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ARTICLE INFO	Heorhiy Rohov, Sergiy Prykhodko, Oleh Kolodiziev, Volodymyr Sybirtsev and Ihor Krupka (2021). Factors of national environmental performance in sustainability management aspect. *Problems and Perspectives in Management*, *19*(3), 70-84. doi:10.21511/ppm.19(3).2021.07
DOI	http://dx.doi.org/10.21511/ppm.19(3).2021.07
RELEASED ON	Wednesday, 04 August 2021
RECEIVED ON	Saturday, 29 May 2021
ACCEPTED ON	Tuesday, 27 July 2021
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JOURNAL	"Problems and Perspectives in Management"
ISSN PRINT	1727-7051
ISSN ONLINE	1810-5467
PUBLISHER	LLC “Consulting Publishing Company “Business Perspectives”
FOUNDER	LLC “Consulting Publishing Company “Business Perspectives”

NUMBER OF REFERENCES	NUMBER OF FIGURES	NUMBER OF TABLES
67	0	2

BUSINESS PERSPECTIVES

LLC "CPC "Business Perspectives"
Hryhorii Skovoroda lane, 10,
Sumy, 40022, Ukraine
www.businessperspectives.org

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FACTORS OF NATIONAL ENVIRONMENTAL PERFORMANCE IN SUSTAINABILITY MANAGEMENT ASPECT

Received on: 29th of May, 2021
Accepted on: 27th of July, 2021
Published on: 4th of August, 2021

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Abstract

The ambitious goals of environmental sustainability stated in international agreements and national programs require developing strategies to achieve them. At the same time, there is a lack of empirical evidence on the environmental performance factors, which can be purposefully changed to achieve an effective result in the short and medium-term. The paper aims to find the institutional factors of national environmental performance, including financial ones, which might be effectively used as environmental sustainability management tools. For this, the relationships between the Environmental Performance Index (EPI), as the dependent variable, and the indicators of control of corruption, the effectiveness of an anti-monopoly policy, financial opportunities, undue influence, corporate culture, innovation output, GDP, and income growth among the poorest population, using a sample of 81 countries, and the technique for constructing nonlinear regression models based on the normalizing transformations for non-Gaussian data were studied.

The study findings show that environmental performance can be predicted with sufficient accuracy by a linear model of its dependence on corruption control, minority shareholders protection, judicial independence, favoritism in decisions of government officials, tax incentives, ease of access to loans, and innovation output. Adding GDP per capita to the explanatory variables of the EPI model does not significantly affect the result accuracy but changes the model shape from linear to nonlinear. The paper substantiates ways to apply results for institutional reforms and sustainability management, such as inflation targeting, public credit guarantee schemes, performance-based loans, etc.

Keywords environmental performance, environmental sustainability, sustainable management, tax incentives, access to loans

JEL Classification O10, Q58, G28

INTRODUCTION

A significant part of the problems and global goals of sustainable development are related to the environmental sphere (The United Nations, 2015; European commission, 2019; The White House, 2021). Air pollution, accumulation of plastic waste in the oceans, natural resource depletion, deforestation, desertification, land degradation, loss of biodiversity negatively affect living standards and development prospects. Achieving sustainable development goals in the environmental dimension requires a comprehensive transformation of socio-economic policy and corporate management. The transformation effectiveness depends on the reliability of determining the factors of national environmental performance.

Nowadays, empirical studies based on statistical information and international rankings are currently being used for this. Wendling et al. (2018), in this regard, indicated a modern trend of "data-driven environmental policymaking" growth. However, as follows from the

Conflict of interest statement:
Author(s) reported no conflict of interest

http://dx.doi.org/10.21511/ppm.19(3).2021.07

literature review below, studies of national environmental performance determinants demonstrate inconsistent results. Moreover, the factors, in particular financial ones, which can be effectively used by policymakers and managers in the short and medium-term, remain out of sight. Thereby factors of national environmental performance need system research in the sustainable management aspect.

1. LITERATURE REVIEW

The literature related to the issue of factors affecting national sustainable development in the environmental dimension has been rapidly expanding lately. The question is to what extent policymakers and managers can use it in practical terms to justify institutional reforms and develop methods for managing environmental sustainability at the macroeconomic and corporate levels. It is worth noting that different environmental indices and indicators became the subject of empirical studies. Some articles focus on individual components of environmental performance associated with climate changes such as carbon dioxide emissions, energy consumption (Povitkina, 2015; Sekrafi & Sghaier, 2018), and urban pollution (Winslow, 2005; Fredriksson & Neumayer, 2013). Another group of empirical studies deals with particular aspects of environmental policy and its consequences. For example, Pellegrini and Gerlagh (2006) explored the factors of environmental policies' stringency. Xu et al. (2020) estimated the determinants of sustainable innovation efficiency. Al-mulali et al. (2015), Bradshaw and Di Minin (2019) used ecological footprint (Global Footprint Network, 2021) as an indicator of environmental performance externalities.

The multifaceted nature of environmental sustainability logically leads to the need to study its integral indicator. In recent years, some studies have been carried out to develop a comprehensive metric. For instance, García-Sánchez et al. (2015) have proposed the Composite Index of Environmental Performance (CIEP). Almeida and García-Sánchez (2017), Dkhili and Dhiab (2019) investigated determinants of ecological quality using CIEP as the dependent variable.

However, the overwhelming majority of empirical studies such as Handoyo and Fitriyah (2019), Gorham et al., (2019), Kim and Go (2020), etc. explored the Environmental Performance Index (EPI) as an indicator of sustainable development in the environmental dimension. EPI is a composite index measured by The Yale Center for Environmental Law & Policy (Yale University) and Center for International Earth Science Information Network (Columbia University). In contrast to absolute indicators, EPI shows how close a country is to establish sustainability targets. It decreases the unwanted effect of national economic structure on environmental performance in empirical studies.

Cross-country comparisons were used on the individual determinants of environmental performance. First, it concerns the impact of corruption (Sekrafi & Sghaier, 2018), development of democracy (Winslow, 2005; Fredriksson & Neumayer, 2013), public governance (Handoyo & Fitriyah, 2019; Basrija & Handoyo, 2019), and the GDP (Dinda, 2004; Dkhili, 2019; Gorham et al., 2019). It was found that corruption is strongly associated with high emissions of CO2 and environmental degradation. Sekrafi and Sgayer (2018) noted that strengthening control over corruption has a positive effect on the quality of the environment, both directly and indirectly, by reducing the informal sector and, consequently, its energy consumption. Environmental performance is usually also positively associated with democracy, however, as Fredriksson and Neumayer (2013) clarified, if only it comes to the democratic capital stock but not current levels of democracy.

Public governance is usually represented in the empiric studies by the Worldwide Governance Indicators (WGI). These indicators include accountability, political stability, government effectiveness, regulatory quality, and control of corruption. The results demonstrate a positive and significant correlation between WGI as a whole and the national environmental performance. However, conclusions regarding the significance of the effect of each indicator do not coincide (Handoyo & Fitriyah, 2019; Basrija & Handoyo, 2019).

The empirical studies of the relationship between environmental performance and the Gross Domestic Product (GDP) have shown inconsistent results. It is often argued that the relationship between the GDP and environmental performance is described by the Environmental Kuznets Curve (Gozgor, 2017; Irdhad & Hussain, 2017; Dkhili, 2019). It has an inverted U-shape, which means environmental degradation with an increase in GDP at an early stage of economic development and a reversal of the trend after reaching a certain threshold.

