP) | WDI |
| Globalization | GLB | KOFGI Globalization index | KOFGI |
| Government expenditure | GOV | Government final consumption expenditure (% of GDP) | WDI |
| Industry value added | IND | Proportion of the value added by the industry sector to GDP | WDI |
| Inflation (annual percentage) | INFA | Consumer price annual change in percentages | WDI |
| Inflation (cumulative) | INFC | Consumer price change cumulated (2000 = 100 %) | WDI |
| Services value added | SRV | Proportion of the value added by the services sector to GDP | WDI |
| Trade openness | TRD | Sum of imports and exports (% of GDP) | WDI |

Vol. 75, issue 2 Year 2023
DOI: 10.56043/reveco-2023-0021

| | | | |
|---|---|---|---|
| ***Environment dimension*** | | | |
| Agricultural land | FA | Forest area (% of total land area) | WDI |
| CO2 emissions per capita | CO2 | CO2 emissions, annual billion tonne per capita | OWD |
| Electricity consumption per capita | EC | Electricity net consumption, kWh per capita | EIA |
| Exposure to Ambient PM.2.5 | PM25 | Mean population exposure to PM2.5 (Micrograms per cubic metre) | OWD |
| Forest cover | AGA | Agriculture area (% of total land area) | WDI |
| Primary energy consumption per capita | PEC | Primary energy consumption, mWh per capita | EIA |
| ***Social dimension*** | | | |
| Child mortality rate | CMR | The number of child deaths per 1000 children | OWD |
| Clean fuels and technologies for cooking | CLN | Access to clean fuels and technologies for cooking (% of population) | WDI |
| Expected years of schooling | EYP | Expected number of years of schooling at birth | HDI |
| Fixed broadband subscriptions | FBB | Fixed broadband subscriptions (per 100 inhabitants) | WDI |
| Governance (average of WGI) | WGI | Corruption, Law, Effectiveness, Regulatory quality, Political stability, Voice & accountability | WGI |
| Internet access (% of population) | INT | Individuals using the Internet (% of population) | WDI |
| Labour force participation rate, female | LFPF | Employed female workers (% of active female population) | WDI |
| Life expectancy at birth | LIFE | The expected years of life at birth | HDI |
| Mobile subscription | MOB | Mobile subscription per 100 inhabitants | WDI |
| Population density | PD | Number of inhabitants per $1km^2$ | OWD |
| Population with secondary education, female | PSEF | Population with at least some secondary education, female (% of total) | WDI |
| Share of seats in parliament, female | SPF | Seats held in parliament by women (% of total) | WDI |
| Total dependency ratio | TDR | The ratio of youth and elderly population per 100 active workers of age 15-64 | OWD |
| Unemployment with advanced education | UAE | Unemployment with advanced education (% of total) | WDI |
| Unemployment | UT | Total unemployment rate | WDI |
| Urbanization | URB | Population living in urban areas (% of total population) | WDI |

Source: Author's construct based on the available data, 2023

Table 1 contains the 32 indicators that are the subjects of the following analyses. The data sources are as follows: WDI stands for World Development Indicators, WGI stands for World Governance Indicators, HDI stands for Human Development Index, OWD stand for Our World in Data, EIA stands for U.S. Energy Information Administration, KOFGI stands for Konjunkturforschungsstelle Globalization Index. Indicators provided by the previously mentioned sources are widely used in studies that address sustainable development, inclusive growth, transitions toward green/renewable energy sources (Hosseini & Kaneko, 2011; Ofori et al., 2022). The grouping of the variables regarding the three dimensions set is similar to the approach of Ozturk & Ullah, 2022 and Ofori & Asongu, 2021.

Given the different scales in which the chosen indicators are represented, the data were normalized prior to the principal component analysis, so that the mean will be equal to 0 and the standard deviation will be equal to 1. This work method is similar to that of Lamichhane et al (2021), Ofori & Asongu (2021) and Ofori et al (2022), where macro data is being analysed. As can be observed in table 2, among the 32 chosen indicators there are various intervals from which the data are taking values, thus the relevance of the process of data normalization is further justified.

