Article

Maturity Analysis of Stock Exchanges in Africa: Prepandemic Sustainability Perspective

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Abstract: This paper focuses on the economic dimension of sustainability by examining the stock exchange interface of financial markets, the influence of capital market stakeholders, and the instruments that contribute to a supportive fiscal framework. Only mature stock exchanges are present in sustainability indices; hence, comparative assessment of stock exchanges is limited and contributes to the complexity of conducting such a study. Utilizing multivariate analysis, this study investigates the potential for African stock exchanges to support sustainability. An empirical study was conducted on a selected sample of 15 African stock exchanges at the end of 2020 using collected 5-year interval data from Q1 of 2021. A total of 22 variables were selected based on their legitimacy to support sustainability. Using exploratory factor analysis, two key sustainability drivers of differentiation and classified exchanges were identified, i.e., hard and soft. K-means classification method verified the results and found that of the four identified homogeneous groups, one—the Johannesburg Stock Exchange, Nigerian Stock Exchange, and the Egyptian Exchange—emerged on top. Two smaller groups had the potential to be strengthened, and the majority group lagged behind. The research demonstrated the importance of identifying key sustainability drivers and examined the materiality of the drivers within an African context.

Keywords: sustainable development; explanatory factor analysis; k-means; United Nations Sustainable Development Goals

1. Introduction

In the last few decades of the twentieth century, a shift from development in the economic sense to the concept of sustainability became increasingly common. The traditional model, i.e., contributing to the development and improvement of the quality of life of societies, was not considered beneficial for all to the same extent [1,2]. The negative effects were intensified mainly in the form of natural environmental degradation [1,3]. A new approach based on the idea of sustainable development was perceived as a solution to contemporary problems and challenges—emphasizing the need for a broader perspective within a triple bottom line approach [4–6], i.e., environmental, social, and economic dimensions. Sustainable development requires the involvement of many actors, including state institutions, multinational corporations, and enterprises [7,8], non-governmental organizations, and the community at large [9]. A key economic function of this involvement is capital markets, i.e., by supporting sustainable capital allocated by responsible investments and sustainability-oriented financing [10–12]. Research consideration focuses on the relevant architecture of stock exchanges in the context of responsible investing, as stock exchanges can achieve spectacular outcomes in terms of the United Nations Sustainable Development Goals (SDGs) [12,13]. To date, an emphasis on institutional quality has downplayed the concept of sustainability by focusing on key determinants of economic development [14].

Stock exchanges fulfill their basic function and prove their maturity by attracting foreign capital and long-term investments, as well as a developed institutional framework that provides trustworthiness [15]. Bodie et al. [16] point out the importance of market transparency for informed decisions. Alley [17] indicates that there is still no consensus on the impact of foreign capital flows in terms of economic wealth, even though it has been well deliberated throughout the literature. Doubts concerning the role of foreign equity arise from the fact that capital might be volatile or speculative [17,18]. Strong requirements by foreign investors to use transparent accounting standards result in a lower risk of illegal activities, e.g., zero tolerance for corruption [19]. Similarly, long-term investors, such as pension funds, are more likely to focus on sustainable aspects, especially as they are subject to strict requirements, e.g., those related to anti-money laundering. The development issues mentioned are relevant to the development problems of Africa's financial markets.

Due to the potential of the market, available natural resources, the pace of development, and the gap in integrating into the world economy, Africa is an extremely important and emerging research area. Although, in recent years, the continent has been one of the fastest developing regions [20], it still remains a place of many challenges, including urban demographic growth, poverty, climate change, access to medical and educational services, and infrastructure underdevelopment [21]. Many African economies are heavily dependent upon natural resources—even those that are nonrenewable and quickly depleting [22,23]. It is crucial that all the actions undertaken to solve these problems must go hand in hand with sustainable production and consumption patterns as well as deep social change. This paper aims to utilize a multivariate analysis to examine the potential of stock exchanges in Africa that support sustainable development by identifying the key sustainability drivers and probing the materiality of these drivers within selected stock exchanges by classifying them in terms of the environmental—social—governance (ESG) approach. Multidimensional comparative analysis techniques are used to comparatively determine the sustainability of the selected stock exchanges. The structure of the paper is as follows: brief literature review on stock exchanges and sustainability in Africa; empirical framework containing a selection of stock exchanges, description of the set of variables utilized, and estimation of measures; explanatory factors analysis (EFA) and k-means verification—results and discussion; and concluding recommendations and limitations of the study.

