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RESEARCH ON THE IMPACT OF FINANCIAL DEVELOPMENT AND HUMAN CAPITAL ON THE SUSTAINABLE DEVELOPMENT GOALS IN CENTRAL AND EASTERN EUROPEAN COUNTRIES (CEECS): EVIDENCE FROM ECONOMETRIC APPROACHES

Gamze Göçmen Yağcılar[1], Mehmet Levent Erdaş[2]✉, Zühal Arslan[3]

[1] *Suleyman Demirel University, Isparta, Türkiye*
[2] *Akdeniz University, Antalya, Türkiye*
[3] *Isparta University of Applied Sciences, Türkiye*

ABSTRACT

In this paper, cointegration and causality relationship among human development (HDI), financial development (FDI) and sustainable development (ESG) for five CEECs are investigated. In the study covering the period 1990–2022, Hatemi-J (2008) test was used to investigate cointegration relationships. The results revealed the existence of a long-term relationship between FDI-ESG and HDI-ESG variables in four countries except the Czech Republic. In the causality analysis, Enders and Jones's (2016) Fourier Granger causality and Gormus et al. (2018) Fourier Toda and Yamamoto tests were first applied. The findings provide strong evidence that human capital has an effect on sustainable development. On the other hand, findings that financial development has an effect on sustainable development were seen only in Romania. However, strong evidence has been obtained in Romania, Hungary and Bulgaria that sustainable development has an impact on financial development. In the last stage, Hatemi-J (2012, 2014) asymmetric causality test, which takes into account the effects of positive and negative cumulative shocks in the causal relationships, was used. In all countries except Poland, causality from positive shocks in HDI to ESG was found. The relationships between FDI and ESG are more limited and complex. This study contributes to the literature by investigating the symmetric and asymmetric relationships between ESG-FDI and ESG-HDI within the scope of CEEC and provides original policy implications based on the findings obtained at the country level.

KEY WORDS

financial globalization, Human Development Index, ESG performance, symmetry and asymmetry relation, Central and Eastern European countries

JEL CODES

C22, O15, O16, Q01

1 INTRODUCTION

It was not until the last few decades that the phenomenon of scarcity of resources, which is part of the traditional definition of economics, has become so noticeable, breaking out of the theoretical framework that everyone has memorized. Humanity has begun to realize that technological advances are not enough to sustain the level of prosperity it has achieved over the centuries, and how much it is dependent on the bounty of nature. The integration of the theme of sustainability into the understanding of development is the result of this awareness and is based on the realization that economic growth alone is not sufficient in evaluating the level of development of countries, and that the welfare achieved should also be bequeathed to future generations.

When we use today's means and resources to achieve maximum prosperity, it will not be possible to ensure the continuity of development in the following years due to depleted resources. Therefore, it would not be wrong to say that the concept of sustainability prioritizes human well-being and is rooted in the desire to bequeath this well-being to future generations. Because in essence, what is meant by sustainability is the continuation of human development, and without sustainability, it is not possible to talk about human development in the real sense (Neumayer, 2010). Maccari (2014) argues that human development is both the goal and the means of economic development. Economic development supports human development by providing decent living standards. However, efforts towards sustainable economic development require a certain level of education, culture and awareness, which is only possible through the education and enlightenment that high human development provides. Indeed, a significant number of the Sustainable Development Goals (SDGs) developed by the United Nations Development Program (UNDP) for the 2030 Agenda are directly related to Human Development (Conceição, 2019). Many studies also mention the close relationship between sustainable development and human development (Anand and Sen, 2000; Scully-Russ, 2012; Helne and Hirvilammi, 2015; Neag and Halmaghi, 2019; Long et al., 2020; Zhang and Wu, 2022; Bekele et al., 2024).

The Environmental, Social and Corporate Governance (ESG) framework was born as a business development approach to modelling sustainable economic development (UNDP, 2024a) and is a widely used indicator for measuring sustainability performance at the firm or country level (Naomi and Akbar, 2021). Country-level studies have looked at the relationship between human development and different sustainability indicators. For example, Opoku et al. (2022) focused on the relationship between human development and environmental sustainability, while Bekele et al. (2024) focused on economic sustainability. Studies on ESG have been conducted at the firm scale and have associated ESG with human capital (Kotsantonis and Serafeim, 2020; Cai et al., 2024; Pham et al., 2024; Song, 2024). A study examining the relationship between ESG and Human Development at the country scale belongs to Naomi and Akbar (2021), who found a positive and significant relationship for 37 OECD countries. This study has a similar objective, taking country-level ESG scores as an indicator of sustainability and linking it with the human development index (HDI). Analyses are conducted for five Eastern European countries individually and country-level findings are obtained.

Another important factor in supporting the development of ESG criteria both at the country and firm level is financial development. Financial development, which refers to a system in which financial markets deepen, financial institutions develop, capital inflows increase and innovative financial products emerge, also increases access to financial instruments and enables wider segments to benefit from financial services (IMF, 2023; World Bank, 2024). In this way, green bonds and similar sustainable financial products developed to fund environmental projects may encourage ESG-oriented investments. In parallel, ESG understanding can be more recognized, adopted and spread by firms, investors and other segments of society. A well-developed financial system can also support more effective measurement and management of ESG-related risks. In this

context, analyzing the ESG-FDI relationship constitutes another objective of this study. A study investigating the role of financial development in ESG practices belongs to Ng et al. (2020). In the study, it was stated that the functions of financial development contribute to the prevention of environmental degradation and revealed that financial development is very important in achieving ESG goals for 42 Asian countries. Kırıkkaleli and Adebayo (2020) on a global scale and Wu et al. (2023) for Nordic countries concluded that financial development has a significant impact on environmental sustainability.

This study contributes to the literature in several ways. First of all, it is recognized that there is a gap in the literature on sustainability and human development in Eastern European countries and the study contributes to the literature in this sense. In addition, the relationship between the Human Development Index, which meets some of the Sustainable Development Goals, and ESG scores, which are considered as a measure of sustainability investments at the country level, is considered as a worthy topic for research. Our study differs from Naomi and Akbar (2021) in terms of the period and sample analyzed as well as the country-based results. Considering the costly nature of ESG investments, the FDI-ESG relationship is another research topic of the study in order to take into account the differences between countries in terms of its financing, and important policy implications have been obtained at this point.

