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- Mobile Banking Applications in Nigeria: An Analysis of User Sentiments
- Fintech and Credit Risk in Nigeria: A Case Study of Neobanks
- Macroeconomic Variables and Bitcoin Volatility: A Direct and Reverse Causation Investigation
- Fintech and the Changing Structure of Financial Inclusion: Evidence from Sub-Saharan Africa
- Synthetical Evaluation of the Evolution of Crypto and Digital Currency in Global Payment Platforms

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EDITORIAL

The Institute's Journal of Banking continues to provide a platform for research publications on topical issues in Banking and Finance and other related areas. This edition focuses on Fintech, Crypto/Digital Currency and Mobile Banking applications as a thematic area which will no doubt be of interest and knowledge engaging to the readers. The edition is very apt especially as the banking/financial services sector and the global economy are being transformed by digital innovation. Existing technologies are being replaced by more advanced ones which can be leveraged upon to make the environment more productive.

Adebiyi and Omotosho in their study 'Mobile Banking Applications in Nigeria: An Analysis of User Sentiments' investigate the inherent sentiments contained in the users' reviews of mobile banking applications developed by Deposit Money Banks (DMBs) in Nigeria. Using the start rating assigned to the apps and qualitative comments by banks customers, the study revealed an above average score, an indication that the reviews were dominated by positive sentiments. The study therefore recommends among others that DMBS should pay more attention to user reviews on their mobile banking apps and ensure that issues driving persistent poor ratings and negative sentiments expressed by customers as observed are resolved.

Evbuomwan and Bosha examined the relationship between fintech and credit risk in Nigeria: A Case Study of Neobanks'. Using Panel Autoregressive Distributed Lag (PARDL) framework for Six (6) neobanks, the long run results indicate that enhanced operating efficiency on the Fintechs reduces credit risks while the increase in the size of respective neobanks is detrimental to credit risk. The study recommends that robust macro-prudential policies that will focus on capital, liquidity and operational risks should be designed to ensure financial stability and mitigate credit risk.

Kalu and Ibe in their study of 'Macroeconomic Variables and Bitcoin Volatility: A Direct and Reverse Causation Investigation' evaluated the interconnectedness of cryptocurrency volatility and selected Macroeconomic variables covering daily series from year 2020 -2022. The result revealed a positive and significant linear association for the swing series of all the variables and a Unidirectional causality between crude price and bitcoin volatility. The study recommends the need for Nigeria and other developing countries to formulate policies that will highlight the benefits of cryptocurrencies and as well mitigates its shortfalls.

Olanrele and Awode assess the trends in Fintech and the changing structure of Financial Inclusion in Sub-Saharan Africa, using content descriptive statistics. The study among others indicates that Fintech promotes financial inclusion by increasing access to financial services through the provision of digital and mobile options for easy conduct of financial operations. The study recommends the need for policy actions to take advantage of Fintech ecosystems in enhancing financial inclusion.

Similarly, Onwumere, Kalu and Ibe worked on 'Synthetical Evaluation of the Evolution of Crypto and Digital Currency in Global Payment Platforms using the review approach. The result shows that the regulatory and other challenges of cryptocurrency have triggered a tidal wave of Central Bank Digital Currency (CBDC) across the world. The authors recommend that the perception dichotomy about cryptocurrencies be bridged, and adequate measures put in place to ensure effective maximization of cryptocurrencies and its benefits.

Conclusively, the article draws out the need for regulatory authorities to strengthen their regulatory ambit in the wake of emerging technological innovations in the financial landscape. Banks and other financial institutions must embrace emerging digital revolution to deepen the industry and the individual offerings of the institution emerging digital revolution.

Sir, 'Seye Awojobi, FCIB, KJW, Ph.D

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Mobile Banking Applications in Nigeria: An Analysis of User Sentiments

Adebiyi M. A. Ph.D [1]
Omotosho B. S. Ph.D [2]

Abstract

Mobile banking apps are solutions enabled on mobile communication networks to offer transactional and non-transactional financial services to customers with bank accounts. This paper investigates the inherent sentiments contained in the users' reviews of the mobile banking apps developed by all the deposit money banks, (DMBs) in Nigeria. To achieve this, we analyse star ratings assigned to the apps as well as the qualitative comments provided by bank customers. In all, 1,027,038 words from 158,047 reviews of 24 commercial banks' mobile banking apps were analysed. The overall mean rating for the apps was 3.45, indicating an above-average score. The sentiment analysis shows that the reviews were dominated by positive sentiments, as 17.3 per cent of the words in the corpus expressed positive sentiment as against only 8.2 per cent, which revealed negative sentiment. Apps developed by DMBs with international authorisation accounted for the largest share of the positive sentiments, followed by non-interest banks. Furthermore, our results showed that, whereas the share of positive sentiments increased during 2013 to 2019, it trended downwards starting from 2020; a development that could be attributable to the increased use of the mobile banking channel for financial transactions following the outbreak of the Covid-19 pandemic. The emotion of "trust" was predominant in the corpus,

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followed by "anticipation", "joy", and "surprise". However, the category of emotion with the least occurrence was "disgust". The study recommends among others, that DMBs should pay more attention to user reviews on their mobile banking apps with a view to resolving legacy concerns that are driving persistent poor ratings and negative sentiments expressed by their customers. Banks with regional authorisation are encouraged to invest in their IT infrastructure in order to remain competitive and sustain the trust of their customers.

