The impact of FinTech/Blockchain Adoption on Corporate ESG and DEI Performance

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Abstract: - Monitoring a company's efficiency is one of its primary responsibilities. There are many approaches in our contemporary society that either use IT or the conventional technique. Methods for measuring efficiency fall into three primary categories: parametric, nonparametric, and ratio indicators. We prioritize a firm's inputs and outputs when choosing metrics to measure efficiency. Establishing objectives and goals in entrepreneurship necessitates a thorough comprehension, appreciation, and knowledge of sustainability, and assessing the economic growth quality of a corporation is an essential task for theoretical and empirical sustainability assessment. When measuring the efficiency of entrepreneurship in terms of achieving desired values of macroeconomic indicators (e.g., sustainable economic growth objectives), data envelopment analysis (DEA), a widely used technique in efficiency analysis, has taken into account the economic, environmental, and social impact of entrepreneurship as the three dimensions of sustainability. The objective of this paper is to test the influence of FinTech/Blockchain adoption on corporate ESG and DEI performances using a novel DEA approach for sustainable development assessment. It highlights the significance of using a scalable technique for ESG efficiency study and gives scholars a more thorough viewpoint on the subject. In a collection of 50 enterprises, a DEA model was utilized for the analysis. For sustainable performance assessment using the proposed DEA technique, we defined as *inputs* six financial metrics, and as *outputs* 11 ESG/Blockchain adoption, and four DEI quality metrics to measure the firm's efficiency. The annual business data was gathered between 2017 and 2023. In all country situations we discovered that, when DEI initiatives mediate, there is a strong correlation between ESG corporate performance and the quality of economic growth (particularly in the innovation and integrity blockchain adoption performance success metrics). Our study provides additional in-depth details on the FinTech/blockchain adoption environment in comparison to the findings of previous researchers. The sustainable entrepreneurship performance (a latent variable regarded as a dependent target factor) is calculated using eight (8) factors as observed variables, which is the first to consider the dynamics of ESG/BCA and DEI quality metrics as DEA *outputs*. The study also examines the mediating role of DEI corporate initiatives. By conducting an empirical investigation, the suggested scalable framework makes it evident which company is more efficient in moving toward sustainability, assisting corporate management in increasing the effectiveness of economic growth.

Key-Words: - FinTech, Blockchain, Economic growth, Monitoring company's efficiency, Digital transformation, ESG, DEI.

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1 Introduction

Research on estimating the potential for economic growth through entrepreneurship is always interesting, [1], [2]. Assessing the sustainability and quality of economic growth is a topic that has been brought up in this field of study, [3], [4], [5], [6], [7], [8].

Monitoring a company's efficiency is one of its most important tasks. Many techniques in today's culture are either based on the conventional way or make use of IT. The three primary types of efficiency measurement techniques are parametric, nonparametric, and ratio indicators. Our primary focus when choosing indicators to measure efficiency is on the inputs and outputs of an organization, [1], [5].

Digital technologies that can revolutionize the way financial services are provided and encourage the creation of new or altered business models, apps, procedures, and goods are referred to as financial technology or FinTech. In actuality, the term "FinTech" is also widely used to refer to the current wave of new technologies being applied in finance and entrepreneurship with excellent digital functions, [1], [2], [5]. Web, mobile, cloud services, blockchain, distributed ledger technologies, machine learning, digital ID, and application programming interfaces (API) are a few examples of these technologies.

FinTech services are being transformed by digital innovation (digital transformation) and FinTech has already improved retail users' access to and convenience with financial services during the last fifteen years, [1], [3], [4].

A FinTech company is one that focuses on providing digital functionality to customers or makes it possible for other providers to supply DFS. Some of these businesses are already well-known public enterprises, but many of them are very new to the financial industry. Digital payment companies like PayPal, cloud server/computing platforms like Amazon's AWS, financial infrastructure companies like Plaid, digital insurers like Policy Bazaar or BIMA, and DLT/peer-to-peer (P2P) lending platforms like Prosper, Happy Money, Funding Circle, and LightStream are a few examples of FinTechs.

Nowadays, state-of-the-art FinTech is the blockchain technologies and the blockchain adoption in collaborative enterprises (BCA), and the BCA quality metrics as observed variables are knowledge sharing, transparency, same-data sharing, smart contracts utilization, fraudulence suspension, cyber-hacking protection, trust, fidelity, integrity, sustainability fair, green functionalities, and volunteer environmental cleanup and awareness, [5], [6], [7], [8].

Sustainability is a concept drawn from ecology that refers to the utilization of a regenerative natural system in a way that maintains its essential qualities and permits the population to naturally replenish itself, [4], [5]. Sustainability, according to [1], [4], and [9], is the ability of processes and systems to endure.

Many areas of human endeavor have demonstrated a great lot of interest in assessing and improving efficiency, and as such, they are worthy of serious thought. Because of this, quantifying efficiency is one of the most often debated topics in current research about the application of mathematical tools in economic analysis.

One such technique is data envelopment analysis (DEA), which is gaining traction and is both straightforward and useful for analyzing complicated problems, [3], [4], [5], [10], [11].

A concise synopsis of contemporary efficiency measurement and an outline of the DEA technique are provided in [10] and [11]. Economic growth is a complicated macroeconomic phenomenon, as evidenced by several studies, and as such, it is still difficult to fully comprehend, describe, and explain its sources, degree of influence, and manner of contribution to growth, [4], [5], [10], [11].

DEA calculates efficiency as the weighted sum of inputs divided by outputs. To create one virtual output and one virtual input (weighted sums), multiple inputs and outputs must be combined. These must then be transformed to ratios, [5].

Technical coefficients are not interchangeable and are treated as variables in the DEA linear programming model. The creators of the original DEA model recommend calculating technical coefficients after resolving a specific linear programming (LP) problem, [5], [11].

DEA has been used extensively in the field of sustainability, but to the best of our knowledge, very few surveys -aside from, [4], [5], [11], and [12]- have been carried out to thoroughly examine the state of the literature and discuss the direction of future research.

Based on local and citation network scores, the authors in [4] demonstrate development patterns and highlight significant publications, but they omit the "*social impact*" (such as DEI efforts) and how it influences corporate assessments of economic achievement.

A critical analysis of methods for integrating environmental concerns into productive efficiency is offered by the authors in [5], [11], and [12]. However, their research only focuses on environmental factors, especially the unintended consequences of production technology modeling, and ignores social factors and DEI corporate initiatives, which are also essential elements of sustainability.

Additionally, every one of these reports is based on subjective and qualitative analyses rather than objective quantitative analysis approaches, [1], [13], [14], [15], [16].

To close this gap, our study gathers information from 50 corporates that were published between 2017 and 2023 and examines the state of research on DEA corporate initiatives in sustainability using the dependent corporate's ESG performance dimensions, and the DEI observed independent latent variables.