At the same time, Al-mulali et al. (2015) stated that the environmental Kuznets curve hypothesis does not prove in all countries, but only in upper-middle- and high-income ones. Raymond (2004) underscored the lack of evidence of its validity to developing countries. Dinda (2004) and Fiorino (2011) argued that this hypothesis applies only to determinants of several indicators of air and water pollution. Aşıcı1 (2013), and Halkos and Zisiadou (2016) did not support the idea that this relationship has an inverted U-shape. Many multivariate models demonstrate a positive relationship between the GDP and EPI (Fakher & Abedi, 2017; Kumar et al., 2019; Alhassan et al., 2020; Kim & Go, 2020). According to Lee and Thiel (2017), EPI is irrelevant to GDP growth. Povitkina (2015) substantiated that the environmental Kuznets curve "is not a product of economic forces, but is rather a proxy for other processes occurring in the society", in particular changing the corruption level.

Multivariate models provide an opportunity to explain the ambiguous impact of some other factors on environmental sustainability. For example, Holmberg et al. (2009) and Povitkina (2015) have shown that neither democracy nor high government effectiveness alone is sufficient for sustainable development. Cole et al. (2006) and Sarmidi et al. (2015) proved that the government's degree of corruptibility affects the relationship between foreign direct investment and environmental policy stringency. It was concluded that good governance enhances foreign direct investment inflows and the protection of the environment.

Other independent variables are often used while investigating the determinants of national environmental performance along with the above-mentioned ones. Alhassan et al. (2020) explored the effect of international trade on EPI, combining this variable with indicators of economic growth and government integrity. It was stated that improving the integrity of the government might avert the environmental degradation driven by trade. Dluhopolskyi et al. (2019) used the indicators of population values and beliefs, along with such independent variables as governance effectiveness, democracy index, and the GDP. It was found that the dominance of the self-realization values over the survival ones in the society positively affects EPI.

Another strand of researchers focuses on the impact of human development and human capital on national environmental performance. The human development index (HDI) is a summary measure of life expectancy, education level, and gross national income per capita (UNDP, 2021). Lai and Chen (2020) proved inter-correlation between HDI and EP based on the canonical correlation analysis. Samimi et al. (2011) found that HDI positively and significantly affects environmental performance but not for developing countries. Shahabadi et al. (2017) confirmed this result for selected OPEC countries, supplementing the multivariate model with the other factors (industry value-added, economy openness, carbon dioxide emissions, Internet development, natural resource abundance index, and governance quality). Studying national environmental performance determinants, Kim and Go (2020) included the human capital index (HCI) in the model instead of the human development index. The findings show HCI positively affects EPI primarily through one of its main components – ecosystem vitality.

In addition to avowed environmental sustainability determinants, indicators that characterize national culture, development of infrastructure and tourism, level of urbanization and consumption, population growth, and some others are also widely studied. For example, Almeida and García-Sánchez (2017) indicated a significant effect of transport, infrastructure, consumption of goods, and tourism on environmental performance. Dkhili and Dhiab (2019) demonstrated a substantial impact of freedom, social inclusion policies, investment in R&D, importing, and exporting on CIEP. Wang et al. (2020) paid attention to the role of ethnic diversity in decreasing carbon dioxide emissions. Gorham et al. (2019) highlighted a positive relationship between urbanization and EPI. Kumar et al. (2019) studied the hypothesis of the links between envi-

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ronmental performance and the six-dimensional index of national culture developed by Hofstede. It was established that individualist culture is the most substantial factor among cultural dimensions.

Discussion of environmental performance determinants rarely focuses on financial factors. Several works examine the impact of financial development and foreign direct investments on carbon dioxide emission and EPI (Al-mulali et al., 2015; Bernard & Mandal, 2016; Wang et al., 2020). However, different proxies were used for the same concept. For example, Bernard and Mandal (2016) represented financial development as domestic credit to the private sector, but Wang et al. (2020) – like stock market capitalization. Results addressing the financial factors are different as well. Wang et al. (2020) argued that financial development increases environmental degradation, whereas Al-mulali et al. (2015) found the opposite result for lower-middle, upper-middle, and high-income countries. Bernard and Mandal (2016) showed that the foreign direct investments' effect on environmental performance is insignificant.

The results of empirical studies of factors affecting environmental sustainability lead to the following generalizations. First, it is considered that the indicators dividing national economies according to the degree of economic development (GDP, infrastructure quality, stock market capitalization) are generally recognized determinants of environmental performance. However, links between environmental performance and the factors characterizing the institutional environment in the social dimension remain out of focus.

Secondly, the independent variables in the models, as a rule, represent natural, socio-political, and cultural factors that are relatively stable even from a strategic perspective. In other words, they can hardly be considered environmental management tools, rather the conditions for achieving the development goals. These factors include natural resource abundance, ethnic diversity, democracy, human capital, cultural characteristics, population values and beliefs, etc.

Third, environmental management variables are represented in an overly generalized manner, for example, government effectiveness, regulatory quality, policies, and institutions for environmental sustainability. This level of abstraction complicates the practical use of the empirical studies results by policymakers and managers. Only a few models provide empirical evidence of those environmental performance factors, in particular financial ones, which could be managed for sustainability purposes. Factors like domestic credit to the private sector as a percentage of the GDP (Bernard & Mandal, 2016) and investment in R&D (Dkhili & Dhiab, 2019) are examples. At the same time, the factors, such as the effect of taxation on incentives to invest, ease of access to loans, antimonopoly policy, corporate ethics, protection of minority shareholders, judicial independence, and favoritism in decisions of government officials, can also be considered environmental management tools. These factors are instrumental for managing environmental sustainability because their positive changes are subject to the implementation of short-term and medium-term development programs.

2. AIMS AND HYPOTHESES

The paper aims to determine the institutional factors of national environmental performance, particularly financial ones, which might be effectively used as environmental sustainability management tools. For this, the following hypotheses were proposed:

H1: *Factors characterizing the institutional environment in the social dimension significantly affect the Environmental Performance Index.*

H2: *Environmental performance depends on the effect of taxation on incentives to invest and ease of access to loans.*

H3: *Environmental performance is positively associated with the innovation output.*

H4: *National environmental performance can be determined with sufficient accuracy using a linear model of its dependence on the indicators of corruption, innovation output, and instrumental factors for managing environmental sustainability.*

3. METHODOLOGY

Multiple regression analysis provides the opportunity to test the hypotheses of the study. The technique (Prykhodko & Prykhodko, 2021) based on the normalizing transformations and prediction intervals for outlier detection was applied for constructing the multiply nonlinear regression models. This technique consists of four steps. In the first step, a set of multivariate non-Gaussian data is normalized using a normalizing transformation. After that, normalized data are checked for multivariate outliers, and, if ones are detected, they are removed. In the second step, the nonlinear regression model is constructed based on the normalizing transformation. In the third step, the prediction intervals of nonlinear regression are calculated. Finally, in the fourth step, it is checked whether, among the data for which the nonlinear regression model was constructed, are rows that go beyond the found bounds of the prediction interval of regression. If the outliers are detected, they are removed, and all operations repeat themselves, starting with the first for new data. For detecting outliers in multivariate non-Gaussian data, the study implemented the statistical technique (Prykhodko et al., 2017) based on normalizing transformations and the squared Mahalanobis distance.

The EPI was chosen as the variable under study, taking into account its advantages outlined above. Table 1 shows the independent variables selected to test the formulated hypotheses. X_5 and X_9 are the control variables. If the influence of the GDP is the most significant, then this means that a noticeable increase in EPI cannot be achieved without long-term progress in improving the country's welfare. Another control variable focuses on income growth among the poorest population and thus describes national sustainable development in economic and social dimensions together.

