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Analysis of the Nigerian stock market before and after the currency note changes using social network analysis

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This paper examines the dependency of stocks in the Nigerian stock market from 2022 to 2023, focusing on the impact of currency note changes in government policy. The study employs the forest of all minimum-spanning trees derived from the correlation matrix of the top 40 stocks across various sectors and four traditional centrality measures to identify the most influential stocks within the network. The network analysis results reveal that the sectors dominating the market before the policy change differed from those dominating after the policy change. Additionally, the analysis indicates shifts in dominance and dependency relationships among the stocks. These findings provide valuable insights for policymakers and market participants, offering a clearer understanding of inter-sector stock relationships and facilitating the identification of stocks with positive or negative correlations.

Keywords: *network analysis; forest of all minimum spanning trees; centrality measures; stock market.*

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1. Introduction

The stock exchange is a marketplace where those who wish to purchase or sell shares, stocks, government bonds, debentures, and other approved securities can be sold, though only through stock exchange members [1]. It is a market where large and small investors buy and sell through stockbrokers. The stock exchange provides essential facilities for companies and the government to raise money for business expansion and development projects through investors who own company shares for the ultimate economic benefit of all members of society.

The stock market comprises investors buying, selling, and trading shares of companies, reflecting their collective value and performance [2]. The stock price reflects the corresponding companies in the stock markets. However, the company's fundamentals do not merely constrain its day-to-day behaviour. They are influenced by the other companies traded in the market and by economic factors [3]. Stock markets are usually divided into sectors by industry classification. Each sector or combination of sectors has an index reflecting the general sector(s) movement. A stock market index is considered a barometer to judge market sentiment and usually monitored by different stock market stakeholders, such as financial market researchers and analysts for accurate analysis, investors to purchase or sell financial assets, and policymakers for future policy formulation [4].

A prospective investor's demand is satisfied when the information they need to decide which stocks to buy or invest in is readily available, intelligible, and logically reasonable [5]. Scholars and professionals studying finance have long recognized that data on stock market sectors enables investors and scholars to track a particular stock's performance against other stocks and stock indices. Campello [6] shows that the market's state significantly impacts individual equities' values.

The money market is the market for short-fund or short-term credits. The securities traded here are money instruments, including treasury bills, certificates, promissory notes, and commercial papers. The capital market is the market for long-term financial claims and obligations [7]. Here, the monetary securities traded have long-term and medium-term maturities ranging from three years to more. Therefore, this means that the capital market is the market for mobilizing and utilizing long-term funds for economic development. Anyanwu [8] states that the capital market is a mechanism whereby economic units desirous to invest their funds interact directly with financial intermediaries and those who wish to procure funds for their business. These securities, whether equities or bonds are raised and procured in an organized market called the Nigerian Stock Exchange (NSE). The NSE is a crucial participant in the capital market. The market float in Nigeria, determined by the ratio of stocks in the market to the total number of outstanding listed securities, is primarily to blame for the market's reputation as being shallow. The task involves attracting foreign investors to the Nigerian Capital Market while also trying to grow and retain our current domestic individual and institutional investor base. The task can be accomplished by being inventive, energetic, and open-minded to receive and apply new ideas helpfully. The market should offer various investment options, innovative trading tools that allow investors to manage risk, a trustworthy environment, ample frameworks, and flexible rules to meet different investment needs. Asymmetric information, or the circumstance when one participant in a transaction has less information than the other, is one of the market failures that have also been associated with the capital market.

The NSE created and maintained 11 indices, which are the All-share Index, Banking Index, Consumer Goods Index, Oil and Gas Index, NSE 30 Index, Insurance Index, Industrial Goods Index, Pension Index, Premium Index, Lotus Islamic Index, and Alternative Securities Market Index. Topological analysis of the NSE sector's indices will give investors an idea of how well a group of companies is expected to perform. Thus, there is a need to analyze the sectors of the NSE. According to Okoro-Okoro [9], the Nigerian financial system consists of financial intermediaries, financial markets, financial institutions, rules, conventions, and norms that facilitate and regulate the flow of funds through the macroeconomy. In Nigeria, the federal government, through statutory regulatory agencies such as the Central Bank of Nigeria, the Nigerian Deposit Insurance Corporation, and the Securities and Exchange Commission, as well as defector regulatory ones such as the National Board for Community Banks and the Nigerian Stock exchange manages the financial system in the country. The Nigerian financial system comprises two main financial markets: money and capital [10].