**Table 2: Indicators' descriptive statistics**

| Variable | Symbol | OBS | MEAN | Std. DEV | MIN | MAX |
|---|---|---|---|---|---|---|
| Economic growth | GDP | 704 | 31842.58 | 23958.28 | 1337.86 | 112417.9 |
| ***Economic dimension*** | | | | | | |
| Agriculture value added | AGR | 704 | 3.12 | 2.98 | 0.2 | 25.41 |
| Foreign direct investment | FDI | 695 | 7.55 | 23.03 | -57.53 | 279.35 |
| Globalization | GLB | 704 | 80.09 | 7.97 | 48.92 | 91.14 |
| Government expenditure | GOV | 704 | 19.39 | 3.47 | 10.42 | 27.93 |
| Industry value added | IND | 704 | 24.38 | 5.7 | 9.97 | 40.29 |
| Inflation (annual percentage) | INFA | 704 | 3.66 | 6.75 | -4.48 | 95.01 |
| Inflation (cumulative) | INFC | 704 | 208.28 | 232.28 | 100.9 | 2367.99 |
| Services value added | SRV | 704 | 61.39 | 7.16 | 40.28 | 80.08 |
| Trade openness | TRD | 704 | 104.56 | 53.86 | 22.49 | 388.12 |
| ***Environment dimension*** | | | | | | |
| Agricultural land | FA | 704 | 41.44 | 18.88 | 2.69 | 77.37 |
| CO2 emissions per capita | CO2 | 704 | 7.91 | 3.52 | 1.22 | 25.99 |
| Electricity consumption per capita | EC | 704 | 7.62 | 8.03 | 1.2 | 54.44 |
| Exposure to Ambient PM.2.5 | PM25 | 704 | 15.56 | 6.21 | 4.95 | 35.04 |
| Forest cover | AGA | 704 | 33.29 | 16.69 | 0.3 | 73.76 |
| Primary energy consumption per capita | PEC | 704 | 47.03 | 29.46 | 7.67 | 197.39 |
| ***Social dimension*** | | | | | | |
| Child mortality rate | CMR | 704 | 0.64 | 0.49 | 0.15 | 3.8 |
| Clean fuels and technologies for cooking | CLN | 704 | 97.19 | 7.52 | 57.6 | 100 |
| Expected years of schooling | EYP | 704 | 16.02 | 1.81 | 9.84 | 20.03 |
| Fixed broadband subscriptions | FBB | 704 | 21.2 | 13.71 | 0 | 47.5 |
| Governance ( average of WGI ) | WGI | 704 | 0.96 | 0.7 | -1.07 | 1.95 |
| Internet access (% of population) | INT | 704 | 63.76 | 25.85 | 1.28 | 99.69 |
| Labour force participation rate, female | LFPF | 704 | 52 | 7.93 | 23.18 | 73.74 |
| Life expectancy at birth | LIFE | 704 | 78.02 | 3.96 | 65.14 | 83.99 |

Vol. 75, issue 2 Year 2023
DOI: 10.56043/reveco-2023-0021

| | | | | | | |
|---|---|---|---|---|---|---|
| Mobile subscription | MOB | 704 | 107.25 | 31.05 | 2.23 | 172.15 |
| Population density | PD | 704 | 121.64 | 103.22 | 2.81 | 519.79 |
| Population with secondary education, female | PSEF | 704 | 82.98 | 16.81 | 16.92 | 100 |
| Share of seats in parliament, female | SPF | 704 | 25.3 | 10.52 | 4.18 | 47.62 |
| Total dependency ratio | TDR | 704 | 49.57 | 4.92 | 38.66 | 63.12 |
| Unemployment with advanced education | UAE | 704 | 5.11 | 3.15 | 1 | 20.86 |
| Unemployment | UT | 704 | 8.14 | 4.53 | 0.79 | 27.69 |
| Urbanization | URB | 704 | 71.83 | 12.86 | 42.49 | 98.12 |

Source: Author's construct based on the available data, 2023

## 4. Results and discussion

This paper addresses the various implications that the economic, environment and social dimensions have on sustainable development. The three-dimensional interconnectivity is constructed by using the indicators presented in table 1. Although the number of indicators-components is not evenly distributed among the three dimensions, the chosen elements are relevant for the current analysis. Table 3 provides valuable insight regarding the extent by which the specific elements characterise the variation of the three-dimensional interconnectivity. As can be seen in columns one and four, the first component explains up to 34.34% of the total variation of the whole 31 components (economic growth, reflected through gross domestic product is not a subject of the principal component analysis).

Furthermore, considering those elements that present an eigenvalue greater than 1, the number of principal components identified extends up to 8. As a consequence, the cumulative variance explained by the 8 principal components amount to 78.90%. Therefore, out of the 31 indicators, 8 of them approximatively explain 78.90% of the total variance. The scree plot of the representative eigenvalues can be seen in figure 1.

**Table 3: Principal components' eigenvalues and relevance toward sustainable development**

| Component | Initial Eigenvalues | | | Extraction Sums of Squared Loadings | | | Rotation Sums of Squared Loadings | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % |
| 1 | 10.65 | 34.34 | 34.34 | 10.65 | 34.34 | 34.34 | 6.14 | 19.79 | 19.79 |
| 2 | 3.24 | 10.46 | 44.80 | 3.24 | 10.46 | 44.80 | 3.86 | 12.45 | 32.24 |
| 3 | 2.58 | 8.32 | 53.13 | 2.58 | 8.32 | 53.13 | 3.58 | 11.56 | 43.80 |
| 4 | 2.18 | 7.03 | 60.15 | 2.18 | 7.03 | 60.15 | 2.51 | 8.10 | 51.90 |
| 5 | 1.90 | 6.14 | 66.29 | 1.90 | 6.14 | 66.29 | 2.27 | 7.32 | 59.21 |
| 6 | 1.65 | 5.32 | 71.61 | 1.65 | 5.32 | 71.61 | 2.24 | 7.22 | 66.43 |
| 7 | 1.26 | 4.05 | 75.65 | 1.26 | 4.05 | 75.65 | 2.13 | 6.88 | 73.31 |
| 8 | 1.01 | 3.25 | 78.90 | 1.01 | 3.25 | 78.90 | 1.73 | 5.59 | 78.90 |
| 9 | 0.98 | 3.15 | 82.05 | | | | | | |
| 10 | 0.82 | 2.64 | 84.69 | | | | | | |

Extraction Method: Principal Component Analysis.