The study used the 2018 Environmental Performance Index and the values of the factors taken from the respective annual reports, given that assembling and studying panel data of EPI scores published in different years leads to unreliable results (Wendling et al., 2018, p.10). Not all 180 countries for which the EPI is published have information available to calculate the rest of the indices used in the study. Therefore, the sample includes 81 national economies for which a full amount of required data is available. Seven predictors (X_1, X_2, X_3, X_4, X_5, X_6, and X_7) passed the preliminary multicollinearity test according to Chatterjee and Price (2012) since variance inflation factors (VIF's) for each variable equal 2.88, 1.45, 1.89, 5.74, 4.15, 4.41, and 6.20 respectively. Initial data for constructing the regression models are shown in Table A1 (Appendix A).

4. RESULTS

At the first stage of the algorithm application, multivariate data distribution needed checking because well-known statistical methods, for ex-

Table 1. Variables and sources of data

No	Variable name	Variable symbol	Data Sources	Hypotheses
1	Innovation output sub-index	X_1	Global Innovation Index (Cornell University et al., 2018)	H_3, H_4
2	Effect of taxation on incentives to invest	X_2	Global Competitiveness Report (GCR) (World Economic Forum, 2016)	H_2, H_4
3	Ease of access to loans	X_3	GCR (World Economic Forum, 2016)	H_2, H_4
4	Undue influence (judicial independence and favoritism in decisions of government officials)	X_4	GCR (World Economic Forum, 2016)	H_1, H_4
5	GDP per capita	X_5	The World Bank, 2018	
6	Protection of minority shareholders	X_6	GCR (World Economic Forum, 2016)	H_1, H_4
7	Corruption perceptions index	X_7	Transparency International, 2018	H_1, H_4
8	Effectiveness of anti-monopoly policy	X_8	GCR (World Economic Forum, 2016)	H_1, H_4
9	Consumption or income per capita, bottom 40% of the population (2011 PPP $ per day)	X_9	The World Bank, 2018	H_4
10	Corporate ethics	X_{10}	GCR (World Economic Forum, 2016)	H_1, H_4

http://dx.doi.org/10.21511/ppm.19(3).2021.07

ample, multivariate outlier detection based on the squared Mahalanobis distance (SMD), detect outliers in multivariate data set under the assumption that the data is subject to Gaussian distribution. The distribution of eight-dimensional data from Table A1 is not Gaussian according to the criteria (Olkin & Sampson, 2001) found on the SMD and the chi-square distribution quantile, since the SMD values for three rows (6, 13, and 42), which are equal to 37.54, 23.26, and 29.52 respectively, are greater than the value of the chi-square distribution quantile, which equals 21.95 for 0.005 significance level. Also, the measures of multivariate skewness and multivariate kurtosis (Mardia, 1970), which estimates are equal to 21.56 and 95.5 respectively, for the initial dataset indicate the distribution of eight-dimensional data from Table A1 is not Gaussian. The estimate is more than twice the theoretical value of, which is 8.89, and the estimate is almost 20% higher than the theoretical value of, which is 80.

If the criterion based on the squared Mahalanobis distance (Johnson & Wichern, 2007) is still applied to detect outliers in the multivariate non-Gaussian data from Table A1, then the data in the three rows (6, 13, and 42) are multivariate outliers for 0.005 significance level. However, the reported outliers relate to three countries (Luxembourg, Ireland, and South Africa), the removal of which from the further analysis is difficult to explain. The statistical technique (Prykhodko et al., 2017) based on the decimal logarithm (Log10) transformation for normalizing the non-Gaussian data from Table A1 determined only two outliers, namely rows 42 and 79 (South Africa and Bangladesh).

The technique (Prykhodko & Prykhodko, 2021) made it possible to construct the seven-factor nonlinear regression model (1) to evaluate the EPI based on the Log10 transformation for the eight-dimensional dataset of the 79 countries (without South Africa and Bangladesh).

$$Y = 10^{\varepsilon+\hat{b}_0} X_1^{\hat{b}_1} X_2^{\hat{b}_2} X_3^{\hat{b}_3} X_4^{\hat{b}_4} X_5^{\hat{b}_5} X_6^{\hat{b}_6} X_7^{\hat{b}_7}, \qquad (1)$$

where ε is a Gaussian random variable defined residuals, $\varepsilon \sim N\left(0, \sigma_\varepsilon^2\right)$, $\hat{\sigma}_\varepsilon$ is the standard deviation estimate, $\hat{\sigma}_\varepsilon = 0.034722$, $\hat{b}_0$, $\hat{b}_1$, $\hat{b}_2$, $\hat{b}_3$, $\hat{b}_4$, $\hat{b}_5$, $\hat{b}_6$, and $\hat{b}_7$ are parameter estimates, which equal 1.204376, –0.0333102, –0.1306871, –0.1117420, –0.1421486, 0.1022126, 0.3408785, and 0.1159778 respectively. The reported values of estimates in model (1) are obtained in the third iteration. For 0.005 significance level, there is only one additional outlier in the data for row 65 (Pakistan). All the removals of the data belong to countries that are the laggards of EPI ranking.

In the fourth iteration for 78 rows of data from Table A1 (except for rows, 42, 65, and 79), the values of $\hat{\sigma}_\varepsilon$, $\hat{b}_0$, $\hat{b}_1$, $\hat{b}_2$, $\hat{b}_3$, $\hat{b}_4$, $\hat{b}_5$, $\hat{b}_6$, and $\hat{b}_7$ are 0.032229, 1.233906, –0.03183253, –0.1225593, –0.1039425, –0.111122, 0.0993573, 0.2778660, and 0.1134541 respectively. There are no outliers for 0.005 significance level in the fourth iteration. There is no multicollinearity between the independent variables X_1, X_2, X_3, X_4, X_6, and X_7 since the values of VIF's, which are measures of multicollinearity (Chatterjee & Price, 2012), for each variable equal 2.11, 1.45, 1.89, 5.70, 4.32, and 5.25 respectively.

To test *H4*, the six-factor nonlinear regression model based on the Log10 transformation for the seven-dimensional data set of the 81 countries from Table A1 (except for the variable X_5) was constructed in the form of model (2).

$$Y = 10^{\varepsilon+\hat{b}_0} X_1^{\hat{b}_1} X_2^{\hat{b}_2} X_3^{\hat{b}_3} X_4^{\hat{b}_4} X_6^{\hat{b}_6} X_7^{\hat{b}_7}, \qquad (2)$$

where ε is a Gaussian random variable defined residuals, $\varepsilon \sim N\left(0, \sigma_\varepsilon^2\right)$, $\hat{\sigma}_\varepsilon$ is the standard deviation estimate, $\hat{\sigma}_\varepsilon = 0.041953$, $\hat{b}_0$, $\hat{b}_1$, $\hat{b}_2$, $\hat{b}_3$, $\hat{b}_4$, $\hat{b}_6$, and $\hat{b}_7$ are parameter estimates, which equal 1.455956, –0.0786227, –0.1374829, –0.1131625, –0.2920071, 0.4501470, and 0.2823528 respectively. The reported values of estimates in model (2) are obtained in the third iteration for 79 rows of data from Table A1 (except for rows 42 and 79). For 0.005 significance level, there are two outliers relating to South Africa and Bangladesh.

A certain advantage of model (1) with seven factors compared with model (2) with six factors is the smaller widths of the prediction interval. The width of the nonlinear regression prediction interval for model (1) with seven factors is less than for model (2) with six factors for all 79 data rows (with the difference until 26%). The null hypothesis proposes that the observed frequency distribution of the values in model (2) is the same as the Gaussian distribution with zero expectation and 0.041953 standard deviation (there is no difference between the distributions) by the Pearson chi-squared test. Testing sustained the null hypothesis with the 0.05 significance level since the test statistic equals 3.67, less than the critical value from the chi-squared distribution that is 9.49 for 0.05 significance level and 4 degrees of freedom.