One of the main factors influencing the Nigerian financial system is the stock exchange. The NSE offers the necessary infrastructure for businesses and the government to generate capital through shareholders who own stock in companies for the long-term economic benefit of all members of society. Much more significant domestic savings and investment and an effective financial system required to preserve macroeconomic stability are the keys to faster economic expansion and productivity gains. Nigeria and other slow-growing countries must increase their savings and investment rates from the current low levels to at least 20% to 25%, and Nigeria's GDP now stands at 12% to 16%, less than required for long-term, sustainable growth [11].

The Nigerian government launched new currency notes at the start of November 2022 [11], which led to a spike in the price of petroleum and other goods and an impact on the high exchange rate between the country's currency and international currencies, mainly the USD. The idea to redesign the Naira was hatched in 2022 by the Central Bank of Nigeria (CBN) with the approval of the President [12]. The policy was born to enable the CBN to control the circulation of Naira, manage inflation, combat counterfeiting, and halt Naira's stockpiling. Since then, there have been significant changes in the economy and stock's dependency on the Nigerian stock market.

Iwedi [13] studied the economic implications of the Naira redesign and concluded that it is not the best solution. Despite the well-intentioned government initiative during the Naira redesign, this policy posed significant challenges to Small and Medium Enterprises (SMEs) in Nigeria, resulting in decreased sales and productivity [14]. At the same time, a study by [15] underscores the significant role of Nigeria's monetary policy and currency redesign in enhancing financial stability and economic growth.

In this study, a network analysis approach is used to analyze the behaviour of the top 40 equities traded on the NSE before and after the currency note change in the country. Interestingly, the network among stocks constitutes a complex system [16]. Their complex interrelationships are in terms of price fluctuations. Usually, those interrelationships can be represented by the correlation analysis among the logarithmic of the stock's open price returns. To filter the vital information in such a complex system, Mantegna [17] introduced the MST in 1999. Based on MST, a filtered network topology that contains important information can be constructed.

Furthermore, the role of importance of each stock can be expressed using centrality measures. The network approach is used to visualize the interconnection between the entities in the stock market. The findings provide a basis for the review of poorly performing sector indices in the NSE. Therefore, the regulators could formulate policies to enhance the performance of such market sectors.

This study aims to analyze the behaviour of the NSE's sector indices. Specifically, the banking index, consumer goods index, oil and gas index, industrial goods index, and communication index were evaluated for evidence of returns correlation, forest of all minimum spanning trees (MSTs), and centrality measures. The study is also helpful to researchers as it contributes to knowledge on sector indices performance in Nigeria and serves as reference material for future studies.

The rest of the paper is organized as follows. In the next section, the methodology of stock network analysis is discussed by constructing the forest of all the minimum spanning trees and the centrality measures. Later, the study's results are highlighted. Finally, the conclusion of the study is presented.

2. Methodology

This section is the technical part of the paper, which presents the dataset of the stocks, the approach of the forest of all minimum spanning trees (MSTs), and the centrality measures. The methods involve the computation of the rate of return, correlation matrix, and distance matrix, where the distance matrix is then used as the input for MST, which employs Kruskal's algorithm. The correlations between equities are widely recognized [18] and can be measured using the Pearson correlation coefficient [19,20]. Four traditional centrality measures were used to identify the network's central and most important stock.

2.1. Dataset

This study uses the Nigerian Stock Exchange (NSE), representing the top 40 companies based on market capitalization. The data was collected from [21], and the study used an adjusted closing price for each stock. The adjusted closing price is used because it reflects the impact of cash dividends, stock dividends, or stock splits that ensure the accuracy of the data. The government issued the change in the country's currency note, enacted on 23 November, 2020. Then, the duration of the exchange note is continued until 31st January, 2023 as a deadline by which old naira banknotes would stop being legal tender. This study applies the data to two durations, before and after the currency note change.