Source: Author's construct based on the available data, 2023

Given that by conducting the PCA, a number of 8 principal components have been identified, the structure of the following 8 principal factors must be addressed with regard to the 31 selected indicators. Table 4 contains the rotated component matrix, which presents the coefficients given to each indicator regarding its relevance toward the construction of the 8 principal factors. The first principal factor is composed of 13 indicators-components. Out of these 13 indicators, only 7 present a coefficient which has an absolute value greater than 0.6 As a consequence, the first factor that reflects sustainable development is characterised by economic aspects such as industrial upgrading, given the negative coefficient of agriculture value added and the negative implications that inflation has on overall sustainability and inclusiveness. Furthermore, the other 4 coefficients, representative to the social dimension, consolidate the first principal factor by adding: the positive implications that governance effectiveness has on sustainability, the importance of the population's overall access to clean fuels and technologies for cooking, the reflection of the health and education investments related to life expectancy at birth. The social dimension's implication toward sustainable development also implies a negative effect through the child mortality rate. Given that both the economic and the social dimension play even parts in the construction of the first principal factor, the interconnection between the two consolidates

Vol. 75, issue 2 Year 2023
DOI: 10.56043/reveco-2023-0021

the impact that the three-dimensional interconnectivity has in the transition from economic growth to sustainable development

The second principal factor comprises a number of 10 indicators-components. Among the 10, only 3 register absolute coefficient's value greater than 0.6. Therefore, the second factor is characterised to a greater extent by elements specific to the environment dimension. As can be seen in column 3 of table 4, the quantity of energy consumed, be it electric or primary, is a valid determinant of the extent by which sustainable development can be achieved. In addition to the two environment related components, a social element also characterises the second factor. Therefore, the degree of urbanization is shown to positively influence sustainable development.

The third generated principal factor is constructed on the basis of 10 indicators. Following the same model of analysis, only social-related indicators register coefficient values greater than 0.6. Therefore, the third principal factor depicts an image where the social dimension is a direct determinant of sustainable development. As can be seen through the means of digitalization, the extent by which the population has access to internet, broadband subscriptions and mobile subscriptions has beneficial influences toward both inclusiveness and sustainability. Education, reflected by the expected years of schooling and the female population that has attained at least secondary education, appears to be of medium but positive influence in generating the third principal factor.

The social dimension characterises the fourth principal factor. As can be seen in column 5, unemployment entirely characterises this principal factor. Although the coefficients have positive values, it is worth noting that the fourth principal factor is negatively correlated with economic growth (table 6). Therefore, unemployment has negative implications toward economic growth, and later on toward sustainable development.

The fifth principal factor is composed of population density, the percentage of land area that is represented by agricultural land and forest area, respectively. The negative coefficient of the forest cover indicator might be explained by the fact that the consumption of natural resources has played an important role toward economic growth, which in turn contributed to sustainability. Population density can be considered to be the intersection of socio-economic aspects and geographical aspects.

The sixth principal factor is of negative influence toward sustainability, given the negative correlation coefficient presented in table 6. In its composition are present a number of 7 components, of which only two register an absolute coefficient value greater than 0.6. Therefore, the total dependency ratio has negative influences toward sustainability, given that the value registered by this indicator is negatively correlated with economic growth. In comparison, lowering levels of trade openness lead to decreases in economic growth.

The seventh principal factor is composed of 3 indicators-components, of which only 2 register absolute values greater than 0.6 This factor reflects the importance that industrial upgrading has toward sustainable development. A negative coefficient registered by industry value added followed by a positive coefficient registered by services value added highlight the importance that transitioning toward technology has for overall sustainability.

The eigth and last principal factor comprises 4 components, of which, only those specific to the social dimension have greater influences. Therefore, the extent by which the female population takes part in the labour force and the degree of the female population that has attained at least secondary education are positively influencing sustainable development.

With regard to the four initially set hypotheses, these have been demonstrated by analysing the structure of each principal factor generated. Therefore, hypothesis one is demonstrated given the strong presence of the economic related indicators within the principal factors. Three principal factors ( factor 1, factor 6 and factor 7) have in their structure economic aspects that register a coefficient absolute value greater than 0.6. In addition to this, with the exclusion of factors 4 and 5, each principal factor comprises economic related indicators. The second hypothesis has been demonstrated through the means of factors 2 and 5. These reflect the environment dimension of sustainable development as seen in energy

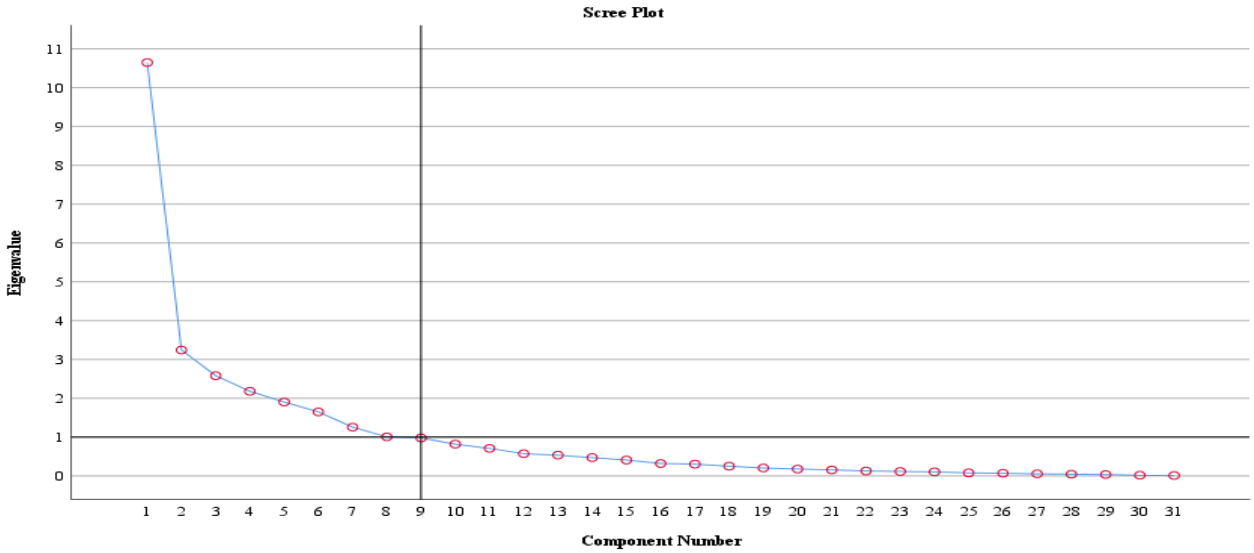
Vol. 75, issue 2 Year 2023
DOI: 10.56043/reveco-2023-0021