This article aims to investigate the impact of FinTech/BCA on business ESG and DEI performance, through a DEA approach to sustainable development evaluation.

In comparison with the results of earlier studies in [3], [4], [5], [10], and [11], our research provides more in-depth details about the FinTech/blockchain adoption ecosystem. This is the first study to take into account the dynamics of DEI quality metrics and ESG/BCA outputs from DEA.

The study also calculates the sustainable entrepreneurship performance, a latent variable that is considered a dependent target factor, using eight (8) factors as observed variables, with the DEI corporate initiatives acting as a mediating factor.

The paper is structured as follows: In subsection 1.1 hypotheses H1, and H2 are presented and in subsection 1.2 research questions RQ1, and RQ2 are put forward.

In Section 2, the method and the procedures for the FinTech sustainable entrepreneurship performance estimation are discussed (with 11 ESG/BCA quality dynamics as observed *output* variables, and four DEI responsibility metrics dynamics as *output* variables) based on a novel DEA framework (with subsection 2.1 Standard CCR DEA model, and subsection 2.2 Proposed DEA model for sustainable assessment considering ESG/BCA activities, and DEI corporate initiatives).

Then, in Section 3, the proposed DEA is tested with panel data from five WB, and five EU countries (five companies/country, 2017-2023 period).

In Section 4, the proposed FinTech/Blockchain adoption framework is discussed, with six financial characteristics, indicators, conditions, and parameters as DEA *inputs*, as well as 11 ESG/BCA and four DEI factors as DEA *outputs*.

Finally, in Section 5 the conclusions are presented for advantages and contributions, findings, applications, implications, limitations, and further research proposals.

1.1 Hypotheses and Data

Hypothesis H1: *Data envelopment analysis can be used to evaluate entrepreneurship's contribution to sustainable economic growth*.

Hypothesis H2: *Business practices related to ESG and DEI could be viewed as "pillars of sustainability" on a scale.*

After a review of relevant studies in [5], [11], [17], [18] and [19] both hypotheses were developed. Approaches for theoretical analysis and quantitative and qualitative examination of DEA results computed from panel data (2017–2023) involving 50 enterprises from five Western Balkans/WB (Albania, Bosnia & Herzegovina, North Macedonia, Montenegro, and Serbia) and five EU nations (Germany, France, Italy, Netherlands, and Greece). Relevant and reliable sources (the UN, World Bank, and Global Footprint Network) provided the data.

1.2 Research Questions

Given the relationship between DEI projects, corporate culture, entrepreneurship performance, green corporate activities, and ESG, it becomes imperative to assess the reliability of these associations.

Consequently, because structural (interior) model fit assessment is the main goal of this study, the main goal is to evaluate the significance of the connection by answering two research questions.

The relationship between ESG and firm performance for a variety of firms is not well studied empirically, and it is unclear what theoretical mechanisms corporate adoption of ESG activities uses to influence firm performance, [17], [20].

The following inspired our first research question (RQ1): "*Does a company's sustainable performance improve when it adopts environmentally friendly ESG practices, and if so, to what extent?*", [20].

By increasing supply chain efficiency and decreasing operating costs, among other benefits, such adoption can produce instant performance increases [20]. Adopting quality metrics dynamics and ESG responsibility, in our opinion, can also raise a company's growth potential, raising expectations for the organization's performance going forward, [1], [20].

As per the authors of [21], [22] and [23], the benefits of implementing ESG could be contingent upon a firm's capacity to incorporate quality dynamics into its operations and the ethnic and cultural makeup of the business milieu in which it functions.

Consequently, the second research question (RQ2) was formulated, posing the following question: "*To what degree does DEI influence the impact of ESG on corporate sustainable performance? How can cultural and social corporate efforts impact or mediate the relationship between ESG corporate activities and sustainable performance?*"

In particular, we examine the relationship that exists between a company's sustainable performance measures and its DEI, cultural, and social activities dynamism, [20].

We employed a structural model fit evaluation using the traditional Structural Equation Model (SEM) method to estimate the standardized coefficients (ESG to sustainable entrepreneurship performance through DEI) to address these two research objectives. Consequently, answering these two research questions is this article's main goal.

The goal of this work is to bridge a major knowledge gap about the relationship between ESG, DEI, SEP, and the country of the organization by developing a novel scalable DEA. For companies aiming to diversify their personnel and resources by entering overseas markets, it adds to the body of information about the assessment of sustainable entrepreneurship and economic growth, [4], [6], [8].

Furthermore, it adds to our understanding of how corporate social responsibility and diversity, equity, and inclusion initiatives affect the "*social impact*," or connection, between community and ESG performance. DEA can be used to identify the best practices of peer decision-making units (DMUs) when there are a lot of *inputs* and *outputs*.

Since it was first presented in [24], a great deal of research has been done in a range of domains. In addition to providing efficiency scores for those units, DEA provides trustful projections for inefficient DMUs onto an efficient frontier.

Since the task of researching and developing blockchain technology is different from that of conventional production, we find it difficult to determine and quantify the genuine investment made in this area. Using the proposed DEA model, the inputs from different decision-making units will be changed to 1, and the output outcomes will then be directly compared, [5], [24], [25], [26]. We shall examine blockchain technology in-depth using output indicators, [27].

Contributions: By merging the "*social impact*" notion with standard DEA, the proposed DEA achieves the following three goals: (i) strengthens discriminatory power; (ii) keeps information about the "pillars of sustainability," the DEI and ESG/BCA initiatives, from being lost; and (iii) offers scalable functionality because the DEI and ESG/BCA dimensions are easily expanded (1D arrays).

Limitations: The performed empirical research responds to the question of which company is the most efficient on the route to sustainability.

However, it is not possible for the DEA technique to determine if a company is developing sustainably or unsustainably, as it is relative and only measures efficiency in terms of other units, [1], [20], [27], [28], [29], [30].

2 Methods and Procedures

2.1 Standard DEA

DMU efficiency in output maximization is usually presented by DEA while using minimum inputs or minimal inputs while obtaining maximum outputs. Furthermore, DEA is carried out using known and current input and output data. It is possible to define hypothesis H1 by taking certain DEA characteristics and the widespread availability of economic data into account.

After analysis, by studying the most efficient observable DMU, the production possibility frontier is empirically reached. Consequently, DMU may be below or on the production possibility border. The production possibility boundary is thus determined by the most efficient observable DMU, which can be regarded as maximally efficient in turn, [5], [6], [18].

DMUs on the production possibility frontier are those whose efficiency is 1; those whose efficiency is between 0 and 1 are those that are below the frontier. Additionally, it may be said that DEA presumes the maximum efficiency achievable, as shown by the most successful, which includes DMU according to [4], [5] and [6].