The main objective of this study is to find out whether financial development and human development are related to ESG scores in Central European countries. Accordingly, after the introduction, this study first presents the studies that examine the relationship between ESG scores and financial development and ESG scores and human development. In the section following the literature summary, the data set and methodology used in the analysis are explained. Then, the findings obtained from the analysis results are presented. In the last section, the findings are discussed and policy recommendations are given. The study is expected to contribute to the literature in terms of investigating the symmetric and asymmetric effects of financial development and human development factors on ESG scores representing sustainable development through Central European countries and by using new econometric analysis methods. Suggestions regarding the analyses results have also been made to reveal the relationships between the variables in question and to take necessary measures for sustainable development.

2 LITERATURE REVIEW

This section includes investigates that examine the relationship between Human Development and Financial Development and ESG scores. However, due to the limited number of studies on ESG scores at the country level, the research is analyzed within the scope of ESG sub-dimensions of environmental, social and corporate governance.

In terms of human development and environmental sustainability, Omri et al. (2019) show that positive developments in human development increase environmental sustainability; Jain and Nagpal (2019) show that the human development index is positively correlated with the environmental performance index; Omri and Mabrouk (2020) show that increasing human development leads to a reduction in carbon dioxide emissions; Yumashev et al. (2020) found that the volume of energy consumption not only affects the human development index in a given country, but is also an important factor in determining the level of sustainable development; Opoku et al. (2022) found that an increase in human development leads to a decrease in ecological footprint, carbon dioxide and greenhouse gas emissions and leads to better and positive environmental sustainability; Arab et al. (2022) found that environmental sustainability increases with an increase in the human development index. In addition, Wang et al. (2023) found that renewable energy consumption, ecological governance and human development positively affect green growth; Rahman and Sultana (2024) concluded that if conscious investments are made in

the socio-economic aspects of human development, demand for renewable energy will increase and environmental sustainability will improve by reducing carbon emissions.

In terms of human development and social sustainability, Šlaus and Jacobs (2011) conclude that the development of human and social capital and innovation are critical determinants of long-term sustainability and that the emergence of mentally conscious individuals will be the most effective approach to ensure a sustainable future; Castells-Quintana et al. (2019) conclude that there is a long-term negative relationship between inequality and education and human development; and Tanjung (2021) conclude that there is no direct relationship between ESG and human development index.

Regarding the relationship between human development and corporate governance; Pradhan and Sanyal (2011) argue that a better institutional mechanism and good corporate governance will accelerate the country's development process and increase the level of human development; Davis (2017) argues that policies and efforts aimed at increasing good governance, government effectiveness and political stability are the most important factors in human development and poverty reduction; Keser and Gökmen (2018) find that improved performance on governance indicators such as government effectiveness, board regulatory factors and rule of law will increase the level of human development; Asongu and Odhiambo (2020) find that improvements in corporate governance will have a net positive impact on human development. In addition, Sarpong and Bein (2021) find that corporate governance efforts are important for improving human development; Rizkallah (2022) find that good corporate governance contributes to achieving sustainable human development only in the short term; Erkoyuncu and Aşkun (2023) find that the relationship between governance and human development is complex and may vary depending on the specific governance dynamics of each country; Ezako (2024) find that governance effectiveness positively affects human development.

In terms of financial development and environmental sustainability, there are different views on the positive, negative and neutral relationship between financial development and environmental sustainability. Looking at the studies that found a positive relationship between financial development and environmental sustainability; Li et al. (2015) found that there is a positive and strong mutual relationship between financial development and environmental quality; Kırıkkaleli and Adebayo (2020) found that financial development has a significant positive impact on environmental sustainability in the long run; Ng et al. (2020), Kayani et al. (2020), Adebayo et al. (2021), Ruza and Caro-Carretero (2022), Usman et al. (2022), Aslam et al. (2023), Khanday et al. (2023), Wu et al. (2023), Asif et al. (2024) concluded that financial development is positively related to environmental performance and Shobande and Ogbeifun (2022) concluded that financial development should be prioritized to reduce carbon emissions and promote sustainability. When the studies that argue that financial development has a negative relationship with environmental sustainability, in other words, environmental degradation will increase as the level of financial development increases; Shahbaz et al. (2020), Umar et al. (2020), Sethi et al. (2020), Yang et al. (2021), Sahoo et al. (2021), Musah et al. (2022), Ju et al. (2023), Pei et al. (2023), Nasreen et al. (2023), Fakher and Ahmed (2023), Stolbov and Shchepeleva (2024) found that as the level of financial development increases, carbon emissions increase and environmental sustainability is negatively affected. In addition, Xu et al. (2022) found that domestic credit to the private sector within the scope of financial development increases total carbon emissions and environmental quality deteriorates and environmental performance decreases. When analyzing the studies arguing that financial development has a neutral relationship with environmental sustainability, in other words, the increase or decrease in the level of financial development does not affect environmental performance, Alhassan et al. (2022) found that carbon emissions have a neutral effect on financial development. In addition, Uche and Effiom (2021) found that there

are stronger asymmetric effects between financial development and carbon emissions in the long run compared to the short run.

Looking at the studies examining the relationship between financial development and social sustainability; Feng et al. (2018) found that there is a positive relationship between financial development and corporate social responsibility; Pradhan et al. (2013) found that there is a long-term relationship between financial development and social performance; Yahya et al. (2022) found that financial development has a positive and significant impact on sustainable competitiveness and financial development increases resource efficiency and social performance. In addition, Cuesta et al. (2022) found that expanding access to financial markets will improve social sustainability by strengthening social cohesion and reducing inequality; Turhan et al. (2023) found that financial development and educational achievement have a positive impact on economic and social sustainability; and Ahmad et al. (2023) found that gender equality and intergroup cohesion will improve financial development.

When the studies based on the relationship between financial development and corporate governance are evaluated; Sayılır et al. (2018) and Bekana (2023) found that there is a positive relationship between corporate governance and financial development; Omri et al. (2021), Shehzad et al. (2023) found that sustainability will improve if the level of financial development increases with sector development, political and corporate governance; Solaymani and Montes (2024) found that encouraging foreign direct investment, which is an indicator of financial development, will realize positive sustainable growth when supported by good corporate governance and stable approaches.