2. Literature Review

2.1. Impact of Stock Exchanges in Africa

Among the few studies on stock exchanges in Africa [24], general issues include underdevelopment [24–28] or weaknesses of individual exchanges caused by, among other factors, sustainability deficiencies in the institutional framework (e.g., the Nigerian Stock Exchange (NSE) [15]) have been predominant (Figure 1—left). Andrianaivo and Yartey [29] underline the general determinants of financial market development, those being stock market liquidity, domestic savings as a main source of stock investments, development of the banking sector, and political risk. Odera [28] draws attention to the fact that the low liquidity of exchanges enables support for the local market via trading systems or brokers since the business volume is low. Other weaknesses of African capital markets include low levels of investor protection and innovation, underdeveloped trading systems or high initial public offering barriers for smaller companies, weak regulatory framework, and low foreign capital [27,30]. At present, only some stock exchanges in Africa are developed—varying deeply due to historical conditions, regulations, and performance. Three different groups of stock exchanges can be distinguished: (1) those founded between the turn of the nineteenth century, those established in the 1990s, and recently opened small exchanges in the last two decades. As a standout exchange and in comparison with other stock exchanges in Africa, the Johannesburg Stock Exchange (JSE) clearly dominates the continent, since it is also the nineteenth largest exchange in the world [30].
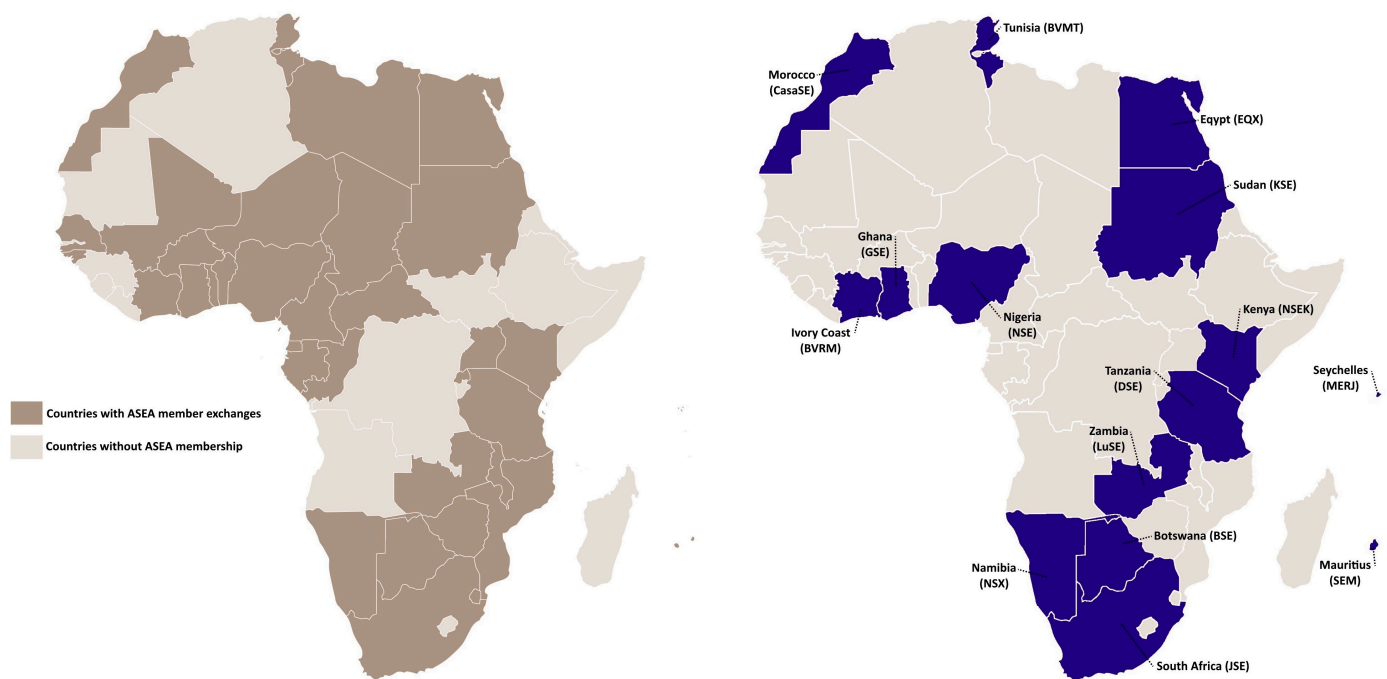
Figure 1. (**left**) African Securities Exchanges Association (ASEA) member exchanges, adapted from Raubenheimer [30], and (**right**) selected countries in the study.

Klagge and Zademach [25] document that the increase in stock exchanges and investment funds operating in Africa does not entail sufficient investment for the continent. This lack of financing, unfortunately, occurs even if the arbitrage theory suggests that the temptation of higher returns in developing countries should attract investors from developed ones. In terms of the low attractiveness for foreign flows of adequate size for domestic companies, Alley [17] states the poverty cycle can be overcome if the financing gap, i.e., a result of low levels of savings and investment, is bridged by foreign direct investment (FDI). However, Raubenheimer [30] noted foreign capital restrictions in some countries, such as Zimbabwe, which restricts foreign investors to no more than 49% equity in any enterprise, and Mauritius, which has foreign ownership restrictions on sugar companies. Any doubtful influence of the financial sector on the economic stability and development model [31,32] is dispelled by prevailing research on the key role of financial markets in economic growth [11,33–38], for example, something which has been diversely developed throughout the African continent. Assefa and Mollick [39] cite research on the importance of African stock markets but with no impact assessment. More consistent conclusions have been derived from research on institutions as a fundamental development factor. Using the example of the sub-Saharan African region, Bonuedi et al. [40] depict the positive and statistically significant association between institutions and real income per capita and, hence, the importance of well-performing and strong institutions for economic growth.

2.2. Sustainability of Stock Markets

According to the United Nations Conference on Trade and Development [12,41], stock exchanges, as intermediary platforms, may contribute to sustainability via two mechanisms: (1) guiding, supporting, and promoting good corporate practices within business and (2) providing a platform for sustainable finance through the mobilization of financial resources using sustainable products and channeling them into sustainability-oriented investments. Converging conclusions were recalled by Busch et al. [42] in terms of the capital market influence on enterprise sustainability. Moreover, financial and investor advocacy influence is noted as key to fostering and facilitating better sustainable business practices. Zhan and Santos-Paulino [13] also consider stock exchanges as providers of a platform for sustainable finance and guidance for corporate governance. A broad approach