Keywords: *User rating, Sentiments analysis, Word cloud, Banking apps*
JEL classification: C46, C55, E44, E58, G20

1.0 Introduction

Mobile application (app) reviews are feedback provided by users about their experiences, requirements, and issues interacting with a mobile app. Most often, the iteration of an app is driven by bug reports and user requirements analyzed and extracted from app reviews. Customer reviews are important information that can be used by providers of goods or services to maintain customer loyalty, understand customer feelings and analyze the business competition. Also, potential customers use feedback and reviews provided by previous buyers to make decisions on whether to buy a product or not (Nufus, et al 2021).

The growth in the use of mobile banking applications (apps) has been boosted by the increase in the number of smart phones, improvement in internet infrastructure, as well as the restrictions to human movement occasioned by the Covid-19 pandemic (Omotosho, 2021). These apps are convenient to use; allowing customers to: browse and download apps from app and play stores, conduct permissible banking transactions, write reviews on apps they have used, and assign star ratings based on their level of satisfaction with the apps. Many studies

have proved that app reviews, which contain problem feedback, feature requests, and other suggestions, can be regarded as references for the iterative design and development of the app (Jabangwe, et al, 2018). Thus, a constant analysis of user reviews is critical for monitoring market conduct, consumer complaints, and overall market stability.

A major challenge for the developers of apps is how to deal with the overwhelming feedback on their apps, as customer reviews usually come in large numbers. Thus, organizing the reviews in a manner that allows for useful inferences remains a great challenge (Auden, 2002). In particular, manual inspection and analysis of mobile banking app reviews can be very time-consuming and impractical (Yang et al., 2021). However, due to advancements in computing power and text mining algorithms, a budding strand of literature focuses on the analysis of textual data collected from user reviews. Thus, an analysis of opinions in reviews in increasingly being widely investigated within the last decade (Pang and Lee, 2008), an endeavor that is typically referred to as sentiment analysis or opinion mining (Liu, 2012).

For instance, Omotosho (2021) analyzed textual data mined from 37,460 reviews written by mobile banking application users in Nigeria. The study, which covered all iOS and Android mobile banking apps available on Google Play and App Store, was the first rigorous attempt at conducting sentiment analysis on reviews written by users of mobile banking apps in Nigeria. However, the study approach did not account for uniform sample period across the mobile banking apps; thus, limiting the ability of the paper to study the evolution of user sentiments overtime and capture the impact of technological advancements on legacy concerns.

The objective of our study is to bridge the gap in literature by analysing the sentiments contained in user reviews of mobile banking apps in

Nigeria in the pre and post Covid-19 periods. In particular, we study the trend in the sentiment indices since 2012, paying attention to developments around the period of Covid-19 pandemic outbreak. This is to study how the level of satisfaction experienced by mobile banking users in Nigeria has evolved over the years. We analyse both the star ratings assigned to the mobile banking apps as well as the textual data contained in the user reviews. The star ratings summarise, in quantitative terms, the users' overall level of satisfaction with the mobile app while the user reviews are useful for extracting the users' emotions and sentiments.

Following this introduction is Section 2, which reviews relevant literature. The study methodology is discussed in Section 3, including a description of the data source and the analytical tools. In Section 4, we discuss the results focusing on the analysis of the star ratings of the mobile banking apps, word clouds, sentiments, and emotions. Section 5 concludes the paper.

2.0 Literature Review

A major challenge facing businesses today pertains to achieving and maintaining customer satisfaction. A debate in this area is the extent to which consumer satisfaction is a cognitive process or an emotional state. One of the theories that best explains customer satisfaction is expectancy-value theory. The theory argues that customers often make some judgment about a product, its benefits, and the likely outcomes of using the product. Some models indicate a link between satisfaction and repeat purchase intention but not yet to actual purchase. The most widely used model to translate theories of customer satisfaction into management practice is the service quality model which is defined as the difference between customer expectations and customer perception of service received. Here, the overall attitude of customers is a function of beliefs about the products' or services' attributes and the strength of these beliefs (Barsky, 1992).