3 DATA, METHODOLOGY AND EMPIRICAL RESULTS

In this section of the study, the data of the variables used in the study are introduced, basic information on the type and sources of the data and the econometric methods applied are given. This study investigates the effects of financial development and human capital on ESG score as a goal of sustainable development. The annual data used in this study cover the period from 1990 to 2022 for five Central and Eastern European Countries (Czech Republic, Poland, Romania, Hungary and Bulgaria). The availability of data for the variables has been effective in the consideration of the period and countries in question. The sample of this study is limited to five CEEC countries, as there is insufficient data for the Baltic States, Slovenia and Slovakia for the period under consideration. Since the last data announced at the time of the study belonged to 2022, the last period was determined in this way. Data on variables are obtained from secondary data sources. In the study, ESG score (PRSDA, 2025) is used to represent sustainable development, globalization index (ETH Zürich, 2025) is used to represent financial development and human development index (UNDP, 2024b) is used to represent economic development. Country-level ESG scores are obtained from the database created by the Pacific Rim Sustainable Development Association (Jiang, 2024). Financial Development index data are obtained from the Swiss Economic Institute database and human development data are obtained from human development reports published by the United Nations Development Program.

In the applied part of the study, the relationships between ESG score and financial development and human development are analyzed with time series methods. First, the degree of integration of the variables is analyzed by Fourier ADF (2012)[1] and Fourier GLS (2012)[2] unit root tests developed with Fourier functions. The existence of a long-run relationship between the variables is analyzed with the Hatemi-J (2008)[3] cointegration test with two possible regime changes. The

[1]For a detailed formulation of unit root tests, please see Enders and Lee (2012) test.
[2]For a detailed formulation of unit root tests, please see Rodrigues and Taylor (2012) test.
[3]For a detailed formulation of unit root tests, please see Hatemi-J (2008) cointegration test.

Tab. 1: Descriptive statistics of the selected variables

	Mean	Med.	Max.	Min.	Std. Dev.	Skew.	Kur.	Jar-Bera	Prob.
$\text{Czech}_{\text{ESG}}$	0.62872	0.62544	0.65538	0.60544	0.01844	0.23711	1.41271	3.77347	0.15156
$\text{Czech}_{\text{FDI}}$	4.38729	3.86354	10.33700	0.09000	2.60015	0.80228	3.02250	3.54083	0.17026
$\text{Czech}_{\text{HDI}}$	0.83866	0.85600	0.89600	0.74600	0.05199	−0.50441	1.83180	3.27585	0.19438
$\text{Poland}_{\text{ESG}}$	0.61336	0.60774	0.64870	0.58667	0.02252	0.26881	1.47966	3.57561	0.16732
$\text{Poland}_{\text{FDI}}$	3.12857	3.18944	6.23080	0.13489	1.59378	−0.01952	2.57703	0.24808	0.88334
$\text{Poland}_{\text{HDI}}$	0.81521	0.82400	0.88100	0.71100	0.05484	−0.52418	2.02394	2.82116	0.24400
$\text{Romania}_{\text{ESG}}$	0.62996	0.62310	0.66296	0.60536	0.02022	0.46097	1.71053	3.45497	0.17773
$\text{Romania}_{\text{FDI}}$	2.97518	2.78361	9.02006	0.00002	2.24096	1.10512	3.86924	7.75606	0.05069
$\text{Romania}_{\text{HDI}}$	0.76345	0.76800	0.83400	0.68300	0.05532	−0.13790	1.34572	3.86746	0.14460
$\text{Hungary}_{\text{ESG}}$	0.63678	0.63457	0.66304	0.61650	0.01577	0.29721	1.62049	3.10251	0.21198
$\text{Hungary}_{\text{FDI}}$	17.27730	7.56713	106.59400	2.13023	22.89200	2.32873	8.40185	69.94890	0.00000
$\text{Hungary}_{\text{HDI}}$	0.79818	0.81500	0.85400	0.71400	0.04762	−0.52041	1.79284	3.49324	0.17436
$\text{Bulgaria}_{\text{ESG}}$	0.61810	0.61661	0.64879	0.59558	0.01863	0.34792	1.64966	3.17296	0.20464
$\text{Bulgaria}_{\text{FDI}}$	5.95930	3.57471	31.22750	0.01938	6.88047	2.18989	7.62415	55.77740	0.00000
$\text{Bulgaria}_{\text{HDI}}$	0.75993	0.77000	0.81300	0.69800	0.04329	−0.25693	1.43815	3.71719	0.15589

short-run relationship between the variables is analyzed with the three-stage method. First, the symmetric causality relationship between the variables is analyzed with the cumulative frequency Granger[4] and Toda and Yamamoto[5] causality tests based on the bootstrap method and augmented with the Fourier approach. In the classical causality tests used in time series, the effects of positive and negative shocks are considered to be the same. Therefore, the shortcoming of this method is that it does not separate variables into positive and negative shocks. In this context, the relationships between the positive and negative components of the variables are analyzed with the help of Hatemi-J (2012, 2014)[6] asymmetric impulse response test based on the bootstrap method. Thus, in addition to the normal values of the series, positive and negative cumulative shocks were also used in the analyses in order to determine the direction of asymmetric causality between the variables. Gauss 24.0 package program, one of the econometric programs, was used for statistical estimation and analysis between variables.

Equation 1 shows the formal regression equation for the Hatemi-J (2008) cointegration test adapted to our model:

$$\text{ESG}_{it} = \mu_{i1} + \mu_{i2}\,\text{D}_{it} + \beta_{i1}\,\text{HDI}_{it} + \beta_{i2}\,\text{D}_{it}\,\text{HDI}_{it} + \gamma_{i1}\,\text{FDI}_{it} + \gamma_{i2}\,\text{D}_{it}\,\text{FDI}_{it} + \varepsilon_{it}, \qquad (1)$$

where ESG_{it} is ESG score of country i at time t (dependent variable), HDI_{it} is Human development index of country i at time t (independent variable), FDI_{it} is Financial development index of country i at time t (independent variable), D_{it} is Regime variable representing structural breaks, μ_1 is Constant before regime, μ_2 is Regime breaking effect at constant, β_{i1}, γ_{i1} are Coefficients before regime, β_{i2}, γ_{i2} are Post-regime coefficient differences, ε_{it} is Error term.

Tab. 1 presents the results of the descriptive statistics of the variables. The descriptive statistics in Tab. 1 show that the averages, maximum and minimum values in terms of ESG scores are quite close to each other. However, the country with the highest average is Hungary (0.63678) and the country with the lowest average is Poland (0.61336). The maximum value belongs to Romania

[4]For a detailed formulation of based on bootstrap symmetric causality test, please see Enders and Jones (2016) test.