to describing various tools and activities for sustainable development can be found in the Sustainable Stock Exchanges Initiative (SSEI) [43], the World Federation of Exchanges (WFE) [44], and ASEA [45]. These publications are also underlined by Kalinowski [46], who used some of the SSEI factors, such as indices or supporting market participants, by offering guides on responsible investing and sustainability disclosure to assess the involvement of stock exchanges in sustainable development. In a guideline for stock exchanges in terms of sustainable practices, additional elements such as stakeholder engagement, incorporating ESG issues into vision and mission statements, reflecting sustainability in governance and risk management, and communicating sustainable commitment [47] can be found. In the literature on sustainable development, studies referring to selected tools are bountiful, including sustainability metrics for evaluation of ESG performance (i.e., ratings, indices, and rankings) as well as sustainability-themed products, e.g., bonds. Various sustainability scoring methods are discussed in the literature, though they are mostly dealt with at the country [48] or enterprise level. Examples of metrics include Vigeo-EIRIS, KLD, MSCI, Morningstar, and Sustainanalytics; however, only several of the best-performing world stock exchanges are present in sustainability indices, such as Swiss Re's Sustainability Report [49], and even if present, they are assessed only as enterprises of the financial sector. More often adopted, one can observe stock exchange ESG indices implemented for sustainability performance as an important element of socially responsible investment (e.g., Marcinkowska [50]). The most recognizable indices include KLD's Domini 400, Dow Jones Sustainability Indexes, and the FTSE4Good Index Series [51].

The existence of sustainability indices organizes the market by identifying entities that meet sustainability-oriented requirements and enables investors to combine financial goals with environmental and social objectives. Such indices also enable the assessment of organizations (e.g., Sikacz [52] and Slager and Chapple [53]); thus, ESG indices can contribute to socially responsible investment [54]. They are also important for enterprises listed on stock exchanges as they encourage continuous improvement of sustainability performance [52–54]. Some authors notice the relationship between the ESG stock indices and risk. Yilmaz et al. [55] note that indexed enterprises may be a lower-risk stock, while others point out the lower corporate financing costs caused by lower risk [56]. ESG indices and the companies listed there appear in publications on the impact of the implementation of sustainable business principles in terms of their results (e.g., Lean and Pizzutilo [57] and Nitani et al. [58]). Researchers are also interested in ESG criteria and their improvement (e.g., Ho [59]).

When analyzing the stock exchange as an intermediary financial platform, dedicated sustainability bonds are also considered [60]. A number of publications mention numerous categories of such bonds, enabling the financing of activities in accordance with sustainable development. In this case, such terminology as ESG, sustainability, the SDGs, transition, development impact, social impact, green, climate, blue, and even COVID-19 response bonds can be found [61–64]. One of the most popular is green bonds used by economic entities for financing sustainable investments and pro-ecological projects (e.g., Maltais and Nykvist [10], Park [65], and Russo et al. [66]). Green bond listings were an integral part of SSEI [67] because stock exchanges are important actors in green bond market development since they can provide market liquidity and regulated, transparent trading platforms [68]. In 2017, according to SSEI [69], only around 0.2% of total bond issuance worldwide was made up of labeled green bonds. Although the sustainable bond market is growing, it is still hardly applicable to the least developed countries, especially in terms of Africa, when juxtaposed with other developing regions [70,71]. As such, about 90% of such funds and bonds are concentrated in developed countries [13]. Similarly, African markets are severely affected by climate change, making sustainable financing awareness strongly required continent-wide [70].

2.3. Concept from the Gaps in the Literature

Based on the literature, the following two hypotheses (H) and five research questions (RQ) provide for the research gaps.

2.3.1. Hypotheses

Hypothesis 1 (H1). *Stock exchanges motivate, i.e., trigger, companies to be more sustainable and transparent.*

Hypothesis 2 (H2). *The level of preparedness for the sustainability approach of African stock exchanges to support local economies (i.e., entities operating on African markets) is high.*

2.3.2. Research Questions

RQ1. Are African stock exchanges ready for foreign capital? This relates to the potential of African markets' readiness for international capital requirements.

RQ2. What is the role of African stock exchanges in sustainable development?

RQ3. Do active and matured stock exchanges engage more strongly in sustainable development given foreign investors, conglomerates, and companies in international supply chains? This relates to whether they are obliged to act sustainability and whether regulatory requirements exist and are enforced.

RQ4. What makes African markets attractive, and how could they fulfill and perform the functions of the financial market, according to Bodie et al. [16]?

RQ5. Are African markets attractive from the perspective of global investors under the growing amount of assets they manage?

3. Materials and Methods

This research was carried out in five stages. First, it was based on a deep review of the literature and pieced together using a set of variables (i.e., two quantitative and 20 qualitative) to describe exchanges. The quantitative criteria were ultimately used to select the research sample of exchanges and then to differentiate the performance of stock exchanges in the study process. The authors assumed that well-performing stock exchanges should create a greater potential to support sustainable development. Second, the initial set of 22 variables was reduced to six measures. Third, EFA with the varimax rotation method was applied to identify two latent factors of differentiation of exchanges. Fourth, using the latent factors as key drivers, stock exchanges were classified into four groups. Fifth, verification of the robustness of the EFA method using k-means was applied. EFA and k-means analyses were conducted within the Statistica Version 14.0 software framework.

The EFA method is used to allow for a certain deviation from an internal element. This is significant since this relationship may result from the existence of one or many common factors that are connected by way of features (i.e., variables) from the analyzed object (i.e., stock exchange in a country). Specifically, EFA reveals the common latent factors responsible for the behavior of the features in question. Hence, in this study, EFA was identified as appropriate since it is based on the assumption that there are hidden common factors in the initial set of features. Moreover, after several latent factors were isolated using EFA, it was necessary to use an appropriate classification method in the next stage of the study. The k-means method was chosen because it consists of reducing a large number of variables to a few basic ones. This allows for the easy orientation of a given phenomenon as well as the ability to draw general conclusions. The use of the k-means method made it possible to establish a typology in terms of the studied objects and to define homogeneous objects of analysis, in which it was easier to isolate systematic factors and possible cause-and-effect relationships.