2.2. Correlation network construction

Correlation matrix. Assume that N stocks are to be examined. Let $p_i(t)$ be the closing price for the stock i, where $i = 1, 2, \ldots, N$. The daily data is applied to quantify the synchronization between the stocks. The closing price for each stock is converted to a logarithmic return [22]. Logarithm return, $r_i(t)$, of price return of stock i at time t each period is in Eq. (1), where $p_i(t)$ is the open-price stock,

$$r_i(t) = \ln p_i(t) - \ln p_i(t-1). \tag{1}$$

The correlation coefficient was computed between all the possible pairs of stocks in the network in each period [22]. Correlation matrix C of size $N \times N$ was constructed to represent the interrelationships of the complex system of the stocks. Equation (2) gives the correlation coefficient between stock i and stock j, where r_i is the statistical average of $r_i(t)$ for all values of t,

$$c_{ij} = \frac{\langle r_i r_j \rangle - \langle r_i \rangle \langle r_j \rangle}{\sqrt{(\langle r_i^2 \rangle - \langle r_i \rangle^2)(\langle r_j^2 \rangle - \langle r_j \rangle^2)}} \tag{2}$$

Distance matrix. To analyze those interpretations, Mantegna [20] suggested the transformation of the correlation matrix C into distance matrix D, where the coefficient c_{ij} forms the distance d_{ij} as in Eq. (3),

$$d_{ij} = \sqrt{2(1 - c_{ij})} \tag{3}$$

for all $ij = 1, 2, \ldots, N$, where d_{ij} is the distance between each pair of stocks i and j. The edge distance satisfies the following axioms of Euclidean distance: (i) $d_{ij} = 0$ if and only if $i = j$, (ii) $d_{ij} = d_{ji}$ and (iii) $d_{ij} \leqslant d_{ik} + d_{kj}$, while c_{ij} does not satisfy the above axioms [23].

2.3. Minimum spanning tree

After constructing the correlation network, the topological characteristics of the stocks were investigated by building an MST in D. MST graph theory is applied to filter data in a weighted connected graph of n objects (stocks). It is a tree that minimizes the sum of the weights and has $(n - 1)$ edges or linkages. MST is constructed by connecting each element in a set of n in a graph defined by a small distance between the stocks. The Kruskal and Prim algorithm is the most used technique for creating an MST [24]. The MST and forest of all MSTs were utilized to filter the data by considering the distance matrix D, and the advantages of the forest of all MSTs as a robust filter [24] compared to the MST were monitored.

Since the construction of the MST has been well explained by Mantegna [19], the methodology is briefly presented here. Let $d(i, j)$ be the i-th row and j-th column element of D; $i, j = 1, 2, \ldots, N$. This refers to the number of stocks studied, which are 40 stocks. The function d on $N \times N$ satisfies:

(i) $0 \leqslant\leqslant d(i, j) < \infty$ and $d(i, j) = 0$ if and only if $(i = j)$;
(ii) $d(i, j) = d(j, i)$; and
(iii) $d(i, j) \leqslant d(i, k) + d(k, j)$ for all i, j and k in $N \times N$.

The matrix $D = d(i, j)$ of size $(N \times N)$ summarizes the dissimilarities among the stocks. It is symmetric and used to determine the MST, a connected subgraph of D consisting of N nodes with $N - 1$ shortest edge. The MST can be found by using Kruskal's or Prim's algorithm. Both techniques are usually used in stock network analysis [25]. In this study, Kruskal's algorithm is used to find MST as described below [26]:

Step 1: Sort the edges according to their weight in ascending order.
Step 2: Select the edge with minimum weight. If there is more than one edge with minimum weight, select one of them. Let e_1 be the edge with the smallest weight, then choose e_2, the smallest among the rest. If $\{e_1, e_2\}$ creates a circuit, change e_2 with the next smallest one until no circuit is formed. Otherwise, choose the next smallest e_3.
Step 3: Next, choose the edge with minimum weight from the remaining edges and make sure that it does not form any loops.
Step 4: Repeat Step 1 until Step 3 as often as possible until the $\{e_1, e_2, \ldots, e_{N-1}\}$ does not contain a circuit. The result is the desired MST.