Every DMU can be divided into two categories: relatively efficient and relatively inefficient. Certain DMUs cannot be considered efficient unless they meet the following criteria: It is impossible to increase one output without also decreasing another, and it is likewise impossible to decrease one input without also increasing or decreasing another, [3], [5], [17].

Although benchmarking and DMU comparison are made possible by the relative nature of the DEA method, it does not offer enough information to determine whether the most efficient DMU, even when designated as such, achieves acceptable absolute levels of input and output values (or, more precisely, whether these absolute levels are consistent with the targeted referent values, if any).

Consequently, stem hypothesis H2: *ESG activities and DEI initiatives can be considered "pillars of sustainability" at a scale*.

A set of similar decision-making units (j DMU) with multiple *i inputs* (x_{ij}) and numerous *r outputs* (y_{rj}) can be certified as effective using the standard DEA linear programming (LP) technique. DEA model Charnes, Cooper, and Rhodes (CCR) is the term used to describe it frequently.

We assess n productive units, or DMUs, in DEA models. Each DMU requires *m* distinct *inputs* to generate *s* distinct *outputs*. Maximizing the efficiency rate of the production unit DMUq is the fundamental component of DEA models used to measure its efficiency. Subject, however, to the requirement that no other unit in the population have an efficiency rate higher than 1.

All features, taken into consideration, must be included in the DEA models; that is, all input and output weights must be larger than zero. A linear divisive programming model is what is known as such a model, [5], [24], [25], [26].

The CCR DEA model is expressed mathematically as follows (Figure 1) and is explained in [5], [24], [25] and [26]:

$$\text{maximize} \quad \frac{\sum_i u_i y_{iq}}{\sum_j v_j x_{jq}} \qquad (1)$$

$$\text{subject to} \quad \frac{\sum_i u_i y_{ik}}{\sum_j v_j x_{jk}} \leq 1 \quad k = 1, 2, \ldots, n$$

$$u_i \geq \epsilon \quad i = 1, 2, \ldots, s$$

$$v_j \leq \epsilon \quad j = 1, 2, \ldots, m$$

This model can be converted into a linear programming model[2] and transformed into a matrix:

$$\text{maximize} \quad z = u^T Y_q \qquad (2)$$

$$\text{subject to} \quad v^T X_q = 1$$

$$u^T Y - v^T X \leq 0$$

$$u \geq \epsilon$$

$$v \leq \epsilon$$

Model (2) is often called primary CCR model (*Charnes, Cooper, Rhodes*). The dual model to this can be stated as follows:

$$\text{minimize} \quad f = \theta - \epsilon(e^T s^+ + e^T s^-) \qquad (3)$$

$$\text{subject to} \quad Y\lambda - s^+ = Y_q$$

$$X\lambda + s^- = \theta X_q$$

$$\lambda, s^+, s^- \geq 0$$

Fig. 1: The Standard Data Envelopment Analysis

Where: $\lambda = (\lambda_1, \lambda_2, \ldots, \lambda n)$, $\lambda \geq 0$ is a vector assigned to individual productive units, s^+, and s^- are vectors of addition *input* and *output* variables, $e^T = (1, 1, \ldots, 1)$ and $\in$ is a constant greater than zero, which is normally pitched at 10^{-6} or 10^{-8}.

A virtual unit that is superior to the *inputs* and *outputs* of the unit DMUq under evaluation is sought for by Model (3) in Figure 1, which is described by *inputs* $X\lambda$ and *outputs* $Y\lambda$, which are a linear combination of inputs and outputs of other population units, [25]. Next, the effectiveness of unit DMUq is assessed using this virtual unit.

For $X\lambda \leq X$q as the virtual unit is *inputs* and $Y\lambda \geq Y$q as its *outputs*. Additionally, because of the weights' flexibility, a DMUj is regarded as efficient if it meets θj=1, and inefficient if θj< 1 according to [3], [4] and [5].

Reaching the sustainability criteria for contemporary ESG entrepreneurship was not included in the original definition of DEA.

Therefore, its distinguishing traits include restricted social impact functionality (DEI initiatives) and low discriminating capacity (loss of ESG information).

2.2 Novel DEA for Sustainability Assessment Considering ESG Activities and DEI Initiatives

To move towards sustainable development, targets must be defined, and the degree of sustainability obtained by a system must be quantified. Goal setting is difficult since it must take into account many different factors, [1], [18], [20], [30].

We are proposing a new DEA method:

Proposed DEA = The Standard DEA + The "*entrepreneurship's social impact*" concept, scalable in three dimensions: diversity, equity, and inclusion.

With the advancement of blockchain technologies, an increasing number of public chain initiatives have been announced. Selecting from a wide range of options the top-performing public chain project has evolved into a creative undertaking.

When assessing the blockchain project, considerations such as the project's popularity, market success, and technical performance of the blockchain must be made, [1], [3], [27], [30], [31], [32].

Consequently, we developed a three-tiered indicator system (Figure 2). First come the technical signs. Market indicators come in second.

The market performance of cryptocurrencies created by blockchain initiatives is a good indicator of what investors expect from these projects, [1], [5], [20], [30], [31].

In this instance, the two main indications we analyze are the rate of return's mean and standard deviation, [20].

Thirdly, the popularity. Google Trends allows us to ascertain the popularity of any FinTech/blockchain project, [20], [21], [22], [23], [24].

Our created 3-level indicator system is depicted in the following Figure 2.

Fig. 2: The evaluation indicators for blockchain technologies evaluation

As per the concept of "*social impact of entrepreneurship,*" as outlined in references [1], [20] and [30], a DMU is deemed efficient of order *k* in the suggested DEA if and only if it is discovered to be efficient in any of the *k*-elements subsets of the *input* variables (in the study discussed in the subsequent Section, *k*=8), [1], [2], [17], [18] (Table 1).

Consequently, the suggested DEA has a scale factor of k and is a DEI (diversity, equality, inclusion) scalable DEA.

The fundamental concept of the suggested enhanced DEA is to repeatedly do the DEA calculations for every possible set of *input* and *output* variable combinations while incorporating a sustainability efficiency for the DEI "*entrepreneurship's social impact*" and a *k* dimension efficiency, [5], [17], [18], [20], [21], [22], [23], [24], [30].

Figure 3 presents the suggested process as a flowchart. A DEI-based scalable DEA with a scale factor of *k* (a subset of *inputs* with cardinality *k*) is described by this methodology, [5], [26], [30].

The DMU is considered efficient of order *k* in the proposed DEA if and only if the efficiency for any subset of the eight cardinality *k* inputs is equal to 1, [5], [20], [30].