3.1. Selection of Stock Exchanges

All African exchanges were considered in the initial selection. However, due to data access and the reliability of data sources, the following two principal criteria were applied: (1) the total market capitalization of an exchange needed to be over USD 1 billion—defined as CAP, and (2) the number of listed companies in an exchange must be above 20—defined as LIST. By applying these criteria, the research aligned itself with Kalinowski's [46] premise in which larger exchanges are able to show support for sustainable business operations in terms of "differential stock market sustainability support level" [46]. It should be acknowledged that sustainable development is particularly important for foreign capital and responsible investments. In light of this, it was decided not to divide domestic capital and FDI as it did not alter the grouping of exchanges or the foreign capital due to low engagement of capital flows. An empirical analysis was performed on the selected sample of 15 stock exchanges in Africa (Table 1, Figure 1—right) using five-year interval data, i.e., 2016–2020, derived from Q1 of 2021 from (1) WFE and (2) ASEA. Note, even though the data finishes at the end of 2020, i.e., one year into the COVID-19 pandemic, the study is oriented to prepandemic levels. Moreover, ASEA data is generally broader ranged but not as up to date as WFE, and WFE data is consistent with the World Bank database (even though many experts allege the 2021 closure of the "Doing Business" report compromised World Bank data at the time [72–74]). In the case of the Ghana Stock Exchange (GSE), inclusion was possible by gathering the data directly from the stock exchange report. However, some exchanges were excluded simply because they did not meet both principal criteria.

Table 1. Research sample of 15 stock exchanges in Africa.

Abbreviation	Country	Stock Exchange Full Name
BRVM	Ivory Coast	Bourse Régionale des Valeurs Mobilières
BSE	Botswana	Botswana Stock Exchange
BVMT	Tunisia	Tunis Stock Exchange
CasaSE	Morocco	Casablanca Stock Exchange
DSE	Tanzania	Dar es Salaam Stock Exchange
EGX	Egypt	The Egyptian Exchange
GSE	Ghana	Ghana Stock Exchange
JSE	South Africa	Johannesburg Stock Exchange Ltd.
KSE	Sudan	Khartoum Stock Exchange
LuSE	Zambia	Lusaka Stock Exchange
MERJ	Seychelles	MERJ Exchange Ltd.
NSEK	Kenya	Nairobi Securities Exchange
NSE	Nigeria	Nigerian Stock Exchange
NSX	Namibia	Namibian Stock Exchange
SEM	Mauritius	Stock Exchange of Mauritius

Source: Assessment based on WFE, the World Bank, and ASEA stock exchange reports.

3.2. Variables and Measures Selection

In the study set, 22 variables were reduced to six categories of measures. The variables were defined both on the basis of SSEI criteria and on the authors' own assessment, i.e., formulated on the basis of the literature review. The two quantitative variables are described in the previous subsection. The next four measures, containing five variables each, are of qualitative nature. These measures include the following categories: market tools for sustainability (MARK), stock exchange partnerships for sustainability (PART), stock exchange sustainability communication (COM), and ESG guidance for issuers and investors (GUID). The first qualitative measure refers to specific tools related to a sustainable capital market and is perceived as directly supporting the implementation of sustainable development (Table 2).

Table 2. Market tools for sustainability.

Variable	Supportive Literature
ESG and sustainability indices	ASEA-SWG [45]
ESG as a listing rule	Maltais and Nykvist [10]
ESG or sustainability bonds	Slager [75]
ESG reporting obligation or requirements for issuers	SSEI [43,76]
Small and medium-sized enterprises' listings platform	WFE [77]; WFE and UNCTAD [78]

Next, two qualitative measures infer the stock exchange's commitment to sustainable development via the promotion and implementation of its operation as an economic entity. Stock exchanges by themselves affect the environment and society and, therefore, need to be managed in terms of minimizing negative outcomes while supporting value creation [47]. They need to incorporate various steps to be more responsible and support sustainable development by setting good practices of commitment [69]. The first of the two is participation in sustainability-oriented initiatives and stakeholder cooperation (Table 3). The second measure refers to the idea of "leading by example," which covers the communication of specific, internal ESG activities undertaken by the stock exchange as an organization (Table 4). The last qualitative measure refers to the soft tools of implementing sustainability principles as well as the dedicated entities present on the stock exchange (Table 5).

Table 3. Stock exchange partnership for sustainability.

Variable	Supportive Literature
Participation in Sustainable Stock Exchange Initiative	AccountAbility [79]
Membership in World Federation for Exchanges	ASEA-SWG [45]
Membership in African Securities Exchanges Association	SSEI [43,76]
Participation in other initiatives related to the financial market and dealing with issues of sustainability (e.g., Marrakech Pledge) and initiatives dedicated to sustainable development support (e.g., UN Global Compact)	UN Global Compact [80]; WFE [44]
Platform for cooperation with stock exchange stakeholders	WFE and UNCTAD [78]

Table 4. Stock exchange sustainability communication.

Variable	Supportive Literature
Sustainability reporting or ESG issues in annual report of stock exchange	ASEA-SWG [45]; Buchholtz and Carroll [81]
Separate tab on stock exchange website, dedicated to ESG and sustainability issues	Gomez [82]; Hetze and Winistörfer [83]
Published documents on sustainability and corporate social responsibility issues (e.g., policies, strategies, codes of conduct, etc.)	GRI [84]; ISO [85]; Kaptein and Schwartz [86]
References to sustainability in the declaration of stock exchanges (i.e., mission, vision, and values statements)	Mansi et al. [87]; SSEI [43]
Published information on the social initiatives of stock exchanges	WFE [44,77]

Table 5. ESG guidance for issuers and investors.