Star ratings are a useful mechanism for app developers to infer user satisfaction and it provides useful assessments of overall performance of an app, in an objective, direct and quick-to-be extracted manner. To obtain further details of the customer star rating, developers need to also inspect the comments left by users, an exercise that cannot be optimally conducted manually. In addition, there is no guarantee that the stars assigned by users match the comments made. Luiz, Viegas & Alencar (2018) found that in spite of the star rating being a good measure of evaluation, the sentiment analysis technique is more accurate in capturing the level of customer satisfaction transmitted via user comments. Several studies have shown that that reviews contain a rich source of information about user experience (Anam & Yeasin, 2013; Hedegaard & Simonsen, 2013; Korhonen, et al, 2010).

Rodrigues et al (2017), conducted experiments to verify the relationship between star ratings and the content of user reviews on applications from Google Play. It was found that the information in reviews did not properly represent the star rating. The authors proposed a new method of evaluating applications by extracting information related to sentiment from the reviews. The study applied machine learning strategies to show that the proposed sentiment-based approach is more effective at predicting the reviews than star rating. A framework capable of extracting useful information about relevant topics and their respective sentiment strength in a corpus of reviews was then proposed.

Sharma, et al (2021) analysed user reviews on the National Digital Library of India (NDLI) mobile app for both android and iOS by conducting sentiment analysis. The study used data set of 4560 user reviews. The study shows the reviews of the NDLI mobile app has 2130 positive and 1808 negative sentiments for android, and 6 positive and 22 negative sentiments for iOS. The overall sentiment score was found to be 66 per cent. The results of the sentiment analysis showed

that Android users are more satisfied, when compared to iOS users. The study also found that the most frequent complaints made by the users were related to functional errors, feature requests and app crashes. Furthermore, it showed that app updates were helpful in attracting more positive reviews from the users. The findings reveal that stakeholders/developers need to pay more attention to make the app more user-friendly.

A number of studies have analysed the determinants of mobile banking apps adoption in Nigeria by conducting in-person surveys (Odumeru, 2013; Ifeonu and Ward, 2015; Olaleye et al., 2017). Some of the drivers of mobile banking apps adoption identified by the studies were features such as security, privacy, convenience, confidentiality, integrity, authentication, access control, and the adaptability of the apps to the peculiar circumstances of the customer.

Omotosho (2021), however, was the pioneer study on the use of text mining techniques to analyse customer reviews on mobile banking apps in Nigeria. He analysed 37,460 reviews written by mobile banking application users over the period 2012 – 2020. The study found that the share of positive sentiment words (17.8%) in the corpus more than doubled that of negative sentiment words (7.7%) and that about 66 per cent of the emotions expressed by the users were associated with 'trust', 'anticipation', and 'joy'. The study further showed that the main topics contained in the corpus pertained to issues around the response level of banks to customer complaints, app functionalities and updates, and concerns regarding operational failures of the apps.

3.0 Data and Methodology

3.1 Data

This study analyses user reviews of mobile banking apps deployed by DMBs in Nigeria sourced from heedzy.com as of April 25, 2022.

These comprise 1,027,038 words from 158,047 reviews written by users of mobile banking apps. The data cover all iOS and Android mobile banking apps available on Google Play and App Store. The analysis, especially for the sentiment analysis is conducted under four categories of banks, namely: commercial banks with international authorisation (CBIA), commercial banks with national authorisation (CBNA), commercial banks with regional authorisation (CBRA), and non-interest banks (NIB).

In line with standard text mining procedures, we processed the textual data by removing numbers, punctuations, white spaces, and special characters from the corpus. Next, the characters in the corpus were all converted to lower case while English stop words such as 'to', 'the', 'this', 'in' were expunged. Informal spelling of words that could alter the contextual meaning of the reviews were also corrected. Finally, we stem the words in the corpus.

3.2 Analysis of Star Ratings

Generally, most mobile banking apps often allow users to write reviews about their mobile banking experience and provide quantitative star ratings. Such feedback constitutes an important source of information for both the service providers and the regulatory authorities. User rating and reviews help the app developer improve on the app usability in subsequent updates. In order to track level of customer satisfaction with their mobile banking apps, we compute average ratings of the apps over the years as follows:

$$\text{Average apps rating} = \frac{\sum rf}{\sum f} = \frac{\sum(rating \times frequency)}{\sum(total\ frequency)}, \quad (1)$$

where r is the rating assigned to a mobile banking app and f is the frequency for each rating.

3.3 Text Mining Analysis

Word clouds was used to identify common terms in the corpus while the analyses of sentiments and emotions were conducted to derive useful insights regarding the type of feelings and experiences that were predominant in the corpus. In particular, the sentiments in the reviews are classified into three categories – positive, neutral, and negative. The share of each category in the total number of words in the corpus is then computed to gauge their level of positivity or negativity. Furthermore, the study explored the emotions expressed in the reviews, classifying same into eight categories based on the Canadian National Research Council (NRC) sentiment dictionary (Mohammad & Turney, 2010).

Lastly, we compute the polarity score, which is a quantitative measure of positive or negative intent found in the tone of the reviews (Kwartler, 2017). The average polarity score ranges between -1 and 1; where a negative value indicates negative sentiment, a value of zero indicates neutral sentiment, and a positive value connotes positive sentiment.