In the selected SEM method (performing a structural model fit assessment to value the standardized path coefficients "*ESG to sustainable corporate performance through DEI*") the latent variable ESG is regarded as the 1st independent factor with eleven (11) responsibility and quality metrics dynamics as blockchain observed variables (*Transparency, Same-data sharing, Knowledge sharing, Smart contracts utilization, Cyber-hacking protection, Sustainability fair, Fraudulence suspension, Fidelity-Integrity-Trust, Green workshops, Environmental awareness, and Volunteer environmental cleanup*), [1], [2], [3], [5], [20], [30], (Figure 4).

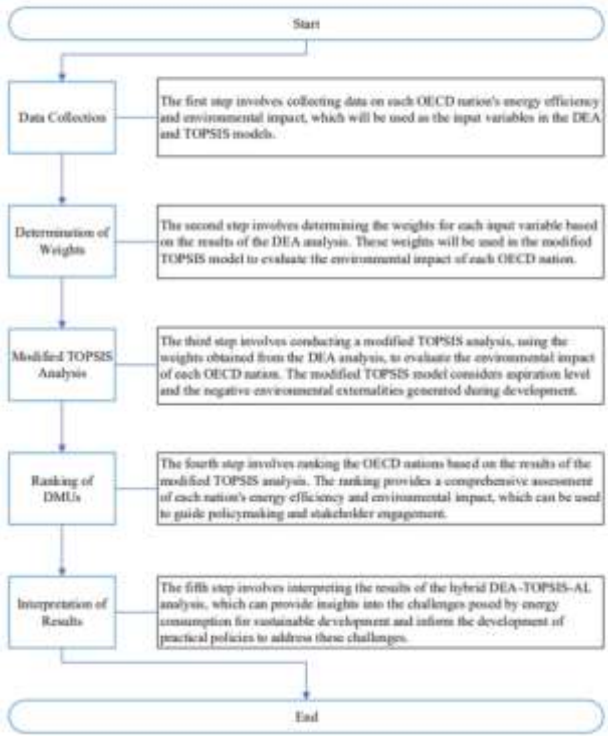

Fig. 3: Flowchart of the novel framework's methodology for monitoring economic growth efficiency (scalable in diversity, equity, and inclusion sustainability)

These eleven (11) observed variables are the dimensions of the underlying FinTech/blockchain ecosystem, [15], [16], [20], [30].

The latent variable SEP (sustainable entrepreneurship performance) is regarded as the 2nd dependent target factor with eight (8) dimensions as observed variables: *Financial performance (FP), operational performance (OP), quality performance (QP), supply chain performance (SCP), CSR performance (CSRP), green corporate performance (GCP), innovation performance (INP), and integrity performance (IP*), [1], [2], [3], [4], [5], [20], [30], [31] (Figure 3).

Finally, the latent variable DEI is regarded as the intervention factor with four (4) features as observed variables: *Staff & laborer, Clients & customers, Local community & Social followers*, [1], [2], [5], [7], [20], [30], (Figure 4).

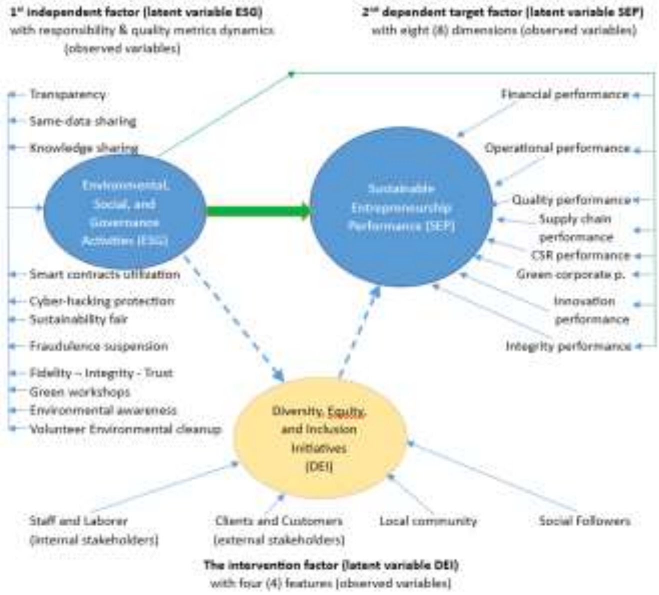

Fig. 4: The proposed performance assessment DEA framework with 11 ESG and four DEI variables

3 Results

The proposed scalable DEA has been tested in 50 companies (5 companies per country for 5 WB and 5 EU countries).

The panel data was selected for the period 2017-2023 from UN Development Programme (UNDP), and World Bank Open Data (WBOD), [19].

As per the evaluating entrepreneurship growth potential empirical model presented by [1], the six *input* variables for the suggested DEA are as follows:

- Firm characteristics (environmental awareness, flexibility to high-tech improvements, ecological footprint, reducing dependence on natural gas/diesel/electric power prices, etc.).
- Macroeconomic, and banking sector indicators (reducing dependence on bank loans, reducing summary of non-performing loans, etc.).
- Macroeconomic conditions (reducing the company's deficit and debt, increasing company economic credit and activity, etc.).
- Micro-financial conditions (reducing the company's product development and operation costs, increasing personnel and job positions, etc.).
- Company governance parameters (internal control procedures, human resources/specialized jobs, auditing quality, government effectiveness, reducing dependence on corruption, etc.), and
- Access to finance opportunities (funding quality, possibility of international financing on competitive terms, funding flow efficiency, etc.).

Additionally, the *output* variables for the proposed DEA are:
(A) The 11 responsibility and quality metrics dynamics (blockchain observed variables) are thematically grouped as follows:

- ESG 1 (sustainability fair),
- ESG 2, 3, and 4 (environmental awareness, green workshops, and volunteer environmental cleanup),
- ESG 5, 6, and 7 (transparency, fraudulence suspension, and fidelity-Integrity-Trust),
- ESG 8, and 9 (same-data sharing, and knowledge sharing), and
- ESG 10, and 11 (smart contracts utilization, and cyber-hacking protection).

These 11 observed variables are the dimensions of the underlying FinTech/blockchain ecosystem, [1], [20], [30], (Figure 4).
(B) Corporate initiatives about culture, society, and DEI as a prevalent and effective practice; also, as the intervention factor (latent variable DEI) with four (4) aspects as observed variables, [20], [30], [31], [32], (Figure 4).

- DEI 1 (staff and laborers as internal stakeholders),
- DEI 2 (clients and customers as external stakeholders),
- DEI 3 (local community as external stakeholders), and
- DEI 4 (social followers as external stakeholders).

In comparison to corporate efficiency, the DEA analysis covered 50 companies for seven years, or 350 DMUs, [1], [5], [17], [20], [21], [22], [30], [31].

The proposed DEA is a scalable non-oriented model with variable return-to-scale functionality (scalable DEA). Every DMU must function at an optimal scale (constant return-to-scale) for the suggested scalable DEA to be implemented, [5], [18], [30], [33], [34].