[5]For a detailed formulation of based on bootstrap causality test, please see Gormus et al. (2018) test.

[6]For a detailed formulation of based on bootstrap asymmetric causality test.

with 0.66304 and the minimum value belongs to Poland with 0.58667. Nevertheless, it is worth underlining that the values are very close to each other. Accordingly, it can be said that the sustainability policies of the five countries analyzed in the period under consideration are close to each other. In terms of the financial development index (FDI), Hungary has the highest average. It is understood that the maximum value of 106.594 has an impact on this high average. The country with the lowest mean is Romania (2.97518) and the lowest FDI score is observed in Romania with 0.00002. It is noteworthy that the standard deviations for the FDI variable are higher than the other variables. It is understood that there have been significant changes in the financial development levels of countries over the years. The Czech Republic has the highest human development index (HDI) both in terms of average (0.83866) and maximum values (0.89600). The lowest values belong to Bulgaria in average (0.75993) and Romania in minimum (0.68300).

Fig. 1 reflects the evolution of selected variables of CEECs between the years 1990 and 2022. As seen in Fig. 1, the ESG score and HDI of Czech, Poland, Romania, Hungary and Bulgaria have an increasing trend and HDI and ESG scores of all selected countries exhibit similar characteristics between the selected years. However, FDI of all countries except Hungary display similar trends between the selected years. In general, it can be observed that the line of ESG score, FDI and HDI has monotonically displayed increasing trends between 1990 and 2022.

After examining the time dimension and trends of the variables, unit root tests were applied to obtain accurate results in time series analysis of variables and to determine whether they are stationary in a time series. Tab. 2 presents the Fourier ADF and Fourier GLS unit root test results for the variables.

The presence of a unit root in variables indicates that the variables are in a stochastic process. Fourier ADF and Fourier GLS unit root tests were used to investigate whether the variables have a stochastic process. When models with constant and constant and trend are estimated for all variables of the countries, the hypothesis H0, which expresses the unit root process, cannot be rejected for all variables except the Romanian ESG variable according to the Fourier-GLS test and for all variables except the Bulgarian-US FDI variable according to the Fourier-ADF test. Therefore, based on the results of both tests, it is determined that the ESG, FDI and HDI variables of the selected countries contain unit roots at level values, in other words, they are non-stationary. Here, the Fourier ADF test results support the Fourier GLS test results. According to the unit root test results, the fact that all variables contain unit roots indicates that the effect of shocks on the variables is permanent. After determining that the variables contain unit roots, that is, they are non-stationary, it is necessary to find out whether these variables move together in the long run. Hatemi-J (2008) cointegration test was applied to analyze whether the variables are cointegrated. Tab. 3 presents the results obtained from cointegration analysis.

Hatemi-J (2008) test results reveal the existence of cointegration relationship between ESG-FDI and ESG-HDI variable pairs for all countries except Czech Republic. According to the ADF and Z_t test statistics of the GH test in Tab. 3, the null hypothesis of no cointegration between the variables with two structural breaks at different significance levels is rejected. However, when the Z_a test statistic is taken into account, the null hypothesis is accepted. When the size and power properties of this test is analyzed, the Z_t test statistic has the best power and size properties (Gregory and Hansen, 1996, pp. 113–114). According to these results, it is possible to say that ESG, FDI and HDI variables move together in the long run. When the structural break dates determined endogenously by the Hatemi-J (2008) method are examined, it is seen that they coincide with different dates on a country basis. Due to the different structural break dates, it can be said that the breaks are mostly caused by the domestic developments of the countries. The existence of a long-run relationship between ESG and FDI suggests that countries' high performance in terms of environmental, social and corporate governance practices is accompanied by an advanced financial system. A well-developed financial system, through