4.0 Results and Discussion

Table 9 shows that commercial banks with international authorisation had the highest number of app reviews (71.4%), followed by banks with national authorisation (24.3%). Banks with regional authorisation accounted for 3.6 per cent of the reviews while non-interest banks had the balance of 0.7 per cent. The analysis was implemented using the *R* statistical software. The distribution of the reviews by bank categories are presented in Table 9 under the Appendix.

The analyses of star ratings and the qualitative comments provided by bank customers while using their mobile banking apps are presented in this section. The ratings were analyzed using averages and

percentage shares while text mining techniques were applied to the qualitative comments.

4.1 Star Rating Analysis

The star rating is a quantitative way of grading app performance or user experiences. Table 1 presents the overall ratings for all the reviews made by banks' customers over the sample period. The results shows that 5-star ratings got the largest share of the ratings with 48.7 per cent followed by 1-star ratings with 28.9 per cent of the total reviews. However, 2-star ratings had the least number of ratings with just 5.5 per cent of the total.

The average star rating by bank categorization is presented in Table 2. The overall rating for all the mobile banking apps was 3.45, indicating an above – average[2] rating for the mobile banking apps considered. The rating is an indication of above – average ratings for apps in the four bank categorizations.

Table 1: Frequency of Star Ratings

	No. of user reviews	Share of total
Rating 1	45,657	28.89
Rating 2	8,619	5.45
Rating 3	10,146	6.42
Rating 4	16,628	10.52
Rating 5	76,997	48.72
Total	158,047	100

[2] *2.5 is the benchmark (average) rating.*

The Non-interest banks (NIB)[3] had the overall highest average ratings of 3.7, followed by the commercial banks with international authorisation (CBIA) with an average rating of 3.6. Thus, both the NIB and CBIA categories had ratings higher than the overall average. The CBNA and CBRA had average ratings of 3.2 and 3.1 respectively, lower than the overall average ratings of 3.5. It is important that banks with regional and national authorisations pay more attention to issues being raised by users of their mobile apps with a view to resolving consumer complaints as they emerge.

Table 2: Star Ratings by Bank Category

Sample	Rating 1	Rating 2	Rating 3	Rating 4	Rating 5	$\sum f$	$\sum rf$	Average rating[4]
CBIA	29489	5770	7212	12729	57600	112800	401581	3.6
CBNA	13904	2384	2452	3251	16467	38458	121367	3.2
CBRA	2055	394	404	542	2350	5745	17973	3.1
NIB	209	71	78	106	580	1044	3909	3.7
All	45657	8619	10146	16628	76997	158047	544830	3.5

In Figure 1, we present the average rating in the four categorizations of banks from 2012 to April 2022. It is important to note that, whereas the NIB's average rating was initially low at inception, the banks in that category appeared to have made significant progress in recent years as they recorded the highest rating of the four, especially during the Covid-19 pandemic lockdowns. It can also be observed that whereas the average rating for the CBIA remained relatively stable at

[3] The high rating of the NIB may be influenced by the fewer number of app ratings available for that category.

[4] Note that average= $\frac{\sum rf}{\sum f} = \frac{\sum(rating \times frequency)}{\sum(total\ frequency)}$ *; Where r is the rating while* f *is frequency for each rating.*

the outset of the pandemic, the ratings for the other categories of banks dwindled. As at April 2022, the CBIA recorded the highest star ratings, while the CBNA had the least.

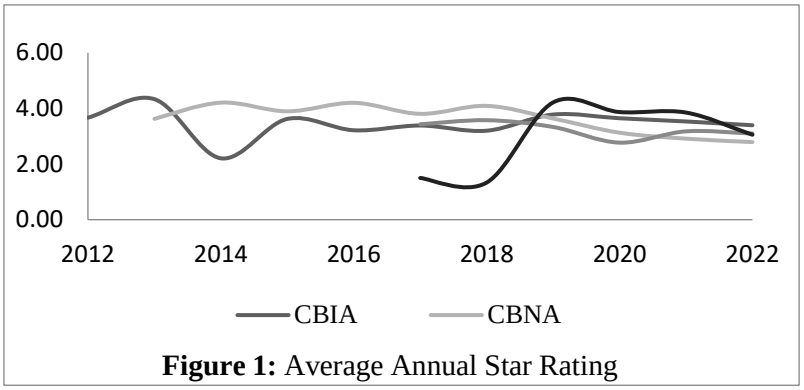

Figure 1: Average Annual Star Rating

It is important to note that while the star ratings are a good way of quantitatively measuring the performance of mobile apps, there is no evidence that the ratings assigned by users often match the reviews written by them. Thus, sentiment analysis generated from user reviews are often considered a more reliable measure of customer satisfaction or dissatisfaction.