Table 1 presents the variable correlation coefficients for the proposed *input* and *output* variables for the ESG performance assessment (FinTech/blockchain adoption ecosystem), [1], [4], [5], [11], [17], [18], [20], [30].

Table 1. The DEA *input*/*output* variable correlation coefficients for the ESG performance assessment (FinTech/blockchain adoption)

	Firm Characteristics	Macro-economic Indicators and Conditions	Macro-financial Conditions	Company Governance, and Access to finance	ESG/ *Sustainability fair*	ESG/ *Green workshops, Environmental awareness, and Volunteer environmental cleanup*	ESG/ *Transparency, Fraudulence suspension, and Fidelity-integrity-trust*	ESG/ *Same-data sharing, and Knowledge sharing*	ESG/Smart contracts utilization, and Cyber-hacking protection
	Input 1	**Input 2, 3**	**Input 4**	**Input 5, 6**	**ESG 1**	**ESG 2, 3, 4**	**ESG 5, 6, 7**	**ESG 8, 9**	**ESG 10, 11**
Input 1	1.00								
Input 2, 3	-0.37	1.00							
Input 4	0.66	-0.43	1.00						
Input 5, 6	-0.18	-0.63	-0.09	1.00					
ESG 1	-0.60	-0.49	-0.79	-0.12	1.00				
ESG 2, 3, 4	0.85	-0.33	0.55	-0.83	0.61	1.00			
ESG 5, 6, 7	-0.29	-0.33	-0.87	0.329	-0.65	0.70	1.00		
ESG 8, 9	-0.40	-0.19	-0.75	0.56	-0.30	-0.47	0.32	1.00	
ESG 10, 11	0.17	0.39	-0.43	0.57	-0.53	-0.62	0.41	0.19	1.00

Table 2 displays the variable correlation coefficients for the proposed *input* and *output* variables for the DEI performance assessment (FinTech/blockchain adoption ecosystem), [1], [4], [5], 11], [17], [18], [20], [30].

Table 2. The DEA *input*/*output* variable correlation coefficients for the DEI performance assessment (FinTech/blockchain adoption)

	Firm Characteristics	Macro-economic Indicators, and Conditions	Macro-financial Conditions	Company Governance	Access to finance	DEI/ *Staff and Laborers (internal stakeholders)*	DEI/ *Clients and Customers (external stakeholders)*	DEI/ *Local community*	DEI/ *Social followers*
	Input 1	**Input 2, 3**	**Input 4**	**Input 5**	**Input 6**	**DEI 1**	**DEI 2**	**DEI 3**	**DEI 4**
Input 1	1.00								
Input 2,3	-0.44	1.00							
Input 4	0.69	-0.30	1.00						
Input 5	-0.59	-0.23	-0.49	1.00					
Input 6	0.06	-0.39	-0.55	-0.16	1.00				
DEI 1	0.80	-0.39	0.61	-0.77	0.65	1.00			
DEI 2	-0.33	-0.39	-0.81	0.34	-0.60	0.75	1.00		
DEI 3	-0.41	-0.62	-0.43	0.60	-0.39	-0.48	0.32	1.00	
DEI 4	0.19	-0.12	-0.65	0.79	-0.39	-0.60	0.57	0.35	1.00

4 Discussion

Monitoring efficiency is one of a company's primary responsibilities. Techniques for measuring corporate efficiency can be disclosed into three categories: nonparametric, parametric, and ratio indicators, while many conventional and IT-based strategies are employed in our contemporary culture, [24], [25], [33].

In this paper, for sustainable performance assessment using the proposed DEA technique, we defined as *inputs* six financial characteristics/indicators/conditions/parameters, and as *outputs* 11 ESG/Blockchain adoption (Table 1) and four DEI (Table 2) quality metrics dynamics to measure the firm's efficiency, [24], [25], [30].

Having the corporate performance as the objective -after estimating the *output* variables ESG/BCA, and DEI- the latent variable sustainable entrepreneurship performance is calculated as a dependent target factor with eight dimensions (observed variables): *Financial performance (FP), operational performance (OP), quality performance (QP), supply chain performance (SCP), CSR performance (CSRP), green corporate performance (GCP), innovation performance (INP), and integrity performance (IP)*.

The results of the conducted analysis (sustainable entrepreneurship performance calculation) are summarized in Table 3 as DEA-evaluated effectiveness ratings by country with DEI corporate efforts acting as a middleman for BCA projects and ESG activities, [1], [5], [11], [20], [30].

Table 3. DEA-assessed efficiency scores by country (mean 7 years panel data for 5 companies/country)

DEA efficiency Score for SEP (scale 0..100%)	FP	OP	QP	SCP	CSRP	GCP	INP	IP	mean
Albania	48.40 48.91 52.57	48.90 52.76 54.88	50.32 54.40 58.89	54.88 56.21 59.90	53.29 56.78 60.04	60.64 63.52 66.89	50.08 52.67 53.54	48.11 52.87 55.90	52.21 54.91 57.59
Bosnia & Herzegovina	76.00 79.94 88.90	77.32 79.43 89.03	67.72 72.99 85.51	70.03 76.32 87.24	72.06 76.42 87.30	75.42 70.54 86.80	70.66 74.48 87.29	73.55 76.77 90.63	72.96 74.02 88.10
North Macedonia	70.85 74.34 80.06	78.20 78.34 82.11	66.10 69.98 72.35	70.33 74.09 78.14	73.65 76.93 78.20	75.90 77.88 81.04	72.56 75.01 79.97	78.31 74.25 77.63	71.99 75.10 79.04
Montenegro	73.90 79.04 86.36	79.92 82.32 87.77	67.20 72.90 77.00	71.93 76.20 81.01	73.88 77.21 80.33	73.49 77.40 80.95	72.96 74.80 80.21	71.50 78.21 80.92	72.97 77.02 82.26
Serbia	72.15 76.66 81.09	76.10 78.90 81.65	66.66 69.06 71.90	70.42 75.68 79.20	73.69 76.03 79.61	75.04 77.70 80.52	72.97 75.32 79.66	71.11 74.84 77.05	72.29 75.43 78.78
Germany	84.47 87.33 90.31	83.57 88.19 91.55	83.82 85.80 89.11	85.18 88.62 90.08	77.70 80.32 84.29	87.71 88.38 90.93	85.22 88.64 90.20	89.65 91.90 93.61	84.98 87.42 90.04
France	83.67 86.87 88.32	85.87 88.52 91.03	83.20 85.80 89.65	84.09 87.80 89.87	77.26 80.80 83.63	65.98 68.05 90.78	84.29 86.55 90.28	88.60 91.09 93.17	84.04 86.97 89.72
Italy	81.72 84.88 88.92	85.02 87.22 91.77	81.67 84.44 89.51	84.12 85.87 87.33	76.22 78.10 80.03	61.80 62.75 84.02	80.64 82.58 85.16	81.70 83.33 85.72	81.67 83.66 86.69
Netherlands	83.72 85.04 88.10	84.17 86.08 90.44	83.20 85.05 88.77	85.02 87.66 89.44	78.78 80.77 84.90	67.11 88.44 90.07	85.33 90.22 94.06	88.88 90.42 93.50	84.53 88.88 89.95
Greece	80.20 82.09 85.22	85.33 87.38 91.04	82.71 84.09 86.10	82.88 84.70 86.03	74.09 76.06 80.12	60.71 62.04 64.66	78.84 80.98 83.92	81.09 83.52 85.07	80.68 82.80 85.27

As a result, computations made with the obtained data allow for WB and EU countries comparison in terms of assessed relative efficiency. The countries that maintained an appropriate coherence of values for economic development, social development, and environmental preservation and had high values of *output* variables and low values of *input* variables yielded the best results, [20], [24], [25], [26], [30].