2.4. Forest of all minimum spanning tree

If there are many MSTs in the network, they may define distinct topological properties from one another, which could lead to misleading information when used as an information filter [24]. This demonstrates how using MST could result in false information being provided. Put differently, the data filtered using MST is not reliable. This justifies using the forest of all MSTs as an information filter rather than a single MST. The forest is unique even though MST might not be. The forest guarantees the robustness of filtered information because it offers a singular source of filtered data [25] as in Eq. (4),

$$\delta(i, j) = \begin{cases} 1; & d(i, j) - d^{+}(i, j) = 0 \text{ and } i \neq j, \\ 0; & d(i, j) - d^{+}(i, j) \neq 0 \text{ or } i = j, \end{cases} \tag{4}$$

where $d^+(i,j)$ is the ultrametric distance between each pair of stock i and stock j. Ultrametric distance is a specific type of metric (a function that defines a distance between pairs of objects) that satisfies a stronger triangle inequality than the usual one. It is a handy filtering technique to find the relevant economic information stored in a complicated system of correlation structures among stocks in a financial market [17]. If Δ is a fuzzy relation where its membership function is given as in Eq. (4), hence, the Δ corresponds to the forest of all MSTs in D [24].

2.5. Centrality measures

Degree centrality. A degree centrality can determine the total linkages to a stock i [27] and be computed as in Eq. (5),

$$D(i) = \frac{\sum_j^N wk_{ij}}{N-1}, \tag{5}$$

where $wk_{ij} = 1$ if there is a connection between stock i and stock j and 0 otherwise. If a stock has the highest degree of centrality value on a financial network, it is considered the most valuable stock and has the most connections with other stocks.

Betweenness centrality. Betweenness centrality examines the tendency of a node to act as a mediator or bridge in a network [28]. Betweenness centrality can be computed by using Eq. (6),

$$B(i) = \sum_{m<n} \frac{T_{mn}(i)}{T_{mn}} \tag{6}$$

where $T_{mn}(i)$ is the total shortest path from stock m to stock n that goes through stock i and T_{mn} is the total minimum distance from m to n.

Closeness centrality. The proximity of vertices to other vertices on a network is determined by closeness centrality. The minimum distance between each vertex and all other vertices is defined [28]. The closeness centrality of stock i is signified as in Eq. (7), where $h(i,j)$ is the shortest path from stock i to stock j,

$$C(i) = \left[\sum_{j=1}^{N} h(i,j)\right]^{-1}. \tag{7}$$

Eigenvector centrality. Eigenvector centrality considers a prominent node, which is a node connected to other significant nodes [29]. Since the node is connected to other crucial nodes, a node with the smallest number of neighbouring nodes can be called an essential node. Eigenvector centrality is expressed in Eq. (8):

$$Eig(i) = \lambda^{-1} \sum_{j=1}^{N} k_{ij} x_j \tag{8}$$

for $i = 1, 2, \ldots, N$, where $\lambda - 1$ is the largest eigenvalue of the adjacency matrix k_{ij} and the weighted average scores of x_j of all stocks connected to stock i. $Eig(i))$ is the eigenvector of eigenvalue λ.

3. Results and discussion

This section discusses the analysis results on the stock market's dependency between the time before the note change (1st January 2022 to 31st December 2022) and the time after the note change (1st January 2023 to 31st August 2023) in Nigeria. With 40 stocks serving as nodes, it has been constructed using the minimum spanning tree (MST) approach. This simple approach, which provides a linked, cycle-free, and planar tree, has the complexity of $N-1$ edges, where N is the number of nodes. A typical graph image, as in Figures 1 and 2, with each node coloured by its industry sector, depicts the tree.