4.2 Word Frequencies

Figure 2 presents word frequencies, showing the most common words that appear in the corpus with their level of occurrences. The 20 most common words appear in the following order: good, use, cant, transact, work, update, tri, bank, pleas, now, nice, time, even, one, can, just, easi, keep, great, transfer. The term “good” is the most occurring word in the corpus appearing 26,339 times, followed by “use” occurring 17,501 times, and “cant” with a frequency of 14,426.

The ordering of these words tend to suggest that mobile app users considered their apps “good” for the purposes they are being used for,

while some users also struggle to perform certain operations as depicted by the frequency of the term “cant”. The similarity in the frequency of the terms “work” and “update” (11,459 and 11,196 respectively) may suggest either that the apps worked better after update or that certain features could not “work” after “update”.

Figure 3 presents the word cloud for the entire corpus of the 158,047 reviews analysed. Consistent with the findings under Figure 2, the term “good” appeared as the most predominant word in the word cloud, indicating that majority of users considered their mobile banking apps relatively good. Similarly, the word “use” predominantly featured in the reviews. Whereas Figure 2 presents a list of the top 20 words, the word clouds presented in Figure 3 shows pictorial representation of a more elaborate list.

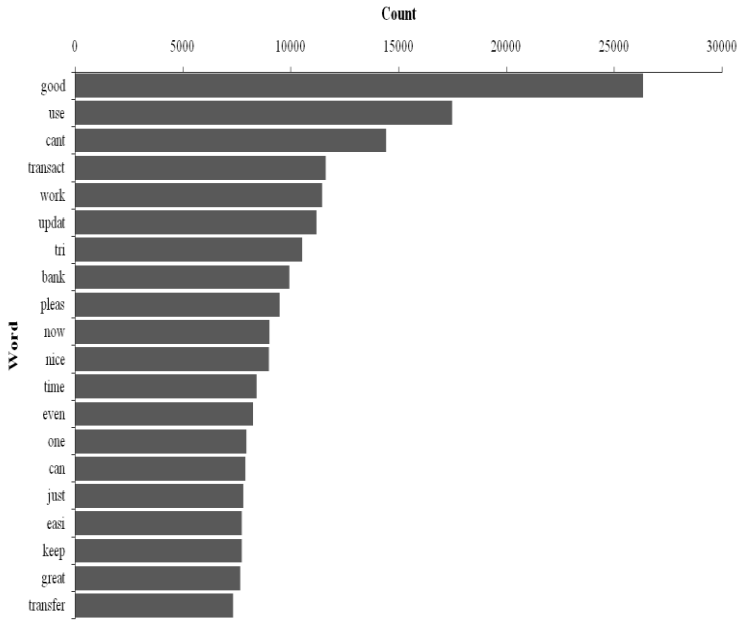

Fig 2: Top frequent terms from sample

Figure 3: Word cloud

4.4 Sentiments Analysis

The results of the sentiment analysis conducted on the user reviews of mobile banking apps in Nigeria are presented in Table 3. The analysis grouped the sentiments into three categories – positive, neutral, and negative; with special emphasis on the positive and negative sentiments. The sentiments analysis filtered 1,027,038 words from 158,047 reviews. Our results showed that about 17.2 per cent of the words in the corpus expressed positive sentiment while only 8.2 per cent expressed negative sentiments.

Table 3: Sentiment Analysis by Bank Category

Sample	Negative	Positive	Neutral	Total
CBIA	53,839	122,029	476,140	652,008
	8.26%	*18.72%*	*73.03%*	
CBNA	25,710	46,859	248,872	321,441
	8.00%	*14.58%*	*77.42%*	
CBRA	3,954	6,993	35,907	46,854
	8.44%	*14.93%*	*76.64%*	
NIB	425	1,228	5,082	6,735
	6.31%	*18.23%*	*75.46%*	
All	83,928	177,109	766,001	1,027,038
	8.17%	*17.24%*	*74.58%*	

The highest share of positive sentiments was recorded by CBIA and NIB with 18.7 per cent and 18.2 per cent, respectively; while CBNA and CBRA recorded the least positive reviews of 14.6 and 14.9, respectively. The negative sentiments analysis by bank categories shows that CBRA and CBIA had the highest negative reviews of 8.4 per cent and 8.3 per cent, respectively, while NIB had the lowest share of negative sentiments at 6.3 per cent.

The trend for the percentage share of positive sentiment words by bank category is presented in Table 4. The trend shows that the overall average positive sentiments increased gradually over the years, and peaked at 18.7 per cent in 2019 before declining afterwards following the outbreak of the Covid-19 pandemic. This could be attributed to the increased pressure on existing IT infrastructure as most bank customers had to resort to mobile banking apps following the Covid-19-related restrictions to human movement. As at April 2022 the overall share of positive sentiment was 31.4 per cent, with CBIA and CBRA having the highest positive emotions of 17.3 per cent and 15 per cent, respectively.