The efficacy of each WB/EU country striving to concurrently attain many distinct sustainable development objectives was assessed via a computation employing the suggested DEA model, permitting validation of hypothesis H1 ("*DEA is applicable in entrepreneurship's sustainable economic growth assessment*.").

The reliability (sustainability) of corporate economic growth estimation increased by more than 4% in WB countries when ESG/BCA activities were incorporated, and by more than 12% when corporate DEI initiatives were adopted in a mediating role. These findings are shown in Table 3 (reliability of SEP's growth estimation).

Respectively, in EU countries, the incorporation of ESG/BCA activities increased the reliability (sustainability) of corporate economic growth estimation by less than 3%, while DEI initiatives in a mediating role increased the reliability of economic growth estimation by about 6%.

From the SEP observed variables (dimensions), the "*innovation*" and "*integrity*" received the highest scores, especially when the DEI corporate initiatives mediate (see Table 3 yellow highlighted).

We found that, in response to the first research question, "*Do the ESG activities improve SEP performance and to what extent?*" (see Table 3, 2nd-row ESG→SEP, mean data for all WB and EU countries), the ESG/BCA business activities increase SEP performance by more than 3%.

As far as the 2nd research question "*Do the corporate DEI initiatives influence ESG activities on SEP performance and to what extent?*" is concerned, we noticed that the DEI mediation improves SEP performance by about 10% (see Table 3, 3rd-row ESG/BCA(DEI)→SEP, mean data for all WB and EU countries).

As a result, favorable responses were given to both research questions (RQ1 and RQ2).

Specifically, in the instance of Bosnia and Herzegovina, the estimation of reliability increases by about 18% when the DEI initiatives mediate the SEP economic growth (mean 7 years data, see Table 3 yellow highlighted). This is to be expected given Bosnia and Herzegovina's distinct features, namely its multiethnic and multicultural population.

Therefore, hypothesis H2 ("*ESG activities and DEI corporate initiatives can be considered as "pillars of sustainability" at a scale*.") has been confirmed.

Determining a company's sustainability is a crucial component of growth development analysis. Being the most efficient in a group does not always mean a business is sustainable; rather, it just means that it performs better or worse than the others in comparison. Because of this, DEA is unable to assess a company's sustainability even though it exhibits high levels of efficiency in reaching and coordinating objectives.

The DEA method could be used in sustainable development analysis while being supplemented by another method/technique, keeping in mind that the analysis of sustainable development must include a label on whether a company can be considered sustainable or not, in addition to comparison and ranking of the countries/companies one against the other (e.g. the TOPSIS, APP or the MCDM/multicriteria decision making approaches) or indicator/process (e.g. the AHP/analytic hierarchy process, [35]) that overcomes this disadvantage.

The kind of optimization is set for each criterion (max or min), which is a benefit of the TOPSIS approach. The APP technique is not used for this. Setting the criteria values for each of the possibilities is necessary for the TOPSIS approach. The criteria values for the AHP approach are not predetermined and are not required, [35], [36].

A consistent weighting of the *inputs* and *outputs* is not necessary when using the efficiency metric that DEA offers. On the other hand, a multicriteria decision-making technique is predicated on the idea that all units (alternatives) must be subject to the same set of weights.

Furthermore, ex-post analysis -where further issues arise regarding the scope of the study if the data is primarily unavailable- and analysis of already collected data are the only uses for DEA. It is not possible to utilize DEA to anticipate future values and changes in the indicators.

One strategy to solve these shortcomings is to thoroughly measure a nation's potential and sustainability restrictions, as well as its (in)efficiency, by examining the gaps between its potential values.

It is difficult to tell with certainty whether or not any specific firms meet the criteria for being sustainable, but in general, DEA can be used to analyze, compare, and assess how well organizations are doing as they progress toward sustainability.

Furthermore, the relative DEA method's outcomes are highly dependent on the choice of DMU and input/output variables. Because of this, it is essential to test out different setups and degrees of analysis concerning the time frame and the countries/companies being observed.

5 Conclusions

In many blockchain applications, the user's selection process requires a dynamic evaluation approach, which this article offers. This study has effectively finished a multi-perspective, in-depth examination of the performance of blockchain technology by employing a DEA (benchmark) technique.

Compared to other researchers' findings in [3], [4], [5], [10], and [11] our study offers more detailed information on the FinTech/blockchain adoption ecosystem. It is the first study considering as DEA *outputs* ESG/BCA, and DEI quality metrics dynamics, and then with the mediating role of the DEI corporate initiatives the sustainable entrepreneurship performance (a latent variable regarded as a dependent target factor) is calculated using eight factors as observed variables.

The proposed framework accurately monitors and shows the dynamic performance of a public blockchain in 11 ESG/BCA dimensions with great FinTech functionality (*transparency, same-data sharing, knowledge sharing, smart contracts utilization, cyber-hacking protection, sustainability fair, fraudulence suspension, fidelity-integrity-trust, green workshops, environmental awareness, and volunteer environmental cleanup*).

To evaluate the sustainability and dependability of the economic growth estimation of entrepreneurship, we have put up a scalable DEA approach.

The successful conduct of the FinTech/blockchain adoption analysis resulted in the confirmation of hypotheses H1 ("*DEA is applicable in sustainable economic growth assessment*") and H2 ("*ESG activities and DEI initiatives can be considered as "pillars of sustainability" at a scale*.").

Advantages and contributions: By merging the "social impact" notion with standard DEA, the proposed DEA achieves the following three goals: (i) strengthens discriminatory power; (ii) keeps information about the "pillars of sustainability," the DEI and ESG/BCA initiatives, from being lost; and (iii) offers scalable functionality because the DEI and ESG/BCA dimensions are easily expanded (1D arrays).