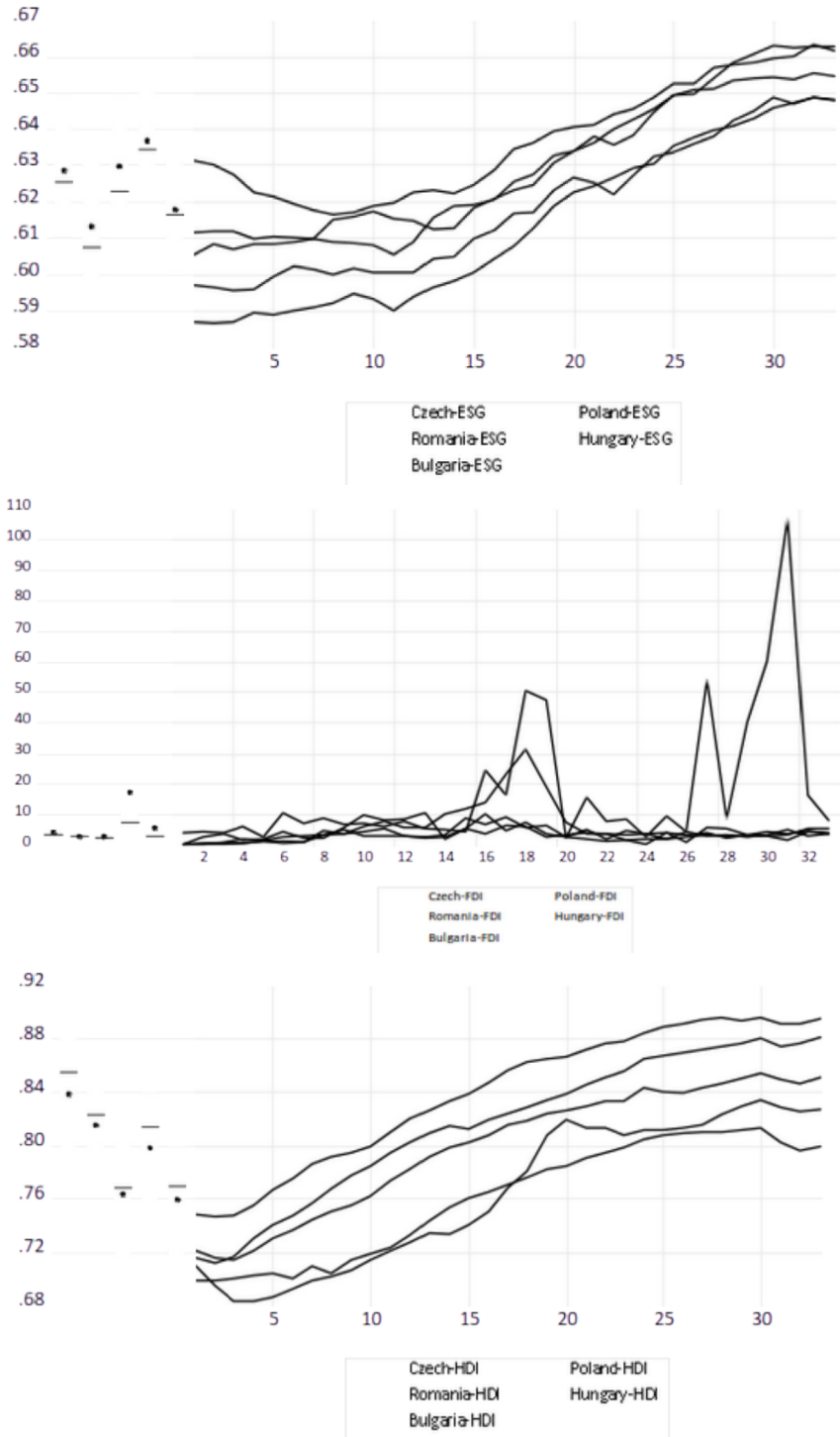

Fig. 1: Time-Series plots of the selected variables

Tab. 2: The results of unit root test

		Critical values Break in level				Critical values Break in level and trend		
Null hypothesis	**Test value**	**1%**	**5%**	**10%**	**Test value**	**1%**	**5%**	**10%**
Fourier GLS,	*H_0: Unit root*							
$\text{Czech}_{\text{ESG}}$	−0.015*	−3.298	−2.601	−2.187	−2.264*	−4.771	−4.175	−3.879
$\text{Czech}_{\text{FDI}}$	−0.413*	−2.888	−2.200	−1.880	−4.387***	−4.771	−4.175	−3.879
$\text{Czech}_{\text{HDI}}$	−1.404*	−2.888	−2.200	−1.880	−2.126*	−3.797	3.149	−2.831
$\text{Poland}_{\text{ESG}}$	−0.628*	−2.888	−2.200	−1.880	−4.046**	−4.771	−4.175	−3.879
$\text{Poland}_{\text{FDI}}$	−0.567*	−2.934	−2.256	−1.918	−3.586*	−4.771	−4.175	−3.879
$\text{Poland}_{\text{HDI}}$	−1.033*	−2.888	−2.200	−1.880	−4.115**	−4.771	−4.175	−3.879
$\text{Romania}_{\text{ESG}}$	−0.255*	−2.888	−2.200	−1.880	−5.385	−4.278	−3.647	−3.316
$\text{Romania}_{\text{FDI}}$	−1.935**	−2.934	−2.256	−1.918	−4.109**	−4.771	−4.175	−3.879
$\text{Romania}_{\text{HDI}}$	−1.970*	−3.911	−3.294	−2.328	−2.616*	−4.044	−3.367	−3.037
$\text{Hungary}_{\text{ESG}}$	−1.018*	−2.888	−2.200	−1.880	−2.867*	−4.771	−4.175	−3.879
$\text{Hungary}_{\text{FDI}}$	−1.332*	−3.298	−2.601	−2.187	−2.683*	−3.797	3.149	−2.831
$\text{Hungary}_{\text{HDI}}$	−0.770*	−2.888	−2.200	−1.880	−3.389*	−4.771	−4.175	−3.879
$\text{Bulgaria}_{\text{ESG}}$	−0.603*	−2.888	−2.200	−1.880	−2.861*	−4.044	−3.367	−3.037
$\text{Bulgaria}_{\text{FDI}}$	−3.064**	−3.911	−3.294	−2.328	−4.116**	−4.771	−4.175	−3.879
$\text{Bulgaria}_{\text{HDI}}$	−1.479	−3.911	−3.294	−2.328	−4.045**	−4.771	−4.175	−3.879
Fourier ADF,	*H_0: Unit root*							
$\text{Czech}_{\text{ESG}}$	−0.329*	−3.970	−3.270	−2.910	−3.494*	−4.690	−4.050	−3.710
$\text{Czech}_{\text{FDI}}$	−2.666**	−3.640	−2.970	−2.640	−4.116**	−4.950	−4.350	−4.050
$\text{Czech}_{\text{HDI}}$	−3.209*	−4.420	−3.810	−3.490	−3.631**	−4.450	−3.780	−3.440
$\text{Poland}_{\text{ESG}}$	−0.257*	−3.770	−3.070	−2.710	−4.022*	−4.950	−4.350	−4.050
$\text{Poland}_{\text{FDI}}$	−1.786*	−3.640	−2.970	−2.640	−3.371*	−4.950	−4.350	−4.050
$\text{Poland}_{\text{HDI}}$	−2.209*	−4.420	−3.810	−3.490	−4.308**	−4.950	−4.350	−4.050
$\text{Romania}_{\text{ESG}}$	−1.483*	−3.580	−2.930	−2.600	−1.418*	−4.200	−3.560	−3.220
$\text{Romania}_{\text{FDI}}$	−2.770**	−3.640	−2.970	−2.640	−4.068**	−4.950	−4.350	−4.050
$\text{Romania}_{\text{HDI}}$	−1.030*	−3.640	−2.970	−2.640	−3.334*	−4.950	−4.350	−4.050
$\text{Hungary}_{\text{ESG}}$	−0.658*	−3.580	−2.930	−2.600	−3.558*	−4.690	−4.050	−3.710
$\text{Hungary}_{\text{FDI}}$	−2.840*	−4.420	−3.810	−3.490	−3.052*	−4.200	−3.560	−3.220
$\text{Hungary}_{\text{HDI}}$	−0.177*	−4.420	−3.810	−3.490	−3.891*	−4.950	−4.350	−4.050
$\text{Bulgaria}_{\text{ESG}}$	−0.994*	−3.770	−3.070	−2.710	−3.457**	−4.450	−3.780	−3.440
$\text{Bulgaria}_{\text{FDI}}$	−5.117	−3.640	−2.970	−2.640	−5.286	−4.290	−3.650	−3.290
$\text{Bulgaria}_{\text{HDI}}$	−0.244*	−3.580	−2.930	−2.600	−3.132*	−4.950	−4.350	−4.050