Variable	Supportive Literature
Written guidance on responsible investment	ASEA-SWG [45]; Khemir et al. [88]
Written guidance on ESG reporting	Kyereboah-Coleman [89]; Park [65]
ESG trainings for investor and issuers	SSEI [43,76]; WFE [77]
Written guidance on ESG bonds issuing	WFE and UNCTAD [78]
Published governance standards including ESG issues	Zhan and Santos-Paulino [13]

Quantitative data for the period of 2016–2020 were attained from Q1 of 2021, i.e., after the first year of the pandemic. Qualitative variables, for the purpose of this study, were collected through the analysis of the following:

- Prepandemic research results on the sustainability of stock exchanges, published in 2018 and 2019 by SSEI, WFE, and ASEA;

- Information concerning ESG, published by individual exchanges on their websites from Q1 of 2021; and
- Information on the membership of exchanges in initiatives for capital market sustainability—based on data from each particular initiative website.

3.3. Normalization Process

Quantitative variables and the set of qualitative variables were normalized on an ordinal scale (i.e., from one to five) (Table 6). The size of the stock exchange, determined by its capitalization and expressed by the number of listed companies, was ordered in the ordinal scale using percentiles. The four qualitative measures, based on qualitative variables, consist of five single indicator variables each (i.e., dummy variables) and indicate whether certain conditions are true. Every qualitative variable has a value of one when conditions hold and a value of zero when they do not. This approach is justified, as a more in-depth assessment may pose as too subjective. The general conclusion is that the best outputs have measures that refer to stock exchange partnerships for sustainability involvement. Such tools as the small- and medium-sized enterprise listings platform or sustainable "green" bonds are still poorly implemented at the individual case level. Moreover, supporting initiatives, such as training and written guidance on responsible investment, ESG reporting, and governance standards, are often poorly compiled and lack completeness.

Table 6. Normalized values from one (i.e., low) to five (i.e., high) for selected stock exchanges in Africa.

Stock Exchange [†]	CAP	LIST	MARK	PART	COM	GUID
BRVM	2	3	1	4	3	1
BSE	4	1	1	4	4	4
BVMT	3	4	1	4	3	1
CasaSE	5	4	2	4	3	2
DSE	2	1	2	3	3	2
EGX	4	5	4	5	5	5
GSE	3	2	1	2	1	1
JSE	5	5	5	5	5	5
KSE	1	3	1	2	1	1
LuSE	1	1	1	3	1	1
MERJ	1	2	1	3	2	1
NSEK	3	3	1	4	4	4
NSE	4	5	4	4	4	4
NSX	5	2	5	4	3	1
SEM	2	4	3	5	3	2

[†] CAP—total equity market capitalization, LIST—total number of listed companies, MARK—market tools for sustainability, PART—stock exchange partnership for sustainability, COM—stock exchange sustainability communication, GUID—ESG guidance for issuers and investors.

4. Results and Discussion

4.1. Exploratory Factor Analysis

The process of EFA assessed the sets of six measures, based on the 22 variables, by transforming the two underlying latent factors (i.e., soft and hard) by way of the linear interrelationships via the output measures. Each factor is determined by the relation pattern between measures and dominated by variables with high loads. The factors identify a structure of variability and show the relationship among the variables, identifying any underlying commonalities across the sample of observed African exchanges. The obtained raw factors in EFA were rotated using an orthogonal method called varimax rotation, i.e., an algorithm to determine the dimensions of the factors where one variable loads highly on one particular factor but loads less on the other [90]. As a result, the final result simplifies the interpretation of factors, where one factor has high loadings on some variables

and low on others. The soft factor is determined by the following measures with the highest loads: PART, COM, and GUID. These measures describe soft, indirect sustainability support provided by the given stock exchanges. Contrarywise, the hard factor is defined by CAP, LIST, and MARK and supports hard, direct measures in favor of sustainability measures. In short, utilizing EFA aided in the robustness of performance measures and overall study checks. The soft factor explains 44.1% complete volatility of all six measures, while the hard factor explains 34%. Both factors determine 78.1% of the whole variability (Table 7). Due to the large values of the specified soft factor and hard factor, a further analysis was performed. The values of factor loadings for both factors were used to classify the analyzed exchanges (Figure 2).

Table 7. EFA factor loadings after varimax rotation.

Measure	Soft Factor	Hard Factor
CAP	0.418	0.722 *
LIST	0.454	0.586 **
MARK	0.280	0.880 *
PART	0.743 *	0.469
COM	0.900 *	0.375
GUID	0.908 *	0.198
Variance explained	*2.647*	*2.039*
Percentage of total variance	*44.1%*	*34.0%*

* significance level at 0.7, ** significance level at 0.6.
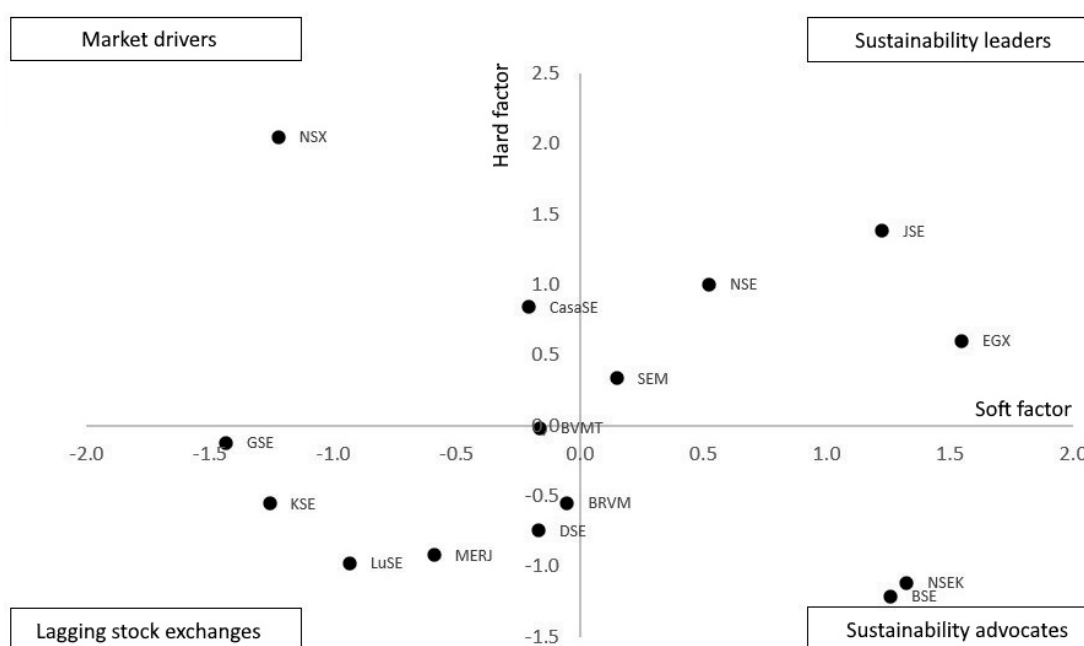
Figure 2. Scatter plot of the stock exchanges in Africa based on EFA.