consumption, as well as in the structure of the land cover. As a consequence, environment related aspects such as forest cover, agricultural land, electricity consumption and primary energy consumption are worth taking into account when addressing issues related to sustainable development. The third hypothesis is demonstrated given the numerous and significant coefficients that the social dimension is registering. Out of the total number of 53 components( with a coefficient's absolute value greater than 0.35) 26 are specific to the social dimenion. Furthermore, the social related indicators are specific to the structure of each of the eight principal factors obtained. The fourth and last hypothesis is demonstrated by the third principal factor. It registers coefficient values greater than 0.6 for the following indicators: broadband subscriptions, internet and mobile subscriptions. The relevance of this finding arguments the importance digitalization plays toward the achievement of the sustainable development objective.

The robustness of the data is justified in table 5 where the value greater than 0.50 for the Kaiser-Meyer-Olkin Measure of Sampling Adequacy Test suggests that the factor analysis is useful with the data at hand. The Bartlett's Test of Sphericity registers a significance threshold which is lower than 0.05, thus proving the statistical significance of the factor analysis. Table A.1 in the appendices section highlights the existing correlations between the selected indicators.

According to the results obtained in tables 4 and 6, the transition from economic growth to sustainable development through the means of the economic, environment and social interconnectivity is presented as follows: economic growth is positively correlated with the first two principal factors. This suggests that countries that register higher economic growth rates or that are economically developed are more likely to experience effective governance. In addition to this, the overall population's life expectancy is higher, the rate of child mortality is low, inflation is held within the targeted intervals and the degree of industrial upgrading is advanced.

**Figure 1: Principal component analysis Eigenvalues Scree Plot**




Source: Author's construct

**Table 4: Principal factors' structure based on the 31 representative indicators**

| Rotated Component Matrix | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Component | | | | | | | |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| ***Economic dimension*** | | | | | | | | |
| Agriculture value added | -0.91 | | | | | | | |
| Foreign direct investment | | | | | | -0.51 | 0.40 | |
| Globalization | 0.81 | | 0.40 | | | | | |
| Government expenditure | | 0.43 | | | | 0.37 | | 0.54 |
| Industry value added | | | | | | | -0.87 | |
| Inflation (annual percentage) | -0.63 | | | | | | | |

Vol. 75, issue 2 Year 2023
DOI: 10.56043/reveco-2023-0021

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Inflation (cumulative) | -0.52 | | 0.39 | | | | | -0.40 |
| Services value added | 0.56 | | | | | | 0.73 | |
| Trade openness | | | | | | -0.62 | | |
| ***Environment dimension*** | | | | | | | | |
| Agricultural land | | -0.40 | | | 0.77 | | | |
| CO2 emissions per capita | 0.36 | 0.56 | | | | -0.53 | | |
| Electricity consumption per capita | | 0.87 | | | | | | |
| Exposure to Ambient PM.2.5 | -0.42 | | -0.37 | 0.39 | | | | |
| Forest cover | | | | | -0.75 | | | |
| Primary energy consumption per capita | | 0.92 | | | | | | |
| ***Social dimension*** | | | | | | | | |
| Child mortality rate | -0.75 | | -0.39 | | | | | |
| Clean fuels and technologies for cooking | 0.74 | | | | | | | |
| Expected years of schooling | 0.52 | 0.39 | 0.36 | | | 0.39 | | |
| Fixed broadband subscriptions | | | 0.79 | | | | | |
| Governance (average of WGI) | 0.72 | 0.37 | | | | | | |
| Internet access (% of population) | | | 0.82 | | | | | |
| Labour force participation rate, female | | 0.41 | | | | | | 0.61 |
| Life expectancy at birth | 0.68 | | | | | | | |
| Mobile subscription | | | 0.79 | | | | | |
| Population density | | | | | 0.80 | | | |
| Population with secondary education, female | | | 0.47 | | | | | 0.61 |
| Share of seats in parliament, female | | 0.41 | 0.43 | | | 0.40 | | |
| Total dependency ratio | | | | | | 0.73 | | |
| Unemployment with advanced education | | | | 0.87 | | | | |
| Unemployment | | | | 0.88 | | | | |
| Urbanization | 0.40 | 0.66 | | | | | | |

*Extraction Method: Principal Component Analysis.*
*Rotation Method: Varimax with Kaiser Normalization.*
*a Rotation converged in 18 iterations.*

Source: Author's construct based on the available data, 2023

Furthermore, with regard to the correlation between the second principal factor and economic growth, we can observe a positive relationship of moderate intensity. This suggests that the degree of economic development of a country is associated with higher energy consumption and greater levels of urbanization. Although positive, the correlations between principal factors 3, 5, 7 and economic growth are of low intensities, thus the interconnection between their components and economic growth is not intense. With regard to the negative correlations, only that of factor 4 and economic growth presents a moderate intensity. This highlights the fact that unemployment is rather specific to those countries that still have economic growth as their primary objective. On the subject of unemployment, given the correlation, the same applies to the extent of unemployment with advanced education. Therefore, within the spectrum of developing countries, strategies regarding employment should be addressed by policy makers.