The MST of the market sector is presented in Figures 1 and 2, which displays the network of 40 stocks resulting from the forest of all possible MSTs. The node is denoted as a stock, and the link between two stocks is based on the correlation. As there is only one MST in the analysis, the MST obtained from the forest of all possible MSTs is unique and robust. It was observed that the stocks are

clustered into four clusters and coloured according to the economic sectors, which are the consumer services (blue), banking services (yellow), oil and gas (red), industries (pink), and communication (green).

3.1. Before the currency note change

As in Figure 1, Dangote Sugar (DAS) is a central node connected to five nodes, which are Sterling Bank (STE), Guinness Drink (GUI), Spero Oil and Gas (SEP), Nigeria Brewery (NBR), and Conoil (CON). The second highest connectivity on the network belongs to CAD, which has four connections: the United Bank for Africa (UBA), Unilever (UNI), NBR, and Trans oil (TRA). Meanwhile, WAP communication (WAP) is the third highest with three connections: TRA, Oando International (OAN), and Flour Mill (FLO). There was a severe dependence on consumer products before the currency note change, where most stocks were linked to consumer products, which were the central stocks. Hence, before the currency note change, consumer products dominated the market and had the strongest correlation with two centrally traded equities: DAS and CAD.

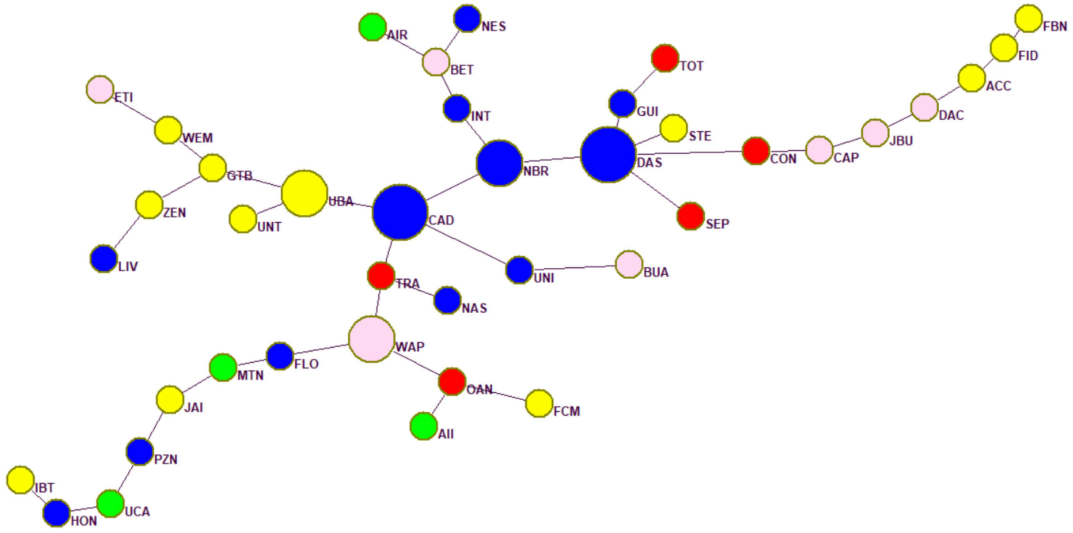

Fig. 1. The forest of all minimum spanning trees for 40 stocks on the Nigerian Stock Exchange before the note change from 1st January, 2022 to 31st December, 2022.

Centrality measures are essential for understanding the network behaviour. A stock's ability to transfer risks to other stocks depends on the degree score, which indicates how many connections it has with other equities. This study uses centrality measures to quantify the relationships between related stocks. Table 1 displays the stocks' degree, betweenness, closeness, and eigenvector centrality measures for the stock's return before the currency note changes.

Table 1. The centrality measures of the top five stocks in NSE from 1st January 2022 to 31st December 2022 before the note changes.