Based on EFA, the leading group with both the greatest factors and best performance measures in terms of sustainability leaders were JSE, NSE, the Egyptian Exchange (EGX), and the Stock Exchange of Mauritius (SEM). JSE, NSE, and EGX represent the greatest quantitative market performance. JSE, with over 330 listed companies and a market capitalization of around USD 1 trillion, is by far the best-matured stock exchange in Africa and tops all other exchanges on the continent. This group also has a strong position in terms of sustainable tools, both in their organizational and market nature. The only exchange that lags in performance is SEM, characterized by low capitalization (i.e., per USD), even though

it still includes a relatively high number of companies and good results in the assessment of the potential for sustainable development (i.e., via the qualitative variables). A deep study of all SEM trading confirms a generally low contribution to sustainability, which corresponds to its smaller size; however, since it had a relatively large number of tools for SDGs, it was included in the leading group based on EFA.

The largest group (i.e., the lagging group) of stock exchanges presented rather low values of both soft factors and hard factors, consisting of Tunis Stock Exchange (BVMT), GSE, Khartoum Stock Exchange (KSE), Lusaka Stock Exchange (LuSE), MERJ Exchange Limited (MERJ), Dar es Salaam Stock Exchange (DSE), and Bourse Régionale des Valeurs Mobilières (BRVM). This group can be described by relatively low outputs of all measures except for PART, which are general-level outputs for all exchanges. These exchanges have less than USD 10 billion of capitalization and do not exceed 55 listed companies, except for BVMT, which had 80. BVMT is not consistent with the other exchanges in this group since LIST and PART measures perform better (i.e., four out of five) while two other measures (i.e., COM and GUID) perform very poorly. The two remaining groups, with average results, include two stock exchanges each. The group presenting low outputs with a soft factor and stronger outputs with a hard factor (i.e., market drivers) include very diverse exchanges: Casablanca Stock Exchange (CasaSE) and Namibia Stock Exchange (NSX). CasaSE, in recent periods, averaged over USD 55 billion (and peaked at USD 65 billion) of capitalization with 76 listed companies. However, being one of the strongest stock exchanges in Africa, CasaSE does not promote advanced sustainability supporting tools. NSX, which is more than twice as high as CasaSE in capitalization and has only 40 listed companies, provides more advanced tools supporting sustainability, including green bonds. The last group of exchanges, i.e., sustainability-friendly exchanges, perform well with soft measures but have lower outputs with hard measures, including the Nairobi Securities Exchange (NSEK) and Botswana Stock Exchange (BSE). BSE is definitely stronger in USD-denominated capitalization but with half (i.e., 32) of the companies listed compared to NSEK (i.e., 62). The remaining four measures have the same value.

4.2. Robustness Check of the EFA Classification

After a thorough analysis of the EFA classification results, two of the exchanges show proximity to both axes (i.e., SEM in the leading group and BVMT in the second lagging group). Due to an analysis of the qualitative measures, it was decided to verify the results using a different classification process, i.e., a robustness check. A non-hierarchical k-means analysis (i.e., developed by MacQueen [91] in 1967) with four clusters (i.e., K = 4) determined a priori with stock exchanges classified to the clusters based upon the smallest distance to the cluster mean [92] (Figure 3). JSE, NSE, and EGX were classified together in the leading group, but the SEM outlier migrated. Clustering outputs were examined for two, three, and four groups, and in every case, those three leading exchanges stayed together while the rest migrated depending on the cluster obtained. A potential explanation for the difference in the grouping of SEM and BVMT under the EFA and k-means method may arise from the fact that each classification is an image of reality, and the results obtained depend on the algorithm used.