The evaluation of business data from 50 WB and EU enterprises has demonstrated the capability of the proposed DEA. As a tool for developing future policies under sustainable development and for advancing technological advancement, the approach can help refine the transition to a more sustainable future.

Findings: When corporate social and DEI actions mediate, we discovered that there is a statistically sound (significant, positive) association between ESG and the quality performance of economic growth (particularly in the *innovation* and *integrity* BCA performance success metrics).

Applications: The proposed scalable approach helps corporate management increase the efficacy of economic growth by demonstrating which company is more efficient in transitioning toward sustainability through an empirical inquiry. Furthermore, our scalable framework offers suggestions for improving the efficiency and sustainability of entrepreneurship.

Implications: The overall effectiveness of the enterprises under observation to support sustainable economic growth is greatly impacted by economic, social, environmental, and DEI aspects.

The presented study links technological innovation to political and national characteristics, it lowers issues related to ethnic and cultural particularities. Therefore, DEA analysis for FinTech/BCA relative efficiency should be used cautiously in light of the issue this study explores, [5], [11], [20], [30].

Technological and innovative developments are usually the biggest forces behind sustained economic progress, with political, racial, cultural, and managerial inefficiencies acting as the main obstacles, [4], [5]. Because of this, assessing the effectiveness of economic growth is crucial when formulating decisions, [28], [29], [30].

Limitations: Given how much the variables and sample selection impact the outcomes of the DEA models, the technique used in this study is primarily to blame for its flaws. Due to its relative nature, the proposed DEA is unable to determine if a company is developing sustainably or not. It can only evaluate efficiency with respect to other units, not determine whether such efficiency is adequate to achieve the goal.

Further research: The proposed DEA is a relative assessment technique. Therefore, the analysis can be modified by changing the countries, and the corporates (e.g. large, medium, and small enterprises) or by choosing different *input* (e.g. financial characteristics, indicators,, conditions, and parameters) and *output* (e.g. ESG/BCA, and DEI quality metrics dynamics) variables, which makes this an interesting topic for further research.

A country's potential could be better measured in terms of variables and gaps between actual and potential values. Databases could also be improved to allow for additional measurements by varying variable combinations and including different DMUs. All these actions would increase the likelihood that the DEA method will be applied to sustainable development analysis with CSR and DLT/Blockchain functionalities, [37], [38].

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References:

[1] Aida, N., Atiqasani, G., Palupi, W.A. The Effect of the Tourism Sector on Economic Growth in Indonesia, *WSEAS Transactions on Business and Economics*, 2024, 21, 1158-1166, https://doi.org/10.37394/23207.2024.21.95.

[2] Mavrommati, A., Kazanas, T., Pliakoura, A., Kalogiannidis, S., Chatzitheodoridis, F. An Empirical Study on Tourism and Economic Growth in Greece: An Autoregressive Distributed Lag Boundary Test Approach, *WSEAS Transactions on Business and Economics* 2024, 21, 588-602, https://doi.org/10.37394/23207.2024.21.49.

[3] Nazarko B.(K.), Performance Evaluation in Macroeconomics based on DEA Malmquist Index with a New Approach for the Efficiency Evaluation in a Two-Stage Process. *WSEAS Transactions on Information Science and Applications* 2024, 21, 169-185. https://doi.org/10.37394/23209.2024.21.17.

[4] Zhou, H., Yang, Y., Chen, Y., Zhu, J. Data envelopment analysis application in sustainability: The origins, development and future directions, *European Journal of Operational Research*, 2018, 264, 1-16, doi:10.1016/j.ejor.2017.06.023

[5] Sotiroski, K., Péter, K., Horvat, A.M., Sedlak, O., Lakić, V., Radovanov, B. Assessing sustainable economic development efficiency: a DEA approach, *Strategic Management – International Journal of Strategic Management (Novi Sad University)*, 2024, 29(2), doi:10.5937/StraMan2300039S.

[6] Gülaliyev, M.G., Nuraliyeva, R.N., Huseynova, R.A., Hatamov, F.E., Yegana, A.S., Abdullayev, E.S. Assessing the Impact of the Oil Price Shocks on Economic Growth in Oil-Exporting Arab Countries, *WSEAS Transactions on Business and Economics*, 2022, 19, 462-473, https://doi.org/10.37394/23207.2022.19.42.

[7] Hasanagas, N.D., Styliadis, A.D., Papadopoulou, E.I, Environmental policy and science management: Using a scientometric-specific GIS for E-learning purposes, *Int. J. Comput. Commun. Control*, 2010, 5(2), 171–178, doi:10.15837/ijccc.2010.2.2472.

[8] Hasanagas, N.D., Styliadis, A.D., Papadopoulou, E.I., Sechidis, L.A. E-Learning & environmental policy: The case of a politico-administrative GIS, *Int. J. Comput. Commun. Control*, 2010, 5(4), 517–524, doi:10.15837/ijccc.2010.4.2509.

[9] Mebratu, D. Sustainability and sustainable development: historical and conceptual review, *Environmental impact assessment review*, 1998, 18(6), 493-520, doi:10.1016/S0195-9255(98)00019-5.

[10] Škare, M., Rabar, D., Measuring Economic Growth Using Data Envelopment Analysis, *Amfiteatru Economic Journal* (Academy of Economic Studies, Romania), 2015, 18(42), 386-406, [Online]. (econstor.eu): https://www.econstor.eu/handle/10419/169008 (Accessed Date: July 10, 2024).

[11] Tsaples, G., Papathanasiou, J. Data envelopment analysis and the concept of sustainability: A review and analysis of the literature, *Renewable and Sustainable Energy Reviews*, 2021, 138, 110664, doi:10.1016/j.rser.2020.110664.

[12] Dakpo, K. H., Jeanneaux, P., Latruffe, L. Modelling pollution-generating technologies in performance benchmarking: recent developments, limits and future prospects in the nonparametric framework, *European Journal of Operational Research*, 2016, 250(2), 347–359, doi:10.1016/j.ejor.2015.07.024.

[13] Morano, P., Tajani, F., Guarnaccia, C., Anelli, D. An Optimization Decision Support Model for Sustainable Urban Regeneration Investments, *WSEAS Transactions on Environment and Development*, 2021, 17, 1245-1251, https://doi.org/10.37394/232015.2021.17.114.

[14] Mavlutova, I., Lesinskis, K., Liogys, M., Hermanis, J. Innovative Teaching Techniques for Entrepreneurship Education in the Era of Digitalisation, *WSEAS Transactions on Environment and Development*, 2020, 16,

725-733, https://doi.org/10.37394/232015.2020.16.75.

[15] Varveris, D., Styliadis, A., Xofis, P., Dimen, L. Tree Architecture & Blockchain Integration: An off-the-shelf Experimental Approach, *WSEAS Transactions on Environment and Development*, 2023, 19, 969-977, https://doi.org/10.37394/232015.2023.19.91.