The study proved the possibility of constructing the six-factor linear regression model to evaluate the EPI based on the seven-dimensional data set of the 81 countries from Table A1 (except for the variable X_5) in the form of model (3).

$$Y = \hat{Y} + \varepsilon = \hat{b}_0 + \hat{b}_1 X_1 + \hat{b}_2 X_2 + \\ + \hat{b}_3 X_3 + \hat{b}_4 X_4 + \hat{b}_6 X_6 + \hat{b}_7 X_7 + \varepsilon, \quad (3)$$

where ε is a Gaussian random variable defined residuals, $\varepsilon \sim N\left(0, \sigma_\varepsilon^2\right)$, $\hat{\sigma}_\varepsilon$ is the standard deviation estimate, $\hat{\sigma}_\varepsilon = 5.71177$, $\hat{b}_0$, $\hat{b}_1$, $\hat{b}_2$, $\hat{b}_3$, $\hat{b}_4$, $\hat{b}_6$, and $\hat{b}_7$ are parameter estimates, which equal 53.54282, –0.1480178, –2.317596, –2.441415, –4.750578, 7.991645, and 0.3332672 respectively. The reported values of estimates in model (3) are obtained in the second iteration for 80 rows of data from Table AI (except for row 42). That is, for 0.005 significance level, there is one outlier in the data for South Africa. It can be explained by a complex of reasons. First, there is a significant difference between issue categories ranks due to the energy consumption structure. South Africa's main environmental problem is a high level of emission of greenhouse gases and pollutants. Around 80% of its emissions come from the energy supply, mostly provided by coal-fired power plants (The Carbon Brief, 2021). As a result, South Africa is one of the laggards in Air Quality, ranking 166th out of 180 countries. At the same time, the country ranks first in terms of Marine Protected Areas. Besides, some predictors from initial data were in the range of values typical of the countries with the better EPI ranks. Given that the effect of institutional reforms manifests itself with a certain lag in time, it is quite indicative that the country climbed up 47 notches in the EPI 2020 ranking.

The null hypothesis proposes that the observed frequency distribution of the ε values in model (3) is the same as the Gaussian distribution with zero expectation and 5.39362 standard deviation by the Pearson chi-squared test. Testing sustained the null hypothesis with the 0.05 significance level since the test statistic equals 5.82, less than the critical value from the chi-squared distribution that is 9.49 for 0.05 significance level and 4 degrees of freedom.

The well-known prediction accuracy metrics are used to judge the prediction accuracy of regression models. These metrics include a multiple coefficient of determination R^2, a mean magnitude of relative error MMRE, and prediction percentage at the level of magnitude of relative error (MRE) of 0.25, PRED (0.25). The R^2, MMRE, and PRED (0.25) values equal respectively 0.8183, 0.0576, and 1 for the seven-factor nonlinear regression model (1) with the estimators of parameters, which are calculated for the 78 data rows. The R^2, MMRE, and PRED(0.25) values equal respectively 0.7529, 0.0796, and 0.9750 for the six-factor linear regression model (3) for the 80 data rows, and equal respectively 0.7317, 0.0785, and 0.9747 for the six-factor nonlinear regression model (2) for the 79 data rows. The R^2 and MMRE values are somewhat better for the seven-factor nonlinear regression model (1) in comparison with the above six-factor regression models, both nonlinear (2) and linear one (3). However, a linear regression model makes it possible to interpret the regression coefficients as the expected change in EPI for a one-unit change in an independent variable when all the others are held fixed.

Model (3) demonstrates that independent variables X_4, X_6, and X_7, which describe judicial independence, favoritism in decisions of government officials, protection of minority shareholders, and control of corruption, essentially affect EPI. In other words, the study results fully support *H1* about the significant relationship between factors characterizing the institutional environment in the social dimension and environmental performance. Model (3) proves that EPI is significantly dependent on financial factors (the effect of taxation on incentives to invest and the ease of access to loans). This fact confirms the validity of *H2*.

The presence of the innovation output factor in model (3) correlates to a certain extent with the study results of Dkhili and Dhiab (2019) regarding the effect of investment in R&D on environmen-

http://dx.doi.org/10.21511/ppm.19(3).2021.07

tal performance. A change in the innovation output sub-index affects EPI less than a change in any other independent variable in the model. This suggests that national economy innovativeness does not guarantee green technologies' implementation if there are no effective sustainable development incentives. Thus, the study only partially supports *H3*.

The linear six-factor model (3), built without the factor of the GDP, turned out to be comparable in prediction accuracy with the seven-factor one, which includes this factor. In addition, unlike models (1) and (2), it applies to all countries in the EPI rating except for South Africa, which, as shown above, has a logical explanation. The model fully supports *H4* about the possibility of improving EPI in the medium or even short term using environmental management tools and controlling corruption.

5. DISCUSSION

The positive impact of control of corruption on environmental sustainability is consistent with empirical evidence of Pellegrini and Gerlagh (2006), Sekrafi and Sghaier (2018), Handoyo and Fitriyah (2019), etc. The relationship between EPI and such a variable as Undue influence (the proxy for indicators of judicial independence and favoritism in decisions of government officials) is quite understandable. Preferential treatment of certain companies or oligarchic groups by officials in the process of monitoring air pollution emissions and water contamination, environmental permitting, and decision making on state support for corporate sustainability programs harms incentives for eco-friendly activities. Lack of judiciary independence has a similar negative effect when considering lawsuits regarding changes in environmental legislation and when challenging penalties against companies for violating environmental standards.

Paradoxical at first glance is the high value of the regression coefficient before the variable X_6 (minority shareholders protection). However, this can be explained by the fact that the indicator of minority shareholders' protection is the only variable in the model that characterizes a company's relationship with vulnerable stakeholder groups, its compliance with the principles of corporate social responsibility. In the countries where companies act in socially responsible ways towards minority shareholders, especially if the CSR rules are enshrined in government and industrial regulation, they would likely act in the same manner towards employer associations, local communities, and other stakeholders, based on the balance of economic, social and environmental dimensions of sustainable development. For managing this factor of environmental performance, its significant dependence on the dividend policy and regulation of the squeeze-out procedure is important (Rohov et al., 2020).

The combination of such factors as taxation on incentives to invest and the ease of access to loans in model (3) characterizes the opportunities to attract financial resources and the conditions for their investment, including in green technologies. It is worth noting that as components of the 8th pillar of the Global Competitiveness Index (financial market development), characterizing access to financial resources, ease of access to loans, and financing through the local equity market are used. The latter component shows to what extent the firms can raise money by issuing shares or bonds on the national capital market. This indicator correlates with the variables X_2 and X_3 used in the model, since the availability of borrowed funds in the form of bank loans and bond issues is usually determined by similar factors, and the opportunities for public equity offerings and equity private placements depends on corporate tax incentives. However, the effect of taxation on incentives to invest has an obvious advantage in the context of the subject of the study, since it, in contrast to the indicator of financing through the local equity market, also characterizes incentives for real investment, including foreign investment.

The significant impact of the financial factors on EPI leaves open questions on how to apply them as instruments in environmental management. The idea that low tax rates always have a positive effect on investment, while high tax rates, on the contrary, is rather simplified. In the medium-term, low tax rates can increase the budget deficit to a critical level. Under these circumstances, government borrowings divert companies' financial resources from investing in new technologies and equipment.