The second method allowed us to analyze the robustness of the EFA classification of the exchanges into four groups, as in Figure 2. Some of the exchanges from different EFA groups are quite close, where the division is not strict depending on the adopted criteria and may move to other groups (i.e., depending on the adopted stock exchange features). The first feature that differs is capitalization, which weighs heavily in the classification. As a second measure, market tools for sustainability were applied. Both measures constitute the hard factor. In the case of BVMT, capitalization determined the transfer to market drivers, while SEM migrated to the same group due to lower capitalization and weaker activity in the field of sustainability, including dedicated market tools. The k-means results show that the exchanges mentioned can indeed migrate to other groups (Table 8).
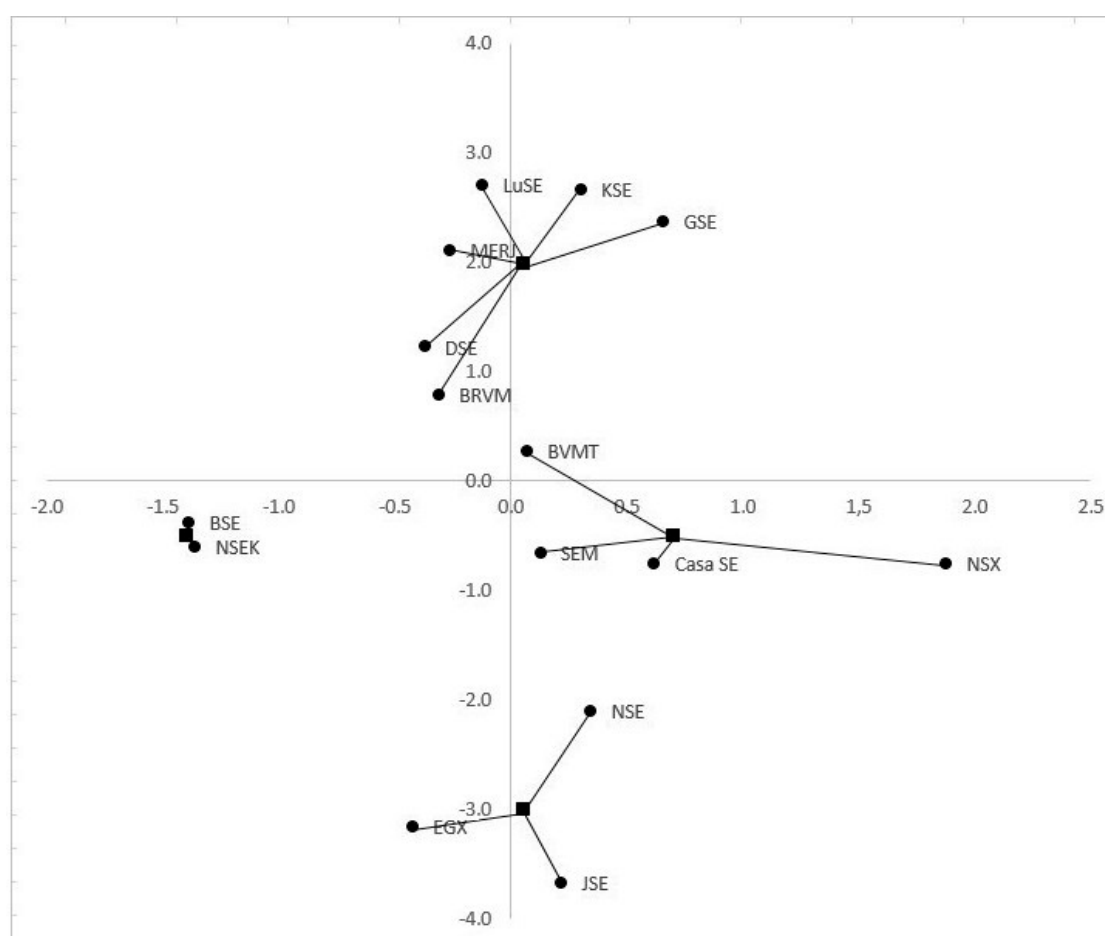
Figure 3. Scatter plot of the stock exchanges in Africa based on k-means.

Table 8. Comparison of the clusters obtained using EFA and k-means.

Cluster	EFA		K-Means
1	BRVM		BRVM
	DSE		DSE
	GSE		GSE
	KSE		KSE
	LuSE		LuSE
	MERJ		MERJ
	BVMT		
2	BSE		BSE
	NSEK		NSEK
			BVMT
3	CasaSE		CasaSE
	NSX		NSX
			SEM
4	EGX		EGX
	JSE		JSE
	NSE		NSE
	SEM		

The two exchanges described above (i.e., BVMT and SEM) have moved to other groups. The results of classification using the k-means method were generally consistent with the results of the EFA method, except for the two outliers, which were classified better. In all, the application of the k-means method to the clas sification of the exchanges gave

convergent results with the classification obtained using EFA. This is evidenced, among others, by the small number of inversions.

4.3. Sustainable Stock Market Finance: General Discussion

In this study, different measures have been used to address sustainable stock market finance. As such, many studies address sustainability by the use of proxies. Gong et al. [93], for example, studied changes in stock return by examining companies with different levels of climate risk during the presidential election cycle in the United States. They found the election cycle did act as an "indicator of international political uncertainty [and that it directly] affects the riskiness of firms with high exposure to climate risk" [93]. It can be inferred that the sustainability approach does not directly provide a higher stock return; however, globally, it can indirectly influence company risk and lower the cost of capital. Venturini [94] analyzes climate risk drivers on the equity market to examine which climate risk affects stock returns. Santi [95], expanding on this, notes the overreaction to climate risk by investors as well as how the investor learning process and corrective mispricing of stocks influence decisions and long-term sustainability. Specifically, sustainable stock market finance in Africa is best when it is synchronized geographically via the emerging markets' sustainability index and when it incorporates the related risk diversification throughout the continent's exchanges [96].

To better understand the different processes of sustainable stock market finance, a number of methods have been applied. For instance, k-means as a method for stock exchange analysis has been utilized in a variety of ways, including modeling and optimization of stock portfolios; choosing prospective sets of assets for portfolios; and influencing changes in stock prices by financial statements, grouping stocks by return, and risk criteria [97–100]. Another application is the classification of stock market indices as laid out by Chmielewski et al. [101]. They highlight the classification of listed companies in terms of ESG criteria, i.e., "the significance of forming clusters and linking sustainability practices with performance characteristics" [102]. Kishan and Kiran [103], correspondingly, focus on SDG 8, which supports small- and medium-sized enterprises (SMEs) as one of the five SDGs identified as an area of action for sustainability by stock exchanges. They analyze the performance of Indian indices dedicated to SMEs and show how a majority of stock exchanges that have adopted SME listings generate "better returns with slightly [higher] volatility" [103]. In terms of understanding clustering effects, a comparative analysis of European stock exchanges shows that exchanges with similar characteristic features tend to cluster in terms of market size, equity trading, and bonds [104]. This parallels findings in this study by way of research methodology and validity. A similar approach, with a breakdown of pillars and components, was launched by the Global Entrepreneurship Development Institute to harmonize the digital and entrepreneurship ecosystems into one platform [105,106]. They state, "for technology to be introduced successfully, the digital ecosystem and the entrepreneurial ecosystem must be developed simultaneously" [105]. Likewise, it can be argued that stock exchanges' soft factors and hard factors need to be developed at the same time for the best sustainability results.