Rank	Degree	Betweenness	Closeness	Eigenvector
1	DAS(5)	CAD (0.6815)	CAD (0.2582)	NBR (0.4280)
2	CAD(4)	NBR (0.5614)	NBR (0.2484)	CAD (0.4265)
3	UBA(3)	DAS (0.4601)	TRA (0.2363)	UBA (0.4007)
4	WAP(3)	TRA (0.4520)	DAS (0.2254)	TRA (0.2648)
5	GTB(3)	WAP (0.4197)	UBA (0.2203)	CON (0.2584)

Table 1 assesses the sectorial centrality measures of the MST. As highlighted by [25], the strength of a node can be studied to identify the key hubs in the network by observing the number of connections through each node. Table 1 shows that two of the 40 stocks have a high degree of centrality across the network, DAS and CAD, with five and four degrees, respectively. Meanwhile, the rest of the stocks have lower degrees of centrality, which is less than four degrees. It is not surprising that DAS with five degrees and CAD with four degrees are among the companies that routinely exhibit average high

node degrees (thus indicating an important position in the network), considering the NSE network's emphasis on consumer items. Additionally, Figure 1 demonstrates how consumer goods are tied to all other sectors, particularly DAS and CAD, which serve as the central stocks in the network.

This measure looks at a stock's propensity to serve as a mediator or bridge in the network that coordinates the flow of information about price fluctuations. The betweenness centrality measure was calculated to determine the importance or significance of stock in a network. The total fraction of all potential shortest paths between a stock that passes through a stock is known as betweenness centrality. It measures a stock's control of the network's information flow. Considering its importance in coordinating information among equities, the stock with the highest score is considered significant. Table 1 indicates that CAD (0.6815) has the highest score. CAD is crucial to the NSE as a liaison that may regulate information flows between stocks. As a result, when additional stocks receive the information going through CAD, they will be impacted. The remaining four significant equities are NBR (0.5614), DAS (0.4601), TRA (0.4520) and WAP (0.4197).

The shortest path between any two feasible pairings of stocks on a network is the aspect of closeness centrality. It is the mean number of shortest pathways that lead from one stock to every other stock that can be reached. Like betweenness centrality, CAD and NBR had the greatest rankings in proximity centrality before the currency reform, followed by TRA, DAS, and UBA. Many stocks were close to CAD; four closest to CAD stocks were UBA (0.1517), UNI (0.2085), TRA (0.2363), and NBR (0.2484). Since the distances were based on the correlation between stocks, CAD can spread information to the four stocks more quickly. CAD also shows a good correlation with the five equities. Because of their popularity on the NSE, these five equities significantly impacted CAD.

To create a prominent stock, a specific stock that can be similarly linked to other crucial stocks must be realized [29]. Eigenvector centrality quantifies a stock's strength with each stock's primary subgroups. As a result, the high-scoring stocks are associated with the higher-scoring stocks. In contrast, stocks with equal linkages to low-scoring stocks make up a smaller portion of the stock scores. The NBR (0.4280) has the highest score, followed by CAD (0.4265), UBA (0.4007), TRA (0.2648), and CON (0.2584). Hence, Consumer goods, which dominated the market, had a positive relationship before the currency change, while Communication stocks had a negative relationship.

3.2. After the currency note change

All sectors have relationships with one another in the stock market, which may be caused by the fact that these stocks share economic data in the network. For instance, after the note change of November 2022, UBA continues to link to the stocks listed under industries, consumer products, and oil and gas. Meanwhile, industries and consumer products are also connected to STE through communications. Also, JAI connects oil and gas and communications. All three stocks (UBA, STE, and JAI) are in the banking sector, that indicates the dependency of all sectors upon banking sectors, which appeared the opposite before the currency change.

Figure 2 illustrates that communication is more related to the banking sector as Airtel Nigeria (AIR), MTN Nigeria (MTN), and AII Communication (AII) are directly related to JAI and STE. All the oil and gas stocks are directly connected with the banking sectors, scattered among other sectors after the currency change.