Notes: *, ** and *** denote 1%, 5% and 10% at significance levels, respectively. Critical values are obtained from Enders and Lee (2012).

its financing opportunities, risk management and transparency, can encourage increased ESG investments, leading to improved ESG performance. Improved sustainability performance, in turn, will create an environment in which environmental risks are mitigated, relations with a wide range of stakeholders, including investors and employees are strengthened, and corporate governance is improved, thereby enabling the financial system to better fulfil its functions and increasing financial development. The cointegration relationship between ESG and HDI can be interpreted as the demand for sustainability practices may increase with the increase in human

Tab. 3: The results of cointegration test – Hatemi-J (2008) Regime Shift; H_0: No Cointegration

		ESG – FDI			ESG – HDI	
Country		**Test stat.**	**Break dates**		**Test stat.**	**Break dates**
Czech	ADF	−4.059	2004–2012	ADF	−7.003	2001–2016
	Z_t	−4.059	2002–2012	Z_t	−7.130	2001–2015
	Z_a	−25.819	2002–2012	Z_a	−39.845	2001–2015
Poland	ADF	−6.099**	2003–2012	ADF	−5.457	1997–2015
	Z_t	−4.796	2002–2011	Z_t	−5.876*	1998–2016
	Z_a	−26.805	2002–2011	Z_a	−33.768	1998–2016
Romania	ADF	−5.986*	2008–2014	ADF	−5.873*	1993–2006
	Z_t	−5.986*	2008–2014	Z_t	−6.273*	2000–2009
	Z_a	−33.984	2008–2014	Z_a	−27.488	2000–2009
Hungary	ADF	−6.042**	2004–2012	ADF	−6.242*	1997–2000
	Z_t	−6.097**	2004–2008	Z_t	−5.845*	1995–2014
	Z_a	−29.383	2004–2008	Z_a	−30.289	1992–1995
Bulgaria	ADF	−6.117**	2001–2009	ADF	−6.216*	2004–2014
	Z_t	−4.890	2002–2012	Z_t	−6.535***	1993–2014
	Z_a	−27.674	2002–2012	Z_a	−31.719	1993–2014

Notes: *, ** and *** denote 1%, 5% and 10% at significance levels, respectively.

	Critical values		
	1%	**5%**	**10%**
ADF	−6.503	−6.015	−5.653
Z_t	−6.503	−6.015	−5.653
Z_a	−90.704	−76.003	−52.232

development, and countries with high ESG performance may achieve higher standards for human development.

Enders and Jones's (2016) Fourier Granger causality and Gormus et al.'s (2018) Fourier Toda and Yamamoto causality approaches were used to analyze the causality relationships between ESG score, FDI and HDI variables, which were found to have a long-run relationship. Tab. 4 presents the results of Fourier Granger and Toda and Yamamoto causality tests between the variables analyzed.

The analysis results provide strong evidence that human capital has an impact on sustainable development in Central European countries for the period 1990–2022. On the other hand, findings that financial development has an impact on sustainable development are only seen in Romania. However, strong evidence that sustainable development has an impact on financial development is obtained in Romania, Hungary and Bulgaria.

After the symmetric causality analysis between the ESG score, FDI and HDI variables was conducted, Hatemi-J (2012, 2014) asymmetric causality test was applied to investigate whether there is an asymmetric relationship between these variables. Hatemi-J (2012, 2014) examines the causality between positive and negative cumulative shocks on the variables by taking into account the positive and negative shocks on the variables. Thus, it takes into account the existence of asymmetric information in the financial markets (Hatemi-J, 2012, p. 448). Tab. 5 shows the results of the Hatemi-J (2012, 2014) asymmetric causality tests.

The results of the Hatemi-J (2012, 2014) test in Tab. 5 reveal the asymmetric effects between the variable pairs. Accordingly, for the Czech Republic, where no causality relationship could

Tab. 4: The results of cumulative causality tests

Cumulative Fourier-frequency Granger Causality					Cumulative Fourier-frequency Toda and Yamamoto Causality				
Direction	**Wald**	**Asym. *p*-value**	**Boost. *p*-value**	**Lag-Freq.**	**Direction**	**Wald**	**Asym. *p*-value**	**Boost. *p*-value**	**Lag-Freq.**
Czech									
ESG ⇒ FDI	6.517	0.259	0.344	5-3	ESG ⇒ FDI	6.265	0.281	0.380	5-3
FDI ⇒ ESG	3.338	0.648	0.639	5-3	FDI ⇒ ESG	4.850	0.435	0.497	5-3
ESG ⇒ HDI	4.302	0.116	0.137	2-3	ESG ⇒ HDI	2.555	0.279	0.292	2-3
HDI ⇒ ESG	14.670*	0.001	0.002	2-3	HDI ⇒ ESG	52.468*	0.000	0.000	2-3
Poland									
ESG ⇒ FDI	4.628	0.328	0.365	4-3	ESG ⇒ FDI	2.815	0.728	0.724	5-3
FDI ⇒ ESG	4.058	0.398	0.436	4-3	FDI ⇒ ESG	2.600	0.761	0.750	5-3
ESG ⇒ HDI	11.542	0.042	0.119	5-3	ESG ⇒ HDI	9.701	0.084	0.213	5-3
HDI ⇒ ESG	8.379	0.137	0.224	5-3	HDI ⇒ ESG	12.625***	0.027	0.079	5-3
Romania									
ESG ⇒ FDI	6.964	0.223	0.304	5-3	ESG ⇒ FDI	13.907***	0.016	0.097	5-3
FDI ⇒ ESG	27.311*	0.000	0.009	5-3	FDI ⇒ ESG	17.815**	0.003	0.049	5-3
ESG ⇒ HDI	8.698	0.122	0.202	5-3	ESG ⇒ HDI	22.026**	0.001	0.026	5-3
HDI ⇒ ESG	6.397	0.269	0.341	5-3	HDI ⇒ ESG	4.713	0.452	0.532	5-3
Hungary									
ESG ⇒ FDI	19.695**	0.001	0.037	5-3	ESG ⇒ FDI	16.710***	0.005	0.065	5-3
FDI ⇒ ESG	0.541	0.991	0.985	5-3	FDI ⇒ ESG	5.603	0.347	0.418	5-3
ESG ⇒ HDI	3.039	0.694	0.729	5-3	ESG ⇒ HDI	4.012	0.548	0.567	5-3
HDI ⇒ ESG	4.245	0.515	0.572	5-3	HDI ⇒ ESG	31.088**	0.000	0.015	5-3
Bulgaria									
ESG ⇒ FDI	3.683	0.596	0.644	5-3	ESG ⇒ FDI	15.126**	0.004	0.030	4-3
FDI ⇒ ESG	2.285	0.809	0.793	5-3	FDI ⇒ ESG	2.532	0.639	0.652	4-3
ESG ⇒ HDI	1.557	0.906	0.901	5-3	ESG ⇒ HDI	1.395	0.845	0.842	4-3
HDI ⇒ ESG	7.554	0.183	0.270	5-3	HDI ⇒ ESG	5.007	0.287	0.331	4-3