In practice, various forms of targeted tax incentives are widely used to enhance the effect of taxation on investments, for example, reduced tax rates, investment allowances, tax credits, accelerated depreciation, and tax holidays. The targeted tax incentives can cause unjustified disparities in investment directions. However, their use is advisable to stimulate sustainable development since the social and ecological externalities of production activity do not receive an adequate economic assessment in the conditions of the existing free market. Some countries at the top of the EPI rankings applying investment allowances and accelerated depreciation take into account the environmental component of the investment effect. In particular, companies in Australia can claim an immediate deduction for expenditure on activities undertaken to prevent environmental pollution and to treat, clean up, and store waste (Australian Taxation Office, 2021). In the Netherlands, accelerated depreciation applies only for several specific assets, first of all, which are in the interest of environmental protection (PwC, 2018).

There is practical evidence that tax incentives can be quite effective. For instance, Jun (2010), studying Korea's tax system development, emphasized that they play a role in preventing companies from moving into the informal sector. This is important in the context of the EPI factors research since the shadow economy is not associated with environmental sustainability. Bermperoglou et al. (2019) proved the positive effect of investment allowances and tax credits on output, which materializes in two or three years. At the same time, the decision to use tax incentives, like any financial instrument, requires a comprehensive analysis, taking into account the specifics of the national economy and investment climate. It would be appropriate when drafting a tax incentive scheme in a developing country to consider a list of items developed by the United Nations Department of Economic and Social Affairs (UN-DESA) and the Inter-American Center of Tax Administrations (UN-DESA, 2018). In environmental management, finding the optimal solution that balances environmental tax increase, required to reduce the harmful effects of economic activities on the one hand and reduce a tax burden on enterprises through investment incentives on the other one, is of great importance.

Waiver of declared incentives and the deterioration of taxation conditions have an extremely negative impact on the investment climate and prospects for sustainable development. Indicative, in this regard, is the tough reaction of the investment market to the cutting the green tariffs by the Ukrainian government and to the bill on introducing an excise tax on renewable energy. Nordic Environment Finance Corporation (NEFCO), in particular, officially announced its decision "to stop investing in new projects in the renewable energy sector in Ukraine until a predictable and sustainable framework is in place and agreements are being honored by the Ukrainian government" (NEFCO, 2021). The effect of taxation on incentives to invest is leveled out in conditions favorable for capital transfer to low or no-tax jurisdictions. National implementation of Action Plan on Base Erosion and Profit Shifting (OECD, 2013) contributes to the solution of this problem.

Another financial factor that affects EPI, as follows from model (3), shows how easy businesses can obtain a bank loan. First, it depends on the overall economic situation in the world, country and industry, expected trends, and enterprise creditworthiness. The influence of corruption is also emphasized (Qi & Ongena, 2019; Liu et al., 2020). It is important to stress that managing these factors might lead to a significant increase in funding for corporate environmental programs in the medium and even short term. This challenge is especially relevant for developing countries where firms' access to bank loans is difficult. However, during economic crises and nowadays, owing to the spread of the coronavirus pandemic, the problem of obtaining loans exists in highly developed countries too. For instance, the survey on the access to finance of enterprises in the euro area in the period from October 2020 to March 2021, conducted by the European Central Bank (2021), indicates no significant improvement in the availability of external financing and demonstrates faster growth rates of demand for external funds than availability.

In emerging and developing economies, where inflation targeting is not practiced, national currency depreciation, as pointed by Ha et al. (2019), has large and persistent effects on inflation. If under these circumstances, the government does not im-

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plement a policy for tying up money, particularly in infrastructure projects, the central bank usually raises the discount rate, which increases the cost of borrowed capital. Financing green technologies requires the ease of access to long-term loans. In weak economies, banks associate long-term lending with high risks, which significantly complicates fixed investment. To a certain extent, these risks are explained by the poor financial management of the borrowing enterprises. In favorable market conditions, such enterprises unjustifiably increase the debt-to-equity ratio, which leads to problems with the payment of interest and loan repayment in the event of declining sales.

To support developing country policymakers in solving the problem of improving access to finance, as a key component of entrepreneurship policy framework, UNCTAD has developed a complex of recommended actions. It includes the development of public credit guarantee schemes, incentives for creating private mutual guarantees, promotion of foreign direct investment and collateral-free loan screening mechanisms, providing performance-based loans and stimuli for innovation and green growth, facilitating the use of the intellectual property as collateral, etc. (UNCTAD, 2021). The topicality of these measures is growing against the backdrop of fears of a sudden capital outflow from emerging and developing economies in the event of Taper Tantrum repeat.

Confirmation of *H4* indicating that a high GDP level does not belong to the fundamental premise of improving environmental standards is consistent with the results of some other empirical studies. For instance, Pellegrini and Gerlagh (2006) argued that environmental standards are more likely to reflect institutional quality than income levels. Dluhopolskyi et al. (2019) indicated the absence of a fatal character in the relationship between economic growth and national environmental performance. It was underscored that investments in the quality of management and institutions more significantly affect EPI.

CONCLUSION

This paper used the international rankings datasets, the World Bank statistics, the sample of 81 countries, and the technique for constructing nonlinear regression models based on the normalizing transformations for non-Gaussian data. It was revealed that environmental performance is predicted with sufficient accuracy by a model of its dependence on the indicators of corruption, innovation output, and the factors, which can be considered like environmental management tools. The latter is instrumental for managing environmental sustainability because their changes are subject to short- and medium-term development programs. These include the effect of taxation on incentives to invest, ease of access to loans, minority shareholders protection, judicial independence, and favoritism in decisions of government officials.

GDP per capita cannot be regarded as the main determinant of environmental performance. Including this indicator in the EPI model, together with the above factors, does not significantly affect the result accuracy but changes the model shape from linear to nonlinear. At the same time, the study makes it possible to assert that EPI depends on the institutional environment in the social dimension, access to financial resources, and economic innovativeness.

The findings may be of interest to policymakers and practitioners. Reforms to strengthen judicial independence and prevent favoritism in decisions of government officials are of great importance. This is a prerequisite for the adoption of effective environmental laws and their proper implementation. A positive result can be expected from the inclusion of the principles of corporate social responsibility in government and industries regulation.

One of the financial policy's key objectives is finding a balance between an environmental tax increase and a reduction of the general tax burden on enterprises through investment incentives, such as allowances, accelerated depreciation, tax credits, and holidays. When solving this problem, the national economy specifics, investment climate, and risks to deteriorate the taxation conditions should be considered. Since the effect of tax incentives diminishes in conditions favorable for capital transfer to low or no-tax jurisdictions, the Action Plan on Base Erosion and Profit Shifting implementation on a national level is advisable.

For sufficient funding state, regional, and corporate environmental programs, the financial policy has to include inflation targeting and tying up money in infrastructure projects. The multi-action approach comprising public credit guarantee schemes, incentives for creating private mutual guarantees, collateral-free loan screening mechanisms, performance-based loans, stimuli for innovation and green growth, and intellectual property used as collateral could be effective for developing countries. As the access to loans depends on firm creditworthiness, environmental sustainability strategies also require financial management improvement.

The prospect for further research is to determine the effect of specific reforms in the financial, tax, investment policies, the judicial system, and corruption control on the EPI score. The studies have to compare environmental performance in both national economies and groups of countries with a common socio-economic policy, such as the EU.