Table 4: Positive Sentiment by Bank Category

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
CBIA	4.9	22.8	16.9	18.5	15.5	17.5	13.7	20.4	19.6	18.6	17.3
CBNA	0.0	23.7	22.1	22.9	24.0	18.9	20.8	17.4	14.6	13.3	13.3
CBRA	0.0	0.0	0.0	0.0	0.0	8.1	11.8	15.7	11.9	15.2	15.0
NIB	0.0	0.0	0.0	0.0	0.0	25.0	14.9	21.1	17.9	19.1	14.8
Mean	1.2	11.6	9.8	10.4	9.9	17.4	15.3	18.7	16.0	16.6	15.1

The share of negative sentiment words in our corpus for the bank categories are presented in Table 5. The negative sentiments expressed by the users for all app ratings increased steadily over the sample

period. As at April[5] 2022 the overall negative emotions stood at 8.4 per cent, with all the categories of banks recording higher negative sentiments compared to the respective levels in 2021.

Table 5: Negative Sentiment by Bank Category

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
CBIA	4.9	5.8	7.8	6.2	7.9	7.6	8.9	7.3	7.8	8.5	8.9
CBNA	0	7.9	3.1	6.2	4.5	7.2	6.8	7.2	7.8	8.4	8.7
CBRA	0	0	0	0	0	5.4	4.6	5.8	8.1	8.2	8.9
NIB	0	0	0	0	0	10	8.5	5.3	5.7	6.5	7.2
Mean	1.23	3.43	2.73	3.1	3.1	7.55	7.2	6.4	7.35	7.9	8.43

Figure 4, which present the overall average positive and negative sentiments by year, revealed that the share of positive sentiments words was consistently higher that them share of negative sentiments words over the years.

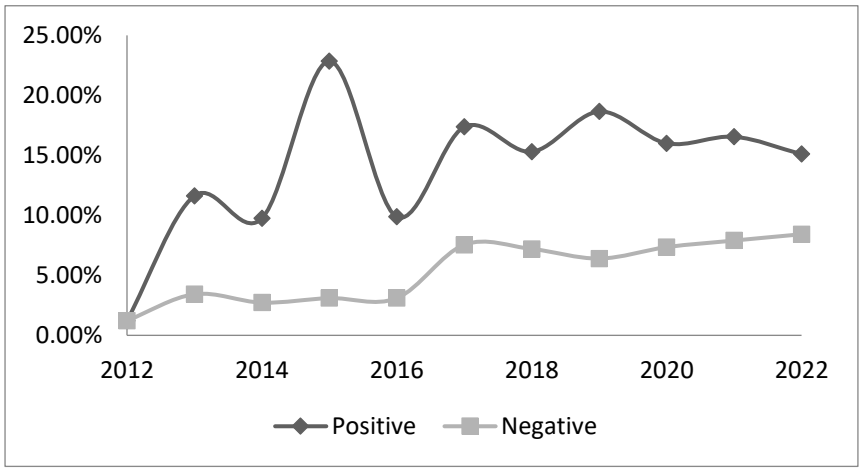

Figure 4: Overall Average Positive and Negative Sentiments

[5] *15.1 per cent was the overall share of negative sentiment words from January to April 25th 2022. In other words, the value does not represent the situation for the entire year.*

In 2015, the share of positive sentiments increased significantly following the introduction of the Bank Verification Number (BVN) and other fraud prevention initiatives by the Central Bank of Nigeria. From 2019, following the outbreak of the Covid-19 pandemic, the share of positive sentiment words shows a declining trend while the negative sentiment increased marginally over time. Overall, the share of positive sentiments outweighed the negative sentiments, indicating a positive net sentiment trend over the study period, driven by non-interest banks and banks with international authorization

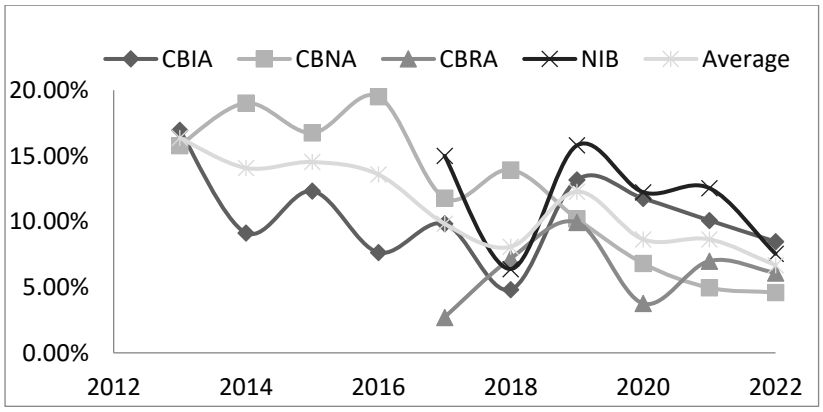

Figure 5: Net Sentiment by Banks Category

Figure 5 presents the net sentiment, which is the difference between the positive and negative sentiments, for the 4 categories of DMBs considered in the study. It measures the direction of change of the sentiments. A positive value indicates that the positive sentiments are higher than the negative sentiments. The chart shows that whereas the net sentiments for the four categories of banks remained in the positive region over the sample period, there has been a general decline since the outbreak of the Covid-19 pandemic. This was more pronounced for banks with national authorisation (CBNA) as its share of positive

sentiments declined rapidly in the face of an increasing negative sentiments (Figure 6b).