[16] Varveris, D., Styliadis, A., Xofis, P., Dimen, L. Distributed and Collaborative Tree Architecture: A Low-cost Experimental Approach for Smart Forest Monitoring, *Baltic J. Modern Computing*, 2023, 11(4), 653-685, doi:10.22364/bjmc.2023.11.4.07.

[17] Orisaremi, K.K., Chan, F.T.S., Fu, X. An Improved DEA for Assessing Economic Growth and Environmental Sustainability in OPEC Member Nations, *Mathematics*, 2023, 11, 4861, doi:10.3390/math11234861.

[18] Galán-Martín, A., Guillén-Gosálbez, G., Stamford, L., Azapagic, A. Enhanced data envelopment analysis for sustainability assessment: A novel methodology and application to electricity technologies, *Computers & Chemical Engineering*, 2016, 90, 188-200, 10.1016/j.compchemeng.2016.04.022.

[19] Silajdžić, S., Selimović, J., Mehić, E. Sustainable Growth in the Western Balkans? Horizons – Journal of International Relations and Sustainable Development, 2021, 19, 176-191, [Online]. (cirsd.org/Horizons): https://www.cirsd.org/files/000/000/008/76/c649ae5e062301a90a75e7eff5433aec8267f3e7.pdf (Accessed Date: July 11, 2024).

[20] Mutairi, A.M.S.A., Bakar, S.B. Influence of Corporate Governance Mechanisms on Financial Risk and Financial Performance: Evidence from Refinitiv ESG Database, *WSEAS Transactions on Computer Research*, 2023, 11, 339-351, https://doi.org/10.37394/232018.2023.11.31.

[21] Morkunas, V. J., Paschen, J., & Boon, E. How blockchain technologies impact your business model, *Business Horizons*, 2019, 62, 295–306, doi:10.1016/j.bushor.2019.01.009.

[22] Chang, V., Baudier, P., Zhang, H., Xu, Q., Zhang, J., & Arami, M. (2020). How Blockchain can impact financial services – The overview, challenges and recommendations from expert interviewees, *Technological Forecasting and Social Change*, 2020, 158, 120166, doi:10.1016/j.techfore.2020.120166.

[23] Salcedo, E., Gupta, M. The effects of individual-level espoused national cultural values on the willingness to use Bitcoin-like blockchain currencies, *International Journal of Information Management*, 2021, 60, 102388, doi:10.1016/j.ijinfomgt.2021.102388.

[24] Charnes, A., Cooper, W.W., Rhodes, E. Measuring the efficiency of decision making units, *Eur. J. Oper. Res.* 1978, 2, 429–444, doi:10.1016/0377-2217(78)90138-8.

[25] Vincová, K. Using DEA Models to Measure Efficiency, *BIATEC*, 2005, XIII, [Online]. (Národná Banka Slovenska): https://nbs.sk/_img/documents/biatec/bia08_05/24_28.pdf (Accessed Date: July 10, 2024).

[26] Lin, S.-W., Lo, H.-W., Gul, M. An assessment model for national sustainable development based on the hybrid DEA and modified TOPSIS techniques, *Complex & Intelligent Systems* 2023, 9, 5449–5466, doi:10.1007/s40747-023-01034-2.

[27] Zhou, Z., Li, R., Cao, Y., Zheng, L., Xiao, H. Dynamic performance evaluation of Blockchain Technologies. *IEEE Access* 2020, 8, 217763, doi: 10.1109/ACCESS.2020.3040875.

[28] Metaxas, K., Papapanagos, H., Koulakiotis, A. Retail Interest Rate Differentials in the Eurozone: A Co-Integration Analysis Approach, *Journal of East-West Business*, 2024, 30,1–32, doi:10.1080/10669868.2023.2252825.

[29] Tsitouras, A., Papapanagos, H. Income Inequality, Economic Freedom, and Economic Growth in Greece: A Multivariate Analysis. In: Tsounis, N., Vlachvei, A. (eds) *Advances in Empirical Economic Research*, 2023, ICOAE 2022. *Springer Proceedings in Business and Economics*, Springer, Cham, doi:10.1007/978-3-031-22749-3_30.

[30] Basdekidou, V., Papapanagos, H. The Use of DEA for ESG Activities and DEI Initiatives Considered as "Pillar of Sustainability" for Economic Growth Assessment in Western Balkans, *Digital* 2024, 4, 572–598, doi:10.3390/digital4030029.

[31] Meskini, F.Z., Alaoui, Y.L., Aboulaich, R. Evaluating Barriers to Blockchain Adoption in the Insurance Sector using Interval-Valued Intuitionistic Fuzzy TOPSIS, *WSEAS Transactions on Business and Economics*, 2024, 21, 1584-1597, https://doi.org/10.37394/23207.2024.21.129.

[32] Basdekidou, V., Styliadou, A.A. Corporate Social Responsibility & Market Volatility:

Relationship and Trading Opportunities, *International Business Research* 2017, 10(5), 1-12, doi:10.5539/ibr.v10n5p1.

[33] Basdekidou, V., Styliadou, A.A. Corporate Social Responsibility Performance & ETF Historical Market Volatility, *International Journal of Economics and Finance* 2017, 6(10), 30-39, doi:10.5539/ijef.v9n10p30.

[34] Ruzgar, N.S. Key Indicators Influencing BRICS Countries' Stock Price Volatility through Classification Techniques: A Comparative Study, *WSEAS Transactions on Business and Economics*, 2024, 21, 1494-1510, doi:10.37394/23207.2024.21.122.

[35] Saaty, T.L. A scaling method for priorities in hierarchical structures. *Journal of Mathematical Psychology* 1977, 15(3), 234-281, https://doi.org/10.1016/0022-2496(77)90033-5.

[36] Mandal, B., Mandal, S. Analytical hierarchy process (AHP) based landslide susceptibility mapping of Lish river basin of eastern Darjeeling Himalaya, India, *Advances in Space Research* 2018, 62(11), 3114-3132, doi.org/10.1016/j.asr.2018.08.008.

[37] Styliadou, A. Introducing a Corporate Registry with Spatial, Cadastre and CSR Functionalities, *RevCAD Journal of Geodesy and Cadastre*, 2018, 24, 173-182, [Online]. https://www.ceeol.com/search/article-detail?id=807385 (Accessed Date: July 8, 2024).

[38] Styliadou, A. Expropriation & Compensation in Greek Land Property Law in Comparison with the ECHR: Reviewing Cases and Discussing Property Management with DLT/Blockchain Functionalities, *RevCAD Journal of Geodesy and Cadastre*, 2018, 24, 183-192, [Online]. https://www.ceeol.com/search/article-detail?id=807387 (Accessed Date: July 8, 2024).

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The authors have no conflicts of interest to declare.