**Table 5**: Data adequacy test

| | | |
|---|---|---|
| KMO and Bartlett's Test | | |
| Kaiser-Meyer-Olkin Measure of Sampling Adequacy. | | 0.754 |
| Bartlett's Test of Sphericity | Approx. Chi-Square | 24313.82 |
| | df | 465 |
| | Sig. | 0 |

Author's construct based on the available data, 2023

**Table 6**: Pearson correlation analyses

| | Pearson Correlation |
|---|---|
| | Economic Growth |
| Factor 1 | .467** |
| Factor 2 | .468** |
| Factor 3 | .219** |
| Factor 4 | -.364** |
| Factor 5 | .119** |
| Factor 6 | -.087* |
| Factor 7 | .234** |
| Factor 8 | -0.066 |

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

Source: Author's construct based on the available data, 2023

## 5. Conclusions

Motivated by the accentuated need for the transition from economic growth to sustainable development, this study sets to identify the interconnectivity between the economic, environment and social dimensions. This is accomplished by selecting a number of 32 specific indicators and by conducting the principal component analysis. Empirically, the study is based on annual macro data for a number of 32 European countries from 2000 to 2021. In the light of the above conducted statistical analysis, the following results have been found. There have been identified 8 principal factors that

Vol. 75, issue 2 Year 2023
DOI: 10.56043/reveco-2023-0021

contain the elements that are the most significant to sustainable development. Within their structure are the 31 selected indicators and their generated coefficients. With regard to the coefficients, 53 influences have been observed. Among these, 16 are economic related, 11 are environment related and 26 are social related. The social related elements have strong influences that are specific to each of the principal factors obtained, whereas economic and environment elements account only for 3 and 2, respectively, principal factors. This finding highlights the fact that sustainable development is an objective that addresses the overall well-being of the population and is achievable through the means of economic and environment effective policies and governance.

The correlations between the principal factors and economic growth highlights the importance that key indicators such as: inflation, globalization, industrial upgrading, governance, life expectancy, energy consumption, urbanization and unemployment can play in the transition from economic to sustainable development. With regard to the previously made statement, future researchers might focus on quantifying the influence that the identified indicators have on sustainable development by conducting a regression analysis. Furthermore, with regard to future research, a sustainable development index can be constructed. The choice of indicators that will be the structure of such an index can be based on the findings shown in table 4. Their weights in the construction of the index can be set with regard to their coefficients and their overall presence within the principal factors. The principal component analysis conducted in this study leaves room for a year specific analysis for each of the years within the range 2000 to 2021. Thus, future research that addresses a year based PCA is relevant given that it will identify the yearly dynamic of the sustainable development composition with regard to the three-dimensional interconnectivity.

With regard to the social dimension, in order for researchers around the world to be able to conduct a comprehensive analysis there is urgent need of data. Indicators reflecting the overall well-being of the population are not entirely available in online databases. Elements reflecting the population's access to safely managed drinking water and sanitation services are not available for a broad range of years or countries. Indicators reflecting inclusiveness, such as income or wealth inequality are also not available. However, they are mandatory for a comprehensive analysis. Therefore, in order for future research to be able to study the importance of sustainable development, there is urgent and justified need of available macro data.