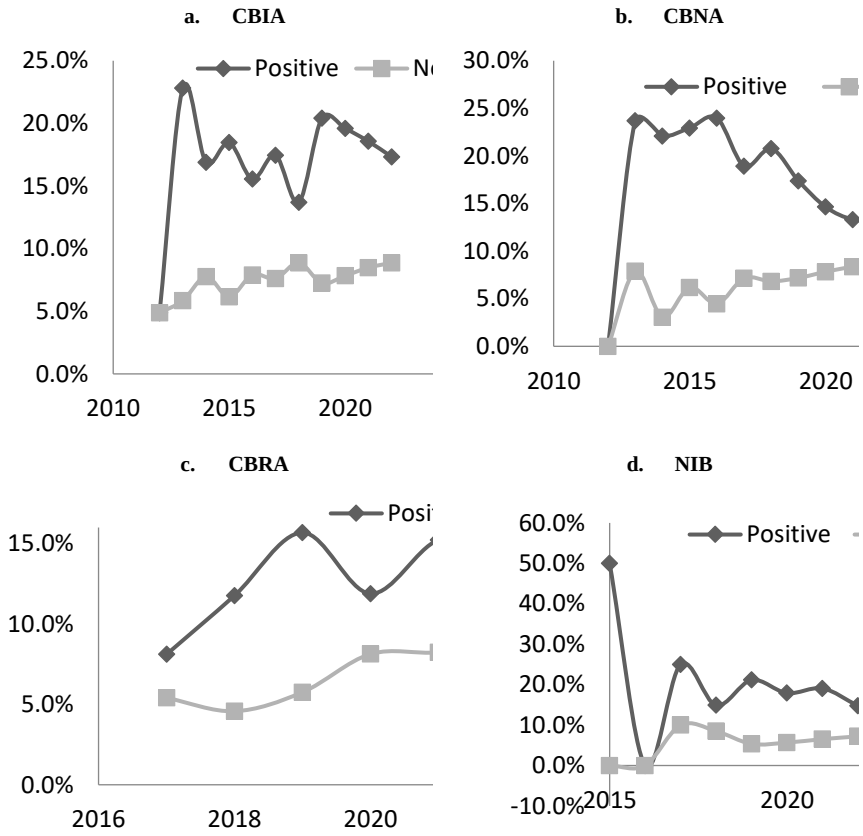

Figure 6: Annual Sentiments by Bank Category

4.5 Sentiments Polarity

Table 6 presents a list of the top ten positive and negative sentiment

Table 6: Top ten words with (a) positive sentiments and (b) negative sentiments

(a)			(b)		
Word	Freq	Weight	Word	Freq	Weight
Good	26,339	0.149	Pleas	9,492	0.113
Work	11,459	0.065	Bad	4,019	0.048
Nice	8,996	0.051	Useless	3,934	0.047
Great	7,668	0.043	Problem	3,776	0.045
Love	7,300	0.041	Worst	3,696	0.044
Best	6,883	0.039	Error	3,258	0.039
Excel	6,698	0.038	Poor	3,117	0.037
Money	6,142	0.035	Slow	2,773	0.033
New	5,807	0.033	Annoy	2,482	0.030
Like	5,130	0.029	Never	1,984	0.024

terms contained in our full sample corpus with their frequencies and weights.

The most common positive terms used by mobile banking apps users to describe their experience occur in the following order: "good", "work", "nice", "great", "love", "best", "excel", "money", "new", and "like"; while the top ten negative sentiment words were: "pleas, bad, useless, problem, worst, error, poor, slow, annoy and never.

In the next step, we compute the average polarity scores for the different categories of banks and the results are presented in Table 7. A negative value of the average sentiment polarity score implies prevalence of negative sentiment terms while a positive value indicates the dominance of positive sentiment terms.

Table 7: Sentiment Polarity by bank category

Bank category	Average polarity	Sd. Polarity
All	0.371	0.620
Commercial Banks with International Authorisation (CBIA)	0.412	0.627
Commercial Banks with National Authorisation (CBNA)	0.261	0.595
Commercial Banks with Regional Authorisation (CBRA)	0.276	0.576
Non-Interest Banks (NIB)	0.395	0.556

As shown in Table 7, the average polarity score for all the apps included in the analysis was 0.37, indicating a relatively high positive sentiment. Notably, DMBs with international authorisation recorded the highest polarity score of 0.41, followed by the non-interest banks with a polarity score of 0.40. However, though lying within the positive territory, the polarity scores for CBNA and CBRA were below the average over the sample period.