AUTHOR CONTRIBUTIONS

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REFERENCES

1. Alhassan, A., Usman, O., Ike, G. N., & Sarkodie, S. A. (2020). Impact assessment of trade on environmental performance: accounting for the role of government integrity and economic development in 79 countries. *Heliyon, 6*(9). https://doi.org/10.1016/j.heliyon.2020.e05046
2. Almeida, T. A. N., & García-Sánchez, I.-M. (2017). Sociopolitical and economic elements to explain the environmental performance of countries. *Environmental Science and Pollution Research, 24,* 3006-3026. https://doi.org/10.1007/s11356-016-8061-7
3. Al-mulali, U., Weng-Wai, C., Sheau-Ting, L., & Mohammed, A. H. (2015). Investigating the environmental Kuznets curve (EKC) hypothesis by utilizing the ecological footprint as an indicator of environmental degradation. *Ecological Economics, 48,* 315-323. https://doi.org/10.1016/j.ecolind.2014.08.029
4. Aşıcı, A. A. (2013). Economic Growth and its Impact on Environment: A Panel Data Analysis. *Ecological Indicators, 24,* 324-333. https://dx.doi.org/10.1016/j.ecolind.2012.06.019
5. Australian Taxation Office. (2021). *Guide to depreciating assets 2021.* Retrieved from https://www.ato.gov.au/Forms/Guide-to-depreciating-assets-2021/
6. Basrija, A., & Handoyo, S. (2019). The Relevance of Public Governance to National Environmental Performance. *Journal of Accounting Auditing and Business, 2*(2),

http://dx.doi.org/10.21511/ppm.19(3).2021.07

1-13. https://doi.org/10.24198/jaab.v2i2.22671

7. Bermperoglou, D., Deli, Y., & Kalyvitis, S. (2019). *Investment tax incentives and their big time-to-build fiscal multiplier* (Kiel Working Paper No. 2143). Kiel Institute for the World Economy (IfW). Retrieved from https://www.econstor.eu/bitstream/10419/209593/1/1685716261.pdf

8. Bernard, J., & Mandal, S. K. (2016). The impact of trade openness on environmental quality: an empirical analysis of emerging and developing economies. *WIT Transactions on Ecology and the Environment, 203*, 195-208. https://dx.doi.org/10.2495/EID160181

9. Bradshaw, C. J. A., & Di Minin, E. (2019). Socio-economic predictors of environmental performance among African nations. *Scientific Reports, 9*(1), 9306. https://doi.org/10.1038/s41598-019-45762-3

10. Chatterjee, S., & Price, B. (2012). *Regression analysis by example*. New York: John Wiley & Son.

11. Cole, M. A., Elliott, R. J. R., & Fredriksson, P. G. (2006). Endogenous Pollution Havens: Does FDI Influence Environmental Regulations? *The Scandinavian Journal of Economics, 108*(1), 157-178. https://doi.org/10.1111/j.1467-9442.2006.00439.x

12. Dinda, S. (2004). Environmental Kuznets Curve Hypothesis: A Survey. *Ecological Economics, 49*(4), 431-455. https://doi.org/10.1016/j.ecolecon.2004.02.011

13. Dkhili, H., & Dhiab, L. B. (2019). Environmental Management Efficiency of GCC Countries: Linking Between Composite Index of Environmental Performance, Socio-Political and Economic Dimensions. *Marketing and Management of Innovations, 1*, 57-69. http://doi.org/10.21272/mmi.2019.1-05

14. Dkhili, H. (2019). Environmental Performance and Economic Growth in Middle East and North Africa Countries. *Journal of Health and Pollution, 9*(24), 191208. https://doi.org/10.5696/2156-9614-9.24.191208

15. Dluhopolskyi, O., Koziuk, V., & Ivashuk, Y. (2019). Environmental Welfare: Quality of Policy vs. Society's Values. *Problemy Ekorozwoju – Problems of Sustainable Development, 14*(1), 19-28. Retrieved from https://ekorozwoj.pollub.pl/no27/d.pdf

16. European Central Bank. (2021). *Survey on the Access to Finance of Enterprises in the euro area.* Retrieved from https://www.ecb.europa.eu/stats/ecb_surveys/safe/html/ecb.safe202106~3746205830.en.html#toc11

17. European commission. (2019). *Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions. The European Green Deal. COM 2019 640 final.*

18. Fakher, H-A., & Abedi, Z. (2017). Relationship between Environmental Quality and Economic Growth in Developing Countries (based on Environmental Performance Index). *Environmental Energy and Economic Research, 1*(3), 299-310. https://dx.doi.org/10.22097/EEER.2017.86464.1001

19. Fiorino, D. J. (2011). Explaining National Environmental Performance: Approaches, Evidence, and Implications. *Policy Sciences, 44*(4), 367. https://doi.org/10.1007/s11077-011-9140-8

20. Fredriksson, P., & Neumayer, A. (2013). Democracy and climate change policies: Is history important? *Ecological Economics, 95*, 11-19. https://doi.org/10.1016/j.ecolecon.2013.08.002

21. García-Sánchez, I.-M., Almeida, T. A. N., & Camara, R. P. B. (2015). A proposal for a Composite Index of Environmental Performance (CIEP) for countries. *Ecological Indicators, 48*, 171-188. https://doi.org/10.1016/j.ecolind.2014.08.004

22. Chatterjee, S., & Price, B. (2012). *Regression analysis by example*. New York: John Wiley & Son.

23. Cornell University, INSEAD, & WIPO. (2018). *The Global Innovation Index.* Retrieved from https://www.wipo.int/edocs/pubdocs/en/wipo_pub_gii_2018-intro5.pdf

24. Global Footprint Network. (2021). *Data and Methodology.* Retrieved from https://www.footprintnetwork.org/resources/data/

25. Gorham, E, Lehman, C., & Kelly, J. (2019). Relationships of the Environmental Performance Index to Six Interrelated Variables in Nations Around the World. *Bulletin of Ecological Society of America, 100*(2), e01525. https://doi.org/10.1002/bes2.1525

26. Gozgor, G. (2017). Does trade matter for carbon emissions in OECD countries? Evidence from a new trade openness measure. *Environmental Science and Pollution Research, 24*, 27813-27821. https://doi.org/10.1007/s11356-017-0361-z

27. Ha, J., Kose, M. A., & Ohnsorge, F. (2019). *Understanding inflation in emerging and developing economies* (Working Paper No. 1902). Koç University-TÜSİAD Economic Research Forum. Retrieved from http://hdl.handle.net/10419/202991

28. Halkos, G., & Zisiadou, A. (2016). *Environmental performance index and economic welfare* (MPRA Paper No. 75561). University Library of Munich. Retrieved from https://www.researchgate.net/publication/327118670_Environmental_performance_index_and_economic_welfare

29. Handoyo, S., & Fitriyah, F. K. (2019). Public Governance and Environmental Performance: An International Perspective. *Journal of Accounting Auditing and Business, 2*(2), 77-89. https://doi.org/10.24198/jaab.v2i2

30. Holmberg, S., Rothstein, B., & Nasiritousi, N. (2009). Quality of government: what you get. *Annual Review of Political Science, 12*(1), 135-161. https://doi.org/10.1146/annurev-polisci-100608-104510

31. Irdhad, H., & Hussain, A. (2017). *Analysis of Ecological Efficiency and its Influencing Factors in Developing Countries* (Working Paper No. 11). Pakistan Institute

of Development Economics. Retrieved from https://www.pide.org.pk/pdf/Working%20Paper/EE_Working_Paper-11.pdf

32. Johnson, R. A., & Wichern, D. W. (2007). *Applied Multivariate Statistical Analysis*. Upper Saddle River, New Jersey: Pearson Prentice Hall.