Vol. 75, issue 2 Year 2023
DOI: 10.56043/reveco-2023-0021

## Appendices section

**Table A.1: Pairwise correlation matrix of the 31 indicators used in the PCA analysis**

| | CO2(1) | EC(2) | PEC(3) | FA(4) | AGA(5) | PM25(6) | TRD(7) | GLB(8) | GOV(9) | INFA(10) |
|---|---|---|---|---|---|---|---|---|---|---|
| CO2(1) | 1 | | | | | | | | | |
| EC(2) | .311** | 1 | | | | | | | | |
| PEC(3) | .564** | .933** | 1 | | | | | | | |
| FA(4) | 0.026 | -.110** | -.104** | 1 | | | | | | |
| AGA(5) | -.141** | -.471** | -.480** | -.589** | 1 | | | | | |
| PM25(6) | -.188** | -.492** | -.507** | -.135** | .336** | 1 | | | | |
| TRD(7) | .455** | -0.003 | .148** | -0.047 | .086* | -.161** | 1 | | | |
| GLB(8) | .241** | .091* | .211** | .083* | -0.011 | -.572** | .200** | 1 | | |
| GOV(9) | .085* | .396** | .399** | 0.045 | -.203** | -.313** | -.192** | .272** | 1 | |
| INFA(10) | -.114** | -.098** | -.138** | -0.059 | 0.06 | .363** | -.179** | -.564** | -.165** | 1 |
| INFC(11) | -.200** | -.130** | -.212** | -0.054 | 0.054 | .360** | -.160** | -.340** | -.267** | .224** |
| AGR(12) | -.400** | -.104** | -.271** | -.181** | .186** | .494** | -.236** | -.812** | -.215** | .571** |
| IND(13) | -0.041 | -0.019 | -0.042 | .239** | -.170** | .174** | -.206** | -.171** | -.220** | .200** |
| SRV(14) | .206** | 0.069 | .174** | -.150** | .095* | -.412** | .309** | .567** | .169** | -.424** |
| EYP(15) | .092* | .421** | .408** | 0.016 | -.201** | -.600** | -0.028 | .589** | .490** | -.384** |
| INT(16) | .115** | .376** | .380** | 0.034 | -.212** | -.676** | .276** | .668** | .300** | -.429** |
| MOB(17) | .155** | .091* | .110** | .149** | -.181** | -.397** | .208** | .520** | 0.066 | -.424** |
| FBB(18) | -0.027 | .269** | .247** | -0.03 | -.110** | -.617** | .210** | .639** | .299** | -.361** |
| PSEF(19) | .130** | .259** | .279** | .109** | -.194** | -.346** | .297** | .264** | .229** | -.298** |
| LFPF(20) | .180** | .562** | .581** | 0.015 | -.422** | -.648** | .133** | .345** | .376** | -.239** |
| UAE(21) | -.232** | -.273** | -.354** | 0.045 | 0.073 | .356** | -.232** | -.276** | -.102** | .157** |
| UT(22) | -.204** | -.269** | -.340** | .150** | 0.063 | .359** | -.174** | -.214** | 0.007 | 0.049 |
| CMR(23) | -.320** | -.321** | -.396** | -.129** | .278** | .531** | -.177** | -.729** | -.391** | .621** |
| TDR(24) | -.162** | .172** | .115** | .081* | -0.032 | -.492** | -.160** | .450** | .397** | -.173** |
| SPF(25) | 0.047 | .483** | .458** | .094* | -.262** | -.595** | 0.02 | .595** | .547** | -.344** |
| LIFE(26) | .194** | .378** | .412** | -0.063 | -.108** | -.542** | .105** | .780** | .315** | -.446** |
| WGI(27) | .368** | .432** | .526** | 0.014 | -.170** | -.651** | .271** | .753** | .363** | -.462** |
| CLN(28) | .251** | .204** | .294** | .104** | -.171** | -.578** | .148** | .543** | .187** | -.495** |
| URB(29) | .430** | .490** | .610** | -.097* | -.184** | -.513** | 0.074 | .499** | .491** | -.224** |
| PD(30) | .167** | -.230** | -0.056 | -.413** | .454** | .109** | .236** | .403** | .099** | -.120** |
| FDI(31) | .087* | -0.056 | 0.009 | -.143** | -.091* | 0.02 | .199** | 0.037 | -.074* | -0.049 |

| | INFC(11) | AGR(12) | IND(13) | SRV(14) | EYP(15) | INT(16) | MOB(17) | FBB(18) | PSEF(19) | LFPF(20) |
|---|---|---|---|---|---|---|---|---|---|---|
| INFC(11) | 1 | | | | | | | | | |
| AGR(12) | .385** | 1 | | | | | | | | |
| IND(13) | .172** | .093* | 1 | | | | | | | |
| SRV(14) | -.387** | -.582** | -.809** | 1 | | | | | | |
| EYP(15) | -.156** | -.515** | -0.023 | .262** | 1 | | | | | |
| INT(16) | -0.036 | -.509** | -.204** | .417** | .614** | 1 | | | | |
| MOB(17) | 0.062 | -.469** | -.140** | .303** | .354** | .703** | 1 | | | |
| FBB(18) | -.090* | -.439** | -.307** | .477** | .560** | .899** | .653** | 1 | | |
| PSEF(19) | -.171** | -.219** | .114** | 0.009 | .239** | .543** | .347** | .431** | 1 | |
| LFPF(20) | -.432** | -.354** | -0.024 | .221** | .408** | .498** | .177** | .419** | .562** | 1 |
| UAE(21) | .395** | .266** | -.185** | -0.027 | -.126** | -.250** | -.117** | -.137** | -.465** | -.436** |
| UT(22) | .166** | .135** | -.082* | -0.033 | -.085* | -.258** | -.146** | -.176** | -.316** | -.311** |
| CMR(23) | .290** | .779** | .163** | -.500** | -.650** | -.642** | -.582** | -.559** | -.314** | -.503** |
| TDR(24) | -.103** | -.232** | -.237** | .279** | .511** | .425** | .177** | .509** | 0.032 | .132** |
| SPF(25) | -.162** | -.351** | -.158** | .270** | .630** | .671** | .318** | .602** | .346** | .478** |
| LIFE(26) | -.298** | -.668** | -.306** | .623** | .634** | .621** | .410** | .637** | 0.023 | .353** |
| WGI(27) | -.557** | -.685** | -.183** | .530** | .556** | .517** | .206** | .422** | .255** | .598** |
| CLN(28) | -.486** | -.708** | -.184** | .545** | .501** | .398** | .269** | .316** | .132** | .309** |
| URB(29) | -.233** | -.456** | -.361** | .532** | .556** | .436** | .174** | .427** | .140** | .364** |
| PD(30) | -.127** | -.266** | -.315** | .443** | .128** | .134** | 0.034 | .207** | -0.023 | -.086* |
| FDI(31) | -0.058 | -0.067 | -.230** | .205** | -.103** | -0.001 | 0.056 | 0.023 | -0.032 | 0.074 |