Nine stocks are related to UBA, implying that the prices of these stocks will be influenced only by the price of UBA, while DAS is the closest stock and NAS is the farthest stock, indicating that UBA and DAS have the closest market ties. The centrality scores of the 40 equities following the note change are shown in Table 2. It reflected each stock's degree, betweenness, proximity, and eigenvector centrality measurements. Table 2 shows that UBA and STE are the most dominant stocks, with nine and seven stocks, respectively, followed by JAI (5), FBN (3), and First City Momentum Bank (FCM) (3). The nine stocks connected to UBA are GUI, Horizontal Niger (HON), International Brewery (INT), Julius Berger (JBU), Nasco Food (NAS), Oando International (OAN), SEP, TRA, and DAS, demonstrate that UBA prices will only affect their prices. There have been changes in the landscape since the note change, where the most dominant stocks shifted from consumer services to the banking sector since all the degree centralities lie on UBA, STE, JAI, FBN, and FCM.

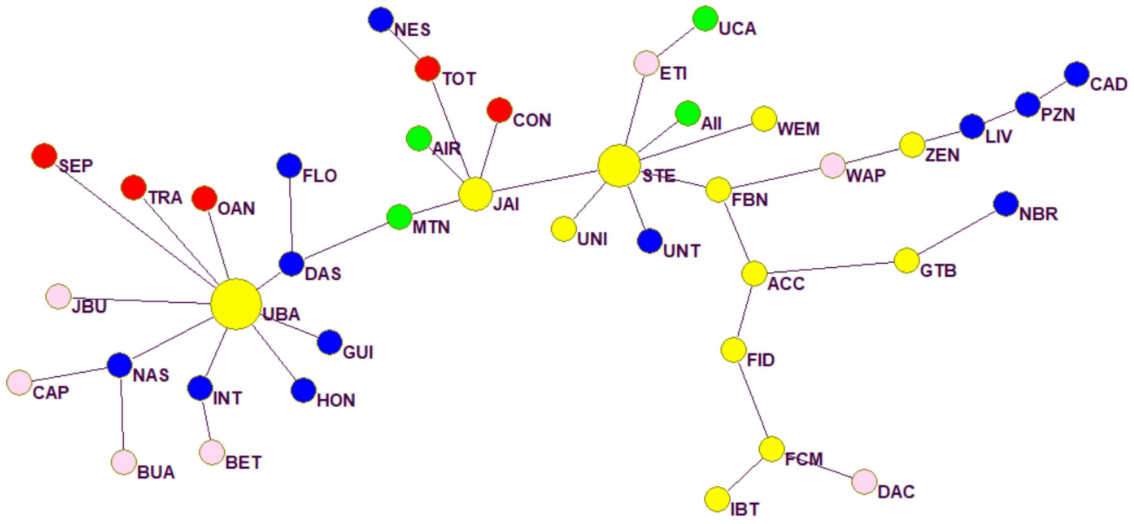

Fig. 2. The forest of all minimum spanning trees for 40 stocks on the Nigerian Stock Exchange after the note change from 1st January, 2022 to 31st December, 2022.

Table 2. The centrality measures of the top five stocks in NSE from 1st January 2022 to 31st December 2022 before the note changes.

Rank	Degree	Betweenness	Closeness	Eigenvector
1	UBA (9)	STE (0.6369)	JAI (0.2889)	DAS (0.6632)
2	STE (7)	JAI (0.6005)	STE (0.2888)	NAS (0.2682)
3	JAI (5)	UBA (0.4844)	MTN (0.2689)	INT (0.2374)
4	FBN (3)	DAS (0.4724)	DAS (0.2484)	GUI (0.2129)
5	FCM (3)	MTN (0.4723)	ETI (0.2280)	HON (0.2129)

After the note change, STE (0.6369) served as the intermediate, followed by JAI (0.6005), UBA (0.4844), DAS (0.4724), and MTN (0.4723). This result suggests that these five stocks, particularly STE, significantly influence many other stocks when information goes via them and is received by the other equities. Figure 2 indicates that DAS could be a bridge for stock information to pass through the central stock (UBA) to all other banking sectors, whereas STE would be the linkage between JAI to UBA and the rest of the banking stocks. 35 stocks have the lowest impact on the other stocks in the network. Accordingly, based on this metric, STE contributes significantly to the Nigeria Stock Market after note change as a liaison with the ability to manage stock information.