33. Jun, J. (2010). Korea's Tax System: A Growth-Oriented Choice. In R. H. Gordon (Ed.), *Taxation in Developing Countries: Six Case Studies and Policy Implications* (pp. 220-254). New York: Columbia University Press. https://doi.org/10.7312/gord14862

34. Kim, D., & Go, S. (2020). Human Capital and Environmental Sustainability. *Sustainability*, *12*(11), 4736. https://doi.org/10.3390/su12114736

35. Kumar, S., Giridhar, V., & Sadarangani, P. (2019). A Cross-national Study of Environmental Performance and Culture: Implications of the Findings and Strategies. *Global Business Review, 20*(4), 1051-1068. https://doi.org/10.1177/0972150919845260

36. Lai, S. L., & Chen, D.-N. (2020). A Research on the Relationship between Environmental Sustainability Management and Human Development. *Sustainability*, *12*(21), 9001. https://doi.org/10.3390/su12219001

37. Lee, S-H., & Thiel, M. (2017). Relations between GDP growth and environmental performance using latent growth curve model applied for environmental Kuznets curve. *International Journal of Sustainable Economy (IJSE), 9*(2), 87-104. https://dx.doi.org/10.1504/IJSE.2017.083362

38. Liu, P., Li, H., & Guo, H. (2020). The impact of corruption on firms' access to bank loans: evidence from China. *Economic Research-Ekonomska Istraživanja, 33*(1), 1963-1984. https://doi.org/10.1080/1331677X.2020.1768427

39. Mardia, K. V. (1970). Measures of multivariate skewness and kurtosis with applications. *Biometrika, 57*(3), 519-530. https://doi.org/10.1093/biomet/57.3.519

40. NEFCO. (2021). *Comment regarding Green Tariffs in Ukraine For the European-Ukrainian Energy Agency*. Retrieved from https://euea-energyagency.org/wp-content/uploads/2021/06/Green-tariffs-Ukraine_Comment-by-Nefco_3-June-2021.pdf

41. OECD. (2013). *Action Plan on Base Erosion and Profit Shifting*. http://dx.doi.org/10.1787/9789264202719-en

42. Olkin, I., & Sampson, A. R. (2001). Multivariate Analysis: Overview. In N. J. Smelser, & P. B. Baltes (Eds.), *International encyclopedia of social & behavioral sciences* (pp. 10240-10247). Oxford: Pergamon.

43. Pellegrini, L., & Gerlagh, R. (2006). Corruption and Environmental Policies: What Are the Implications for the Enlarged EU? *European Environment, 16*(3), 139-154. https://doi.org/10.1002/eet.414

44. Povitkina, M. (2015). *Democracy, Bureaucratic Capacity and Environmental Performance* (Working Paper Series 2015:13). University of Gothenburg. Retrieved from https://www.gu.se/sites/default/files/2020-05/QoGWP_2015_13_Povitkina_MP_changes.pdf

45. Prykhodko, S., & Prykhodko, N. (2021). Mathematical Modeling of Non-Gaussian Dependent Random Variables by Nonlinear Regression Models Based on the Multivariate Normalizing Transformations. In S. Shkarlet, A. Morozov, & A. Palagin (Eds.), *Mathematical Modeling and Simulation of Systems (MODS'2020). MODS 2020. Advances in Intelligent Systems and Computing, 1265* (pp. 166-174). Springer, Cham. https://doi.org/10.1007/978-3-030-58124-4_16

46. Prykhodko, S., Prykhodko, N., Makarova, L., & Pugachenko, K. (2017). Detecting outliers in multivariate non-Gaussian data on the basis of normalizing transformations. *Proceedings of the IEEE First Ukraine Conference on Electrical and Computer Engineering (UKRCON),* 846-849. Kyiv. https://doi.org/10.1109/UKRCON.2017.8100366

47. PwC. (2018). *Worldwide Tax Summaries – Corporate Taxes 2017/18.* Retrieved from https://www.pwc.com/gx/en/tax/corporate-tax/worldwide-tax-summaries/pwc-worldwide-tax-summaries-corporate-taxes-2017-18-europe.pdf

48. Qi, S. S., & Ongena, S. (2019). Will money talk? Firm bribery and credit access. *Financial Management, 48*(1), 117-157. https://doi.org/10.1111/fima.12218

49. Raymond, L. (2004). Economic growth as environmental policy? Reconsidering the environmental Kuztnes curve. *Journal of Public Policy*, *24*(3), 327-348. https://doi.org/10.1017/S0143814X04000145

50. Rohov, H., Kolodiziev, O., Shulga, N., Krupka, M., & Riabovolyk, T. (2020). Factors affecting the dividend policy of non-financial joint-stock companies in Ukraine. *Investment Management and Financial Innovations, 17*(3), 40-53. http://dx.doi.org/10.21511/imfi.17(3).2020.04

51. Samimi, A. J., Kashefi, A., Salatin, P., & Lashkarizadeh, M. (2011). Environmental Performance and HDI: Evidence from Countries Around the World. *Middle-East Journal of Scientific Research, 10*(3), 294-301. Retrieved from https://www.idosi.org/mejsr/mejsr10(3)11/3.pdf

52. Sarmidi, T., Nor, A., & Ridzuan, S. (2015). Environmental stringency, corruption and foreign direct investment (FDI): Lessons from global evidence. *Asian Academy of Management Journal of Accounting and Finance, 11*(1), 85-96. Retrieved from https://www.researchgate.net/publication/282951221_Environmental_stringency_corruption_and_foreign_direct_investment_FDI_Lessons_from_global_evidence/stats

53. Sekrafi, H., & Sghaier, A. (2018). The effect of corruption on carbon dioxide emissions and energy consumption in Tunisia. *PSU Research Review, 2*(1), 81-95. https://doi.org/10.1108/PRR-11-2016-0008

54. Shahabadi, A., Samari, H., & Nemati, M. (2017). Factors Affecting Environmental Performance Index (EPI) in Selected OPEC Countries. *Iranian Economic Review, 21*(3), 457-467. Retrieved from https://www.sid.ir/en/journal/ViewPaper.aspx?id=612644

55. The Carbon Brief. (2021). *The Carbon Brief Profile: South Africa*. Retrieved from https://www.carbonbrief.org/the-carbon-brief-profile-south-africa

56. The United Nations. (2015). *Resolution adopted by the General Assembly on 25 September 2015. Transforming our world: the 2030 Agenda for Sustainable Development.* Retrieved from https://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E

57. The White House. (2021). *Leaders Summit on Climate Summary of Proceedings.* Retrieved from https://www.whitehouse.gov/briefing-room/statements-releases/2021/04/23/leaders-summit-on-climate-summary-of-proceedings/

58. The World Bank. (2018). *Indicators*. Retrieved from https://data.worldbank.org/indicator

59. Transparency International. (2018). *The Corruption Perception Index.* Retrieved from https://www.transparency.org/en/cpi/2018/index/dnk

60. UNCTAD. (2021). *Entrepreneurship Policy Framework and Implementation Guidance. Improving Access to Finance.* Retrieved from https://unctad.org/topic/enterprise-development/entrepreneurship-policy-hub/5-Access-to-Finance

61. UN-DESA. (2018). *Design and Assessment of Tax incentives in Developing Countries.* Retrieved from https://www.un.org/esa/ffd/publications/design-and-assessment-of-tax-incentives-in-developing-countries.html

62. UNDP. (2021). *Human Development Index (HDI).* Retrieved from http://hdr.undp.org/en/content/human-development-index-hdi

63. Wang, C., Cardon, P.W, Liu J., & Madni, G. R. (2020). Social and economic factors responsible for environmental performance: A global analysis. *PLoS ONE, 15*(8), e0237597. https://doi.org/10.1371/journal.pone.0237597