Notes: *, ** and *** denote 1%, 5% and 10% at significance levels, respectively. Optimal lag and Fourier frequency lengths are determined by HJC criterion. The number of bootstrap replications is 1000.

be determined in the cumulative Fourier-frequency tests, a causality relationship was observed from negative shocks in ESG to FDI. Thus, it was possible to say that deterioration in ESG performance could be the cause of changes in FDI. For Bulgaria, it was observed that both positive shocks from ESG to FDI and from FDI to ESG created causality. An increase in either of these two variables causes a change in the values of the other. The test results for the ESG-HDI pair show that the direction of the relationship is from HDI to ESG and is caused by positive shocks. Accordingly, the increase in human development in all countries except Poland is also the cause of ESG. When the asymmetric causality relationship between the ESG score and HDI variables is examined, it is shown that the HDI variable causes a positive shock on the ESG score in all countries except Poland, but the HDI variable does not cause a negative shock on the ESG score. When the asymmetric causality relationship between the ESG score and FDI variables is examined, an asymmetric relationship is detected in the Czech Republic and Bulgaria. It is seen that the FDI variable causes a positive shock on the ESG score in Bulgaria; while the ESG score variable causes a negative shock on the FDI variable in the Czech Republic.

Tab. 5: The results of Hatemi-J (2012, 2014) asymmetric causality test

				Critical bootstrap value		
Countries	H_0	**Model**	**Test value**	**1%**	**5%**	**10%**
Czech	ESG $\not\Rightarrow$ FDI	Pos	2.236	12.531	6.667	5.176
	ESG $\not\Rightarrow$ FDI	Neg	8.824***	16.397	10.181	7.680
Poland	ESG $\not\Rightarrow$ FDI	Pos	0.061	9.489	4.953	3.227
	ESG $\not\Rightarrow$ FDI	Neg	2.253	9.791	4.758	2.784
Romania	ESG $\not\Rightarrow$ FDI	Pos	0.765	11.477	5.395	3.398
	ESG $\not\Rightarrow$ FDI	Neg	0.033	10.503	4.724	3.112
Hungary	ESG $\not\Rightarrow$ FDI	Pos	3.804	16.019	11.298	8.820
	ESG $\not\Rightarrow$ FDI	Neg	0.232	8.318	4.668	3.355
Bulgaria	ESG $\not\Rightarrow$ FDI	Pos	4.430***	12.534	5.769	3.924
	ESG $\not\Rightarrow$ FDI	Neg	0.046	10.330	5.652	3.616
Czech	ESG $\not\Rightarrow$ HDI	Pos	0.871	13.402	8.166	5.802
	ESG $\not\Rightarrow$ HDI	Neg	0.092	11.692	4.868	3.054
Poland	ESG $\not\Rightarrow$ HDI	Pos	2.654	8.236	4.800	2.983
	ESG $\not\Rightarrow$ HDI	Neg	0.045	23.045	7.311	3.157
Romania	ESG $\not\Rightarrow$ HDI	Pos	3.627	8.458	5.291	3.977
	ESG $\not\Rightarrow$ HDI	Neg	0.133	14.805	7.092	5.581
Hungary	ESG $\not\Rightarrow$ HDI	Pos	0.626	11.229	5.776	4.004
	ESG $\not\Rightarrow$ HDI	Neg	0.072	7.948	4.575	3.193
Bulgaria	ESG $\not\Rightarrow$ HDI	Pos	4.927	14.286	7.975	5.710
	ESG $\not\Rightarrow$ HDI	Neg	2.469	29.317	16.768	12.581
Czech	FDI $\not\Rightarrow$ ESG	Pos	1.158	13.324	6.914	5.393
	FDI $\not\Rightarrow$ ESG	Neg	0.643	16.035	9.766	7.314
Poland	FDI $\not\Rightarrow$ ESG	Pos	0.529	8.150	4.210	3.003
	FDI $\not\Rightarrow$ ESG	Neg	0.014	7.982	4.478	2.952
Romania	FDI $\not\Rightarrow$ ESG	Pos	1.815	7.239	4.067	2.827
	FDI $\not\Rightarrow$ ESG	Neg	0.000	12.077	4.918	2.899
Hungary	FDI $\not\Rightarrow$ ESG	Pos	0.027	12.734	5.667	3.805
	FDI $\not\Rightarrow$ ESG	Neg	0.669	7.949	4.692	3.210
Bulgaria	FDI $\not\Rightarrow$ ESG	Pos	3.635***	8.490	4.682	3.509
	FDI $\not\Rightarrow$ ESG	Neg	1.065	14.092	6.824	4.777
Czech	HDI $\not\Rightarrow$ ESG	Pos	6.886***	14.095	8.168	6.445
	HDI $\not\Rightarrow$ ESG	Neg	0.051	11.449	5.118	3.056
Poland	HDI $\not\Rightarrow$ ESG	Pos	0.015	8.481	4.845	3.224
	HDI $\not\Rightarrow$ ESG	Neg	0.004	22.413	5.867	2.785
Romania	HDI $\not\Rightarrow$ ESG	Pos	5.751***	9.450	6.003	3.966
	HDI $\not\Rightarrow$ ESG	Neg	0.311	11.198	6.323	4.349
Hungary	HDI $\not\Rightarrow$ ESG	Pos	8.534***	14.195	8.688	6.649
	HDI $\not\Rightarrow$ ESG	Neg	2.327	8.996	4.338	2.926
Bulgaria	HDI $\not\Rightarrow$ ESG	Pos	20.719**	24.988	15.751	12.355
	HDI $\not\Rightarrow$ ESG	Neg	5.960	16.427	9.327	7.373

Notes: *, ** and *** indicate significant coefficients at the 1%, 5%, and 10% levels, respectively. The optimal lags in VAR(p) model was determined based on Hatemi-J Criterion (HJC). Additional lags = 1. The bootstrap p-values are, in each case, based on 1000 replications.