Closeness centrality measures how close a stock is to all other stocks. The higher the score of a particular stock, the faster it spreads the information from it to all others. JAI is the stock with the highest scoring in terms of closeness centrality. It has a score of 0.2889, followed by STE (0.2888), MTN (0.2689), DAS (0.2484), and ETI (0.2280). JAI, STE, and MTN are closely related in terms of proximity and serve as intermediates between other stocks in the network described in betweenness centrality. As a result, the stocks are likely to be important to the market's overall performance.

To develop a significant stock, a specific stock that may be related to other important stocks must be realized [29]. The eigenvector centrality measure determines which node is connected to the most connected nodes. The dynamics of stocks in the same sector were expected to be clustered or closely placed in the MST. One could, however, not predict in advance which stock would become synchronized with the first eigenvalue (a market mode). Surprisingly, the consumer products (DAS, NAS, INT, GUI, and HON), the first five highest eigenvectors, behaved differently compared to banking services, which became much more synchronized. The Banking sector, which dominated the market, had a positive relationship after the currency change, while Industrial stocks behaved with a negative relationship.

4. Conclusions

A network analysis approach is used to analyze the behavior of the top 40 equities traded on the NSE before and after the currency note change in Nigeria. In a correlation-based network, the stocks and correlations between the logarithms of stock price returns are considered complicated. The network is reduced to a representation of the forest of all MSTs, and the four traditional centrality measures namely degree, betweenness, closeness, and eigenvector centralities. These measures are used to ascertain the relative importance of each stock. The results show shifts in the dominance and dependency association between the stocks. Additionally, the network's correlation structure varies between two periods. To be more precise, the sectors that had a high level of connectedness before the transition are not in the same position after the policy change.

Before the currency note change, consumer goods dominated the market and were strongly correlated with the two centrally traded equities, CAD and DAS. Following the change in currency notes, UBA and STE were discovered to be the most significant equities in the network. UBA and STE were among the top five stocks that scored the highest in degree, betweenness, and closeness centrality measures. Most stocks in other sectors are closely related to the banking sector and predominantly depend on UBA, STE, and JAI.

Nonetheless, most of the stocks in the banking industry are connected. This may be because banks are the primary source of fresh Naira notes and foreign currency for everyday transactions, depending on them for all other economic activity. Bank lending or credit is one of the monetary instruments used by the government through CBN to control banks as well as boost the nation's activities [30]. Before the exchange of currency notes, all other equities, aside from those in consumer goods, were linked to stocks in various sectors. However, following the currency note exchange, most equities were grouped according to their sectors.

Figures 1 and 2 generally observe and portray comparing the correlation networks before and during currency changes. The analysis shows that the correlation strength changed for both periods. The network presented helps the market participants get an overview of the relationship, and it is easier to identify which stocks have a positive or negative relationship.

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Аналіз фондового ринку Нігерії до та після зміни грошових купюр за допомогою аналізу соціальних мереж

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Ця робота досліджує залежність акцій на нігерійському фондовому ринку з 2022 по 2023 рік, зосереджуючись на впливі змін урядової політики щодо грошових купюр. У дослідженні використовується ліс усіх мінімальних остовних дерев, отриманий з кореляційної матриці 40 провідних акцій у різних секторах, а також чотири традиційні міри центральності для виявлення найбільш впливових акцій у мережі. Результати мережевого аналізу показують, що сектори, які домінували на ринку до зміни політики, відрізнялися від тих, що домінували після неї. Крім того, аналіз вказує на зсуви в відносинах домінування та залежності між акціями. Ці висновки надають цінну інформацію для політиків та учасників ринку, пропонуючи більш чітке розуміння міжсекторальних відносин акцій та сприяючи ідентифікації акцій з позитивними або негативними кореляціями.

Ключові слова: *мережевий аналіз; ліс усіх мінімальних кістякових дерев; міри центральності; фондовий ринок.*