64. Wendling, Z. A., Emerson, J. W., Esty, D. C., Levy, M. A., de Sherbinin, A., Spiegel, N. R., Pinkerton, V., Boucher, L., Ratté, S., Mardell, S., Ichihara, M., Battles, J., & Quay, A. N. (2018). *2018 Environmental Performance Index*. New Haven, CT: Yale Center for Environmental Law & Policy. Retrieved from https://epi.yale.edu/downloads/epi2018reportv06191901.pdf

65. Winslow, M. (2005). Is Democracy Good for the Environment? *Journal of Environmental Planning and Management, 4*(5), 771-783. https://doi.org/10.1080/09640560500183074

66. World Economic Forum. (2016). *The Global Competitiveness Index (GCI).* Retrieved from http://reports.weforum.org/global-competitiveness-report-2015-2016/competitiveness-rankings/

67. Xu, K., Loh, L., & Chen, Q. (2020). Sustainable Innovation Governance: An Analysis of Regional Innovation with a Super Efficiency Slack-Based Measure Model. *Sustainability, 12*(7), 3008. https://doi.org/10.3390/su12073008

APPENDIX A

Table A1. The initial dataset for constructing the regression models

No	Y	X_1	X_2	X_3	X_4	X_5	X_6	X_7
1	81.6	13	3.1	2.9	5.5	56120.1	5	88
2	80.51	3	3.7	4.1	5.5	53119.7	5.1	85
3	78.64	8	3.6	4	6	48635.9	6.1	85
4	77.49	24	3.8	4.3	5.9	63756.3	6	84
5	75.46	2	4.4	3.1	5.7	56772	5.3	82
6	79.12	4	5.3	4.4	5.5	111908	5.5	81
7	72.18	26	4.1	3.8	5.2	47870.7	5.4	81
8	79.89	6	4.4	2.7	5.3	46239.7	5.4	80
9	78.37	5	3.8	3.3	5.1	54327.1	4.7	80
10	78.57	19	3.8	2.8	4.8	57597.3	4.8	76
11	78.97	28	3.1	2.9	4.5	56253.1	4.9	76
12	77.38	23	3	3.3	5.1	50774.9	5	75
13	78.77	9	4.7	2.2	5.6	84069.4	4.8	73
14	64.31	17	4.7	3.3	4.9	35747.4	4.3	73
15	83.95	16	2.9	3.8	4.5	45877.1	4.5	72
16	71.19	7	4	3.9	4.3	62641	5.1	71
17	64.65	59	3.6	2.8	4.9	23530.6	4.6	70
18	57.49	53	3.7	3.7	4.3	25283.9	4.4	67
19	71.91	33	3	2.4	4	34065.2	4.1	64
20	51.7	107	4.6	3	4.1	18583	4.4	61
21	67.57	29	2.7	1.6	3.1	38674.4	3.4	60
22	64.11	40	3.3	2.6	3.7	32356.5	4.1	60
23	69.33	44	3.5	2.6	3.5	33252.7	3.8	59
24	67.68	20	3.8	3.3	3.5	39998.4	4.3	59
25	72.6	22	4.7	2.4	3.8	36155.5	4.3	59
26	78.39	27	3	1.7	3.2	40854.6	3.7	58
27	66.12	38	3.8	2.5	3.5	28362	3.9	58

No	Y	X_1	X_2	X_3	X_4	X_5	X_6	X_7
28	55.69	62	4.8	2.4	3.8	11420.6	3.8	58
29	43.68	120	4.1	3.2	5.1	2253.5	4.9	56
30	67.85	51	3.3	2.2	4.1	17645.1	4.4	56
31	80.9	14	4.6	3.8	4	41548.5	4.9	54
32	58.46	103	4.1	2.8	3.9	11134.8	4.9	53
33	76.96	32	1.9	1.6	2.9	42080.4	3.5	52
34	70.6	36	3.2	3.3	2.2	34329.3	3.7	50
35	65.45	42	2.4	2.4	2.9	26295.5	3.5	48
36	64.78	48	2.9	2.9	3.2	26595.4	3.7	47
37	59.22	39	5.2	4.8	4.8	31698.4	5.3	47
38	65.01	25	3	2	2.9	30978.9	3.8	46
39	61.33	55	3.9	3	3.3	19354.9	3.7	45
40	73.6	52	2.5	1.7	3.3	29873.6	4.1	45
41	62.35	63	3.8	2.8	3.5	12483.5	3.9	43
42	44.73	65	3.9	3.5	4	13661.4	6	43
43	67.85	34	3.8	3	2.5	20948.1	3.7	42
44	52.96	43	3.5	2.9	2.9	28815.5	4.1	41
45	49.66	102	3.8	2.9	3.6	4738.3	4.1	41
46	59.3	81	1.9	1.7	2.1	20567.3	3.3	40
47	57.49	58	2.9	2.2	2.5	16433.4	2.8	39
48	50.74	10	3.8	3.7	3.9	18210.1	4.1	39
49	60.61	80	3.8	2.9	3.5	13449.9	4.5	38
50	46.92	73	4.1	3.9	3.9	13056.6	4.3	38
51	62.71	66	4.7	4	2.7	25508.6	4.4	37
52	57.51	47	3.8	1.5	2.7	13735.4	3.3	37
53	61.06	93	4.6	3	3.3	15298.9	4.1	37
54	49.88	45	3.8	3.6	3.5	19017.7	4.7	36

No	Y	X_1	X_2	X_3	X_4	X_5	X_6	X_7
55	57.65	68	3.6	3.5	3.4	8935.3	4.4	36
56	65.22	72	2.7	2.8	2.5	14999.4	4.2	36
57	50.97	119	3.5	2.5	3.6	4216.5	4.5	35
58	61.92	83	3.4	3.2	2.7	14393.5	4.2	35
59	53.91	113	3.2	3	3	8317	3.6	35
60	61.21	79	3.4	1.9	4.3	12390.4	3.9	35
61	60.7	70	2	2.7	2.7	16068	3.9	35
62	62.07	50	3.5	2.5	3	10324.9	3.6	35
63	57.42	97	2.6	3.4	2.2	11713.7	3.7	34
64	46.96	41	3.6	2.6	3.3	7434.7	3.6	33
65	37.5	92	3.7	2.6	3.3	5543.9	3.5	33
66	51.97	37	3.4	2.4	2.1	7300.9	3.3	33
67	52.87	35	2.7	2.6	2.5	9233.2	2.9	32
68	49.21	108	2.8	2.3	3.1	1308.7	4	32
69	54.56	91	4.1	3.2	3.6	27830.6	4.3	31
70	64.71	77	3.2	2.8	2.4	17798.8	3.9	30
71	53.93	86	5	3	2.1	13570.9	3.6	29
72	54.86	101	3.4	2.3	2.8	3877.9	3.3	29
73	51.51	106	3.2	2.9	3.2	5129.7	4.2	29
74	55.98	117	3.5	3.6	2.7	7859.3	3.7	29
75	63.79	56	3.1	3	2.9	27147.3	3.5	28
76	59.69	61	3.1	2.4	2.8	19969.5	4.2	28
77	58.16	46	3.5	1.6	3.5	21011.3	3.4	28
78	44.28	111	3.2	2.5	3	2033.3	3.6	26
79	29.56	105	3.5	2.4	2.3	4364	3.1	26
80	47.85	88	3.2	3.6	3.8	3443.7	3.7	25
81	46.37	109	3.5	1.9	2.6	1327.9	3.4	23

http://dx.doi.org/10.21511/ppm.19(3).2021.07