4 CONCLUSIONS AND POLICY IMPLICATIONS

When the unconscious consumption of natural resources comes together with modern production techniques, the results that emerge have raised concerns that future generations will not only not have the prosperity achieved today, but also the minimum conditions needed for a healthy life. This approach, brought to the agenda with the theme of sustainability, is based on the understanding that human well-being requires a healthy environment, a fair and equal social life, and corporate governance practices as well as economic foundations. In this context, Environmental, Social and Governance performances have begun to be measured in order to observe the paths that companies and countries follow to achieve sustainable development goals.

The aim of this study is to identify the cointegration and causality relationships between ESG performance and the human development index (HDI) and financial development index (FDI) at the country level. The study, which is comprised entirely of developing countries and covers five Eastern European countries, revealed that the relationships between the ESG-FDI and ESG-HDI variable pairs may differ across countries. However, it is possible to say that these variables are generally related to each other.

Investigating long-term relationships between variables is of great importance in terms of policy making and decision making. The cointegration relationship between ESG and FDI, which was detected in four countries except the Czech Republic, can be interpreted as the possibility that these two variables may affect each other in the long term. The increase in ESG performance contributes to financial asset diversity by developing investment instruments specific to the financing of sustainability investments. It can also contribute to financial development by encouraging the entry of large funds that want to support such investments into the country. A developed financial system can also support sustainable business by providing the necessary financing and risk management tools for the realization of ESG investments. In addition to the many benefits it provides, high ESG performance contributes to the development of the financial system by increasing transparency, reducing information asymmetry, increasing the opportunity to compare with competitors, providing the opportunity to find long-term investors, and protecting the rights of shareholders (Şeker and Şengür, 2022, p. 364).

The causal relationship between ESG and FDI is weaker. Although the variables move together in the long term, there is limited evidence to say that they directly affect each other. While bidirectional causality is seen in Romania, unidirectional causality from ESG to FDI is found in Hungary and Bulgaria. No causal relationship is found for the Czech Republic and Poland. However, when asymmetric effects are considered, causality from negative shocks of ESG to FDI is found in the Czech Republic; and bidirectional causality from positive shocks is found in Bulgaria.

A long-term relationship between ESG and HDI was also found in four countries except the Czech Republic. It can be said that ESG performances are higher in countries with a high level of human development and this relationship approaches balance in the long term. This finding underlines that sustainability is a cultural understanding and can be implemented if it is adopted by society. A higher level of education, better health conditions and a more qualified social life can provide motivation for the efforts required to achieve sustainable development goals. Causality tests show that there is an effect from positive shocks in HDI to ESG in Romania, Hungary and Bulgaria. Cumulative Fourier-frequency tests also show an effect from HDI to ESG in three countries except Bulgaria, and from ESG to HDI in Romania.

In order to benefit from the positive results of ESG and FDI and HDI interactions, it would be appropriate for policy makers to take measures to strengthen the connections between these variables. In this context, increasing access to financial markets, encouraging foreign portfolio investments, developing tools for measuring and managing risks specific to sustainability investments, and increasing the variety of instruments specifically produced for financing ESG

investments are expected to ensure the development of the financial system while also encouraging sustainability investments. Subhani et al. (2025) pointed out that there may be a perception among credit institutions that firms that make intensive ESG investments in BRICS countries will face higher operating expenses and lower financial performance. This situation, which may cause difficulties in accessing credit financing, has been shown that a developed financial system can moderate this negative correlation between ESG investments and access to debt (Subhani et al., 2025, p. 11). Fatima et al. (2025) pointed out the importance of financial development in providing financial support for green innovative technologies in Sub-Saharan Africa and revealed that the development of the financial sector is positively related to the improvement of environmental conditions. A developed financial system can also increase the chances of success of ESG investments, which are a relatively new technique. Establishing standards for the valuation of ESG-focused investments could enable these investments to achieve higher returns with lower risk. This seems possible only with the existence of a financial system that is developed in terms of competition, transparency, product diversity, efficiency, and so on.

Similarly, it is necessary to emphasize the importance of human capital development in increasing ESG performance. HDI is closely related to the social dimension of ESG. Ensuring a good quality of life in terms of education, health and income levels will lead to an increase in ESG performance. For this purpose, it is important to ensure equal opportunities in education in every country, to increase the quality of education, to invest more in qualified labour, and to increase the life expectancy and quality by establishing a solid infrastructure in the field of health. Yang et al. (2022) stated that human activities have significant impacts on the Sustainable Development Goals by shaping their interactions (e.g. trade-offs and synergies). Therefore, it is critical to focus on research on policy-making and governance for the regulation of human activities (Yang et al., 2022). Šlaus and Jacobs (2011) established the connection between human development and sustainability through education. Accordingly, the solution to the damage caused by rapid economic development and increasing consumption levels and the realization that the ultimate goal of human existence is not constantly increasing material consumption is only possible with an education that will enable evolution to a high level of human consciousness (Šlaus and Jacobs, 2011, p. 106). In this context, integrating the sustainability approach into education policies, producing public policies that support the spread of capital to the base, and companies providing more humane working conditions for their employees, including occupational health and safety, ensuring equal opportunities in the workplace and implementing fair wage policies will produce effective results.

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AUTHOR'S ADDRESS

Gamze Göçmen Yağcılar, Department of Banking and Finance, Faculty of Economics and Administrative Sciences, Suleyman Demirel University, Isparta, Türkiye, e-mail: gamzeyagcilar@sdu.edu.tr, ORCID: 0000-0002-5009-4696

Mehmet Levent Erdaş, Department of Economics and Finance, Faculty of Business, Akdeniz University, Antalya, Türkiye, e-mail: leventerdas@akdeniz.edu.tr, ORCID: 0000-0001-6594-4262 (corresponding author)

Zühal Arslan, Department of Banking and Insurance, Büyükkutlu Faculty of Applied Sciences, Isparta University of Applied Sciences, Isparta, Türkiye, e-mail: zuhalkucukcakal@isparta.edu.tr, ORCID: 0000-0002-4757-1260