The novelty of this study is that, for the first time, the specific method and approach employed have been used to examine stock exchanges. The analysis of broad but general aspects of the sustainability approach looks at what instruments and practices African stock exchanges use to perform sustainability as well as how they deal with international requirements and investor needs. The examined stock exchanges parallel organizations in that the study is developed via "rules and rule setters." From the organizational side, memberships and participation in international initiatives are considered alongside communication through reporting and published declarations. In terms of rules for listed companies, the consider instruments aimed at sustainability and supporting initiatives of stock exchanges to support and motivate companies, e.g., training, guidance, and standards, are applied. The research duplicates aspects of the Chmielewski et al. [101] study in that we differentiate exchanges by way of size and capital performance. The contribution of this

study is twofold. First, it adds to the literature on general stock exchange sustainability performance. Second, it contributes to the methodological analysis of stock exchanges based on qualitative dimensions. This is exemplified by the grouping of stock exchanges in terms of their sustainability (i.e., approach and performance). At length, the research expands the knowledge base on African stock exchange sustainability and informs whether they have sustainability tools and practices. The novelty of performing general sustainability advocacy of such exchanges also reinforces support of international assets invested in Africa.

5. Conclusions

Stock market research is crucial for understanding the role of the capital market in developing the concept of sustainable development in the real economy. The classification of the selected stock exchanges in Africa was performed to determine and compare their pre-pandemic potential to support the sustainability approach. The study is based on a multicriteria assessment of the level of commitment of stock exchanges to sustainability, taking into account not only traditionally analyzed elements (i.e., sustainable stock exchange indices and sustainable financial instruments) but also categories such as reporting and knowledge support for investors. As a result, four groups of stock exchanges were identified, providing a practical reference for the effective implementation of the sustainability approach. The research is based on a set of variables that is much broader than in previously published analyses. The systematized set of variables evaluates the exchanges using two methods: EFA and k-means. The results of the classification of the stock exchanges into four classes are, in principle, consistent. The research shows that the following stock exchanges in Africa have the greatest relative potential for implementing sustainable development: JSE, NSE, and EGX. Our findings are in agreement with theoretical and empirical research concepts in the field of the maturity of stock exchanges [37] and action-oriented sustainable development impact assessments [12,43,45,46,77,78]. The study develops the current approach to assessing exchanges in terms of ESG through the use of a multidimensional approach. It combines existing knowledge into one approach aiming to group and compare stock exchanges and tries to fill a significant research gap in assessing the impact of stock exchanges on sustainable development.

The fundamental limitation of a satisfactory sample selection of exchanges and their fair distribution due to quantitative data is the gaps in the availability of recent data, both on the websites of these institutions and in the exchange reports. (This is why, for example, the Zimbabwe Stock Exchange, with over 60 listed companies, could not be included). Moreover, another problem concerning quantitative data is its completeness and consistency, e.g., WFE has data only for some exchanges, but not all of it includes the best performance; the World Bank has WFE data even though WFE data is more recent, some data between WFE and ASEA is inconsistent, and some WFE data does not seem to confirm the rankings of the best-performing exchanges based on African financial portals. For future research, it would be worth enriching the analysis by verifying the post-pandemic stock exchanges based on the stock market development relational dimension proposed by Levine and Zervos [107], e.g., capitalization to gross domestic product and the number of listed enterprises. In the research, the authors departed from the variables based on FDI, as the share of this capital is not high; furthermore, in some countries, restrictions and limits for foreign investors have been introduced, which would require further analysis outside the purview of this study.

The difficulties related to qualitative data, i.e., the different ways in which exchanges are presented, are another limitation. In some cases, declared actions (e.g., answers provided by SSEI or ASEA) are difficult to confirm even by analyzing the content of the exchange's website. As such, the study assumes that it is sufficient to indicate an action in at least one of the sources (i.e., reports from SSEI or ASEA or content of the exchange's website). Another limitation derives from the approach to scaling of variables. For most variables, dummy variables were adopted, which only confirm the fact that the tool is

implemented by the given exchange without assessing its quality—the assessment of instruments on the basis of their intrinsic characteristics can be difficult and subject to the risk of misinterpretation. Setting these limitations aside, the research demonstrates the importance of identifying key sustainability drivers and examines the materiality of the drivers within an African context. These drawbacks should be considered as future goals to better the research and, ultimately, aid in defining future ESG-based comparative and growth potential research of stock exchanges in Africa. At length, this fiscal maturity can be fundamental to increasing economic and business development via the SDGs initiative—continent-wide.

Author Contributions: Conceptualization, data curation and collection, J.P., R.P. and B.L.; methodology, J.P. and A.Z.; software, quantitative analysis, A.Z.; investigation, J.P., R.P. and A.Z.; resources, J.P., R.P., B.L. and G.T.C.; writing—original draft preparation, J.P., R.P. and G.T.C.; writing—review and editing, funding acquisition, G.T.C.; visualization, J.P., A.Z and G.T.C.; supervision, J.P.; project administration, J.P. and G.T.C. All authors have read and agreed to the published version of the manuscript.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data are available from the corresponding author on reasonable request.

Conflicts of Interest: The authors declare no conflict of interest.

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