| | UAE(21) | UT(22) | CMR(23) | TDR(24) | SPF(25) | LIFE(26) | WGI(27) | CLN(28) | URB(29) | PD(30) | FDI(31) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| UT(22) | .842** | 1 | | | | | | | | | |
| CMR(23) | .207** | .079* | 1 | | | | | | | | |
| TDR(24) | -0.05 | -0.064 | -.294** | 1 | | | | | | | |
| SPF(25) | -.219** | -.161** | -.528** | .527** | 1 | | | | | | |
| LIFE(26) | -.107** | -.107** | -.764** | .462** | .580** | 1 | | | | | |
| WGI(27) | -.470** | -.339** | -.662** | .352** | .604** | .743** | 1 | | | | |
| CLN(28) | -.278** | -.233** | -.544** | .154** | .259** | .502** | .604** | 1 | | | |
| URB(29) | -.133** | -.141** | -.417** | .449** | .548** | .522** | .552** | .400** | 1 | | |
| PD(30) | -.163** | -.161** | -.118** | 0.057 | .150** | .287** | .246** | .115** | .286** | 1 | |
| FDI(31) | .081* | 0.034 | -0.069 | -.225** | -.115** | 0.058 | 0.067 | 0.027 | 0.007 | .097** | 1 |

**p<0.01 ; *p<0.05

Source: Author's construct

Vol. 75, issue 2 Year 2023
DOI: 10.56043/reveco-2023-0021

## References


- Aksin-Sivrikaya, S., & Bhattacharya, C. B. (2017). Where digitalization meets sustainability: Opportunities and challenges. In Sustainability in a Digital World (pp. 37–49). *Springer International Publishing*. https://doi.org/10.1007/978-3-319-54603-2_3
- Alsayegh, M. F., Abdul Rahman, R., & Homayoun, S. (2020). Corporate economic, environmental, and social sustainability performance transformation through ESG disclosure. Sustainability, 12(9), 3910. https://doi.org/10.3390/su12093910
- Cerdeira Bento, J. P., & Moutinho, V. (2016). CO 2 emissions, non-renewable and renewable electricity production, economic growth, and international trade in Italy. *Renewable and Sustainable Energy Reviews, 55, 142–155*. https://doi.org/10.1016/j.rser.2015.10.151
- Colás-Bravo, P., Conde-Jiménez, J., & Reyes-de-Cózar, S. (2021). Sustainability and digital teaching competence in higher education. *Sustainability, 13(22), 12354*. https://doi.org/10.3390/su132212354
- Ding, Q., Huang, J., & Chen, J. (2023). Does digital finance matter for corporate green investment? Evidence from heavily polluting industries in China. *Energy Economics, 117(106476), 106476*. https://doi.org/10.1016/j.eneco.2022.106476
- Dong, F., Hu, M., Gao, Y., Liu, Y., Zhu, J., & Pan, Y. (2022). How does digital economy affect carbon emissions? Evidence from global 60 countries. *The Science of the Total Environment, 852(158401), 158401*. https://doi.org/10.1016/j.scitotenv.2022.158401
- Ghouse, G., Aslam, A., & Bhatti, M. I. (2022). Green energy consumption and inclusive growth: A comprehensive analysis of multi-country study. *Frontiers in Energy Research, 10*. https://doi.org/10.3389/fenrg.2022.939920
- Güney, T. (2017). Governance and sustainable development: How effective is governance? *The Journal of International Trade & Economic Development, 26(3), 316–335*. https://doi.org/10.1080/09638199.2016.1249391
- Hansmann, R., Mieg, H. A., & Frischknecht, P. (2012). Principal sustainability components: empirical analysis of synergies between the three pillars of sustainability. *International Journal of Sustainable Development and World Ecology, 19(5), 451–459*. https://doi.org/10.1080/13504509.2012.696220
- Khan, Z., Hossain, M. R., Badeeb, R. A., & Zhang, C. (2023). Aggregate and disaggregate impact of natural resources on economic performance: Role of green growth and human capital. *Resources Policy, 80(103103), 103103*. https://doi.org/10.1016/j.resourpol.2022.103103
- Lamichhane, S., Eğilmez, G., Gedik, R., Bhutta, M. K. S., & Erenay, B. (2021). Benchmarking OECD countries' sustainable development performance: A goal-specific principal component analysis approach. *Journal of Cleaner Production, 287(125040), 125040*. https://doi.org/10.1016/j.jclepro.2020.125040
- Lee, C.-C., Wang, F., & Lou, R. (2022). Digital financial inclusion and carbon neutrality: Evidence from non-linear analysis. *Resources Policy, 79(102974), 102974*. https://doi.org/10.1016/j.resourpol.2022.102974
- Little, A. W., & Green, A. (2009). Successful globalisation, education and sustainable development. International *Journal of Educational Development, 29(2), 166–174*. https://doi.org/10.1016/j.ijedudev.2008.09.011
- Mengxin Wang, Ran Gu, Meng Wang, Junru Zhang. Research on the impact of finance on promoting technological innovation based on the state-space model[J]. *Green Finance, 2021, 3(2): 119-137*. https://doi.org/10.3934/gf.2021007
- Mirshojaeian Hosseini, H., & Kaneko, S. (2011). Dynamic sustainability assessment of countries at the macro level: A principal component analysis. *Ecological Indicators, 11(3), 811–823*. https://doi.org/10.1016/j.ecolind.2010.10.007

Vol. 75, issue 2 Year 2023
DOI: 10.56043/reveco-2023-0021


- Moriña, A. (2017). Inclusive education in higher education: challenges and opportunities. European Journal of Special Needs Education, 32(1), 3–17. https://doi.org/10.1080/08856257.2016.1254964
- OECD (2017), Green Growth Indicators 2017, OECD Green Growth Studies, *OECD Publishing, Paris*, https://doi.org/10.1787/9789264268586-en
- OECD (2022), Green Economy Transition in Eastern Europe, the Caucasus and Central Asia: Progress and Ways Forward, OECD Green Growth Studies, *OECD Publishing, Paris*, https://doi.org/10.1787/c410b82a-en
- OECD Green Growth Studies. (2011). OECD. https://doi.org/10.1787/22229523
- Ofori, I. K., & Asongu, S. A. (2021). ICT diffusion, foreign direct investment and inclusive growth in sub-Saharan Africa. *Telematics and Informatics, 65(101718), 101718*. https://doi.org/10.1016/j.tele.2021.101718
- Ofori, I. K., Gbolonyo, E. Y., & Ojong, N. (2022). Toward inclusive green growth in Africa: Critical energy efficiency synergies and governance thresholds. *Journal of Cleaner Production, 369(132917), 132917*. https://doi.org/10.1016/j.jclepro.2022.132917
- Ofori, I. K., Osei, D. B., & Alagidede, I. P. (2022). Inclusive growth in Sub-Saharan Africa: Exploring the interaction between ICT diffusion, and financial development. *Telecommunications Policy, 46(7), 102315*. https://doi.org/10.1016/j.telpol.2022.102315
- Ozturk, I., & Ullah, S. (2022). Does digital financial inclusion matter for economic growth and environmental sustainability in OBRI economies? An empirical analysis. *Resources, Conservation, and Recycling, 185(106489), 106489*. https://doi.org/10.1016/j.resconrec.2022.106489
- Pao, H.-T., & Fu, H.-C. (2013). Renewable energy, non-renewable energy and economic growth in Brazil. Renewable and Sustainable Energy Reviews, 25, 381–392. https://doi.org/10.1016/j.rser.2013.05.004
- Pickett, K. E., & Wilkinson, R. G. (2010). Inequality: an underacknowledged source of mental illness and distress. The British Journal of Psychiatry: *The Journal of Mental Science, 197(6), 426–428*. https://doi.org/10.1192/bjp.bp.109.072066
- Pickett, K. E., & Wilkinson, R. G. (2015). Income inequality and health: a causal review. *Social Science & Medicine (1982), 128, 316–326*. https://doi.org/10.1016/j.socscimed.2014.12.031
- Razzaq, A., Sharif, A., Ozturk, I., & Skare, M. (2023). Asymmetric influence of digital finance, and renewable energy technology innovation on green growth in China. *Renewable Energy, 202, 310–319*. https://doi.org/10.1016/j.renene.2022.11.082
- Rodríguez-Martínez, García-Sánchez, Vicente-Galindo, & Galindo-Villardón. (2019). Exploring relationships between environmental performance, E-government and corruption: A multivariate perspective. *Sustainability, 11(22), 6497*. https://doi.org/10.3390/su11226497
- Sachs, J., Kroll, C., Lafortune, G., Fuller, G., & Woelm, F. (2021). Sustainable Development Report 2021. *Cambridge University Press*. https://doi.org/10.1017/9781009106559
- Sachs, J., Kroll, C., Lafortune, G., Fuller, G., & Woelm, F. (2022). Sustainable Development Report 2022. *Cambridge University Press*. https://doi.org/10.1017/9781009210058
- Silvestre, B. S., & Ţîrcă, D. M. (2019). Innovations for sustainable development: Moving toward a sustainable future. *Journal of Cleaner Production, 208, 325–332*. https://doi.org/10.1016/j.jclepro.2018.09.244
- Tan, F., & Lu, Z. (2016). Assessing regional sustainable development through an integration of nonlinear principal component analysis and Gram Schmidt orthogonalization. *Ecological Indicators, 63, 71–81*. https://doi.org/10.1016/j.ecolind.2015.11.018
- van der Waal, J. W. H., Thijssens, T., & Maas, K. (2021). The innovative contribution of multinational enterprises to the Sustainable Development Goals. *Journal of Cleaner Production, 285(125319), 125319*. https://doi.org/10.1016/j.jclepro.2020.125319

Vol. 75, issue 2 Year 2023
DOI: 10.56043/reveco-2023-0021


- Wang, Q., Qu, J., Wang, B., Wang, P., & Yang, T. (2019). Green technology innovation development in China in 1990-2015. *The Science of the Total Environment, 696(134008), 134008*. https://doi.org/10.1016/j.scitotenv.2019.134008
- Wang, W., Yang, X., Cao, J., Bu, W., Dagestani, A. A., Adebayo, T. S., Dilanchiev, A., & Ren, S. (2022). Energy internet, digital economy, and green economic growth: Evidence from China. *Innovation and Green Development, 1(2), 100011*. https://doi.org/10.1016/j.igd.2022.100011
- Wesseling, W. I. E. (2021). Toward a more all-inclusive evaluation of interventions for unemployed youth: A longitudinal investigation of participant, programme, relational and contextual factors. *Social Policy & Administration, 55(7), 1145–1161*. https://doi.org/10.1111/spol.12705
- Zheng, Chunji, et al. "Green credit policy, institution supply and enterprise green innovation." *Journal of Economic Analysis 1.1 (2022): 20-34*. https://doi.org/10.58567/jea01010002