4.6 Analysis of Emotions

In this section, we analyse the nature of emotions expressed by users of mobile banking apps and the results are presented in Table 8. The results show a total of 37,331 emotive words in the corpus. The eight types of emotions considered under the NRC dictionary, namely: 'trust', 'anticipation', 'joy', 'surprise', 'sadness', 'fear', 'anger', and 'disgust' and their respective percentage shares are shown.

The result shows that "trust" featured as the dominant emotion for the four categories of banks. While NIB had the largest contribution to the overall trust emotion (33.9%), the rest category of DMBs each had about 28.0per cent respectively. Aside "trust", "anticipation" also appeared prominently across all categories with about 19 per cent share for CBIA and CBNA, while CBRA and NIB had 17.8 per cent

and 18.6 per cent, respectively. However, emotions relating to "disgust", "anger", "fear" and "sadness" were less prominent. This further reinforces the earlier finding that majority of the users are satisfied with their mobile banking apps.

Table 8: Emotion by Bank Category

Emotion type	CBIA	CBNA	CBRA	NIB
Disgust	4	4.5	4.3	2.3
Anger	5.6	7.1	7.6	3.8
Fear	5.6	6.7	6.6	5
Sadness	7.5	9.4	9.0	7.3
Surprise	10.7	8.5	9.4	10.1
Joy	18.8	16	16.5	18.8
Anticipation	19.1	19	17.8	18.8
Trust	28.7	28.8	28.8	33.9

5.0 Conclusion

The study analysed the star ratings and the qualitative comments provided by bank customers while using their mobile banking apps. In particular, the sentiments expressed in the textual data collected from user reviews were analysed. The ratings were analysed using averages and percentage shares while text mining techniques were applied to the qualitative comments. The sentiments analysis made use of 1,027,038 words from 158,047 reviews included in our corpus.

The results show that 5-star ratings got the largest share of the star ratings with 48.7 per cent, followed by 1-star ratings with 28.9 per cent of the total number of ratings assigned by the users. The overall rating for all banks was 3.5, indicating an above – average rating for the Nigerian mobile banking apps. The rating is also an indication of above average ratings for apps in the four bank categorizations. The

non–interest banks (NIB) had the overall highest average ratings of 3.7 while the DMBs with regional authorisation had the least rating of 3.1.

The sentiment analysis shows that, of the over one million words in the corpus, about 17.2 per cent expressed positive sentiment while only 8.2 per cent expressed negative sentiment. The highest contributor to the positive sentiment was the category of banks with international authorisation, followed by the non – interest banks. This result was further confirmed by the polarity scores which indicated that CBIA had the highest average polarity score of 0.41, indicating that users of the CBIA mobile banking apps had the highest positive sentiments followed by the NIB with a polarity score of 0.4. A trend analysis of the sentiments indicated that, overall, users of mobile banking apps in Nigeria expressed positive sentiments about the quality of service received over the sample period. However, at the outset of the Covid-19 pandemic, the positive sentiments dwindled while negative sentiments increased, leading to a decline in the net sentiment during the period. This was however more pronounced in the case of the banks with national authorisation (CBNA).

In terms of the emotions contained in the corpus, our results showed that the "trust" emotion dominated, and this was the case across the four categories of DMBs considered. This was followed by emotions of "anticipation", "joy", and "surprise". Furthermore, we found that emotions pertaining to "disgust", "anger", and "fear" were less dominant.

The study recommends that banks should pay more attention to user reviews and resolve legacy concerns that have contributed to persistent negative sentiments in the user reviews. This will help in building customers satisfaction and loyalty in the banking system. The study also recommends that bank regulators should consistently conduct sentiment analysis on mobile banking app user reviews as a way of

getting independent feedback on issues raised by bank customers and its attendant effect on the banking system. The Central Bank of Nigeria can get reliable and first-hand information from users' reviews that may help to improve market conduct and further strengthen financial system stability.

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Appendix

Table 9: Distribution of User Reviews by Bank

Bank authorisation	Mobile application	Period	No. of reviews	Percent of Total
Commercial Banks with International Authorisation (CBIA)	Access Bank	July 2014 - April 2022	10,864	6.87
	FCMB	March 2015 - April 2022	1,798	1.14
	Fidelity Bank	October 2015 - April 2022	16,021	10.14
	First Bank	October 2015 - April 2022	16,426	10.39
	Guaranty Trust Bank	November 2012 - April 2022	10,593	6.70
	Union Bank	January 2018 - April 2022	5,590	3.54
	United Bank for Africa	August 2015 - April 2022	38,328	24.25
	Zenith Bank	November 2013 - April 2022	13,180	8.34
	Sub-total		***112,800***	***71.37***
Commercial Banks with National Authorisation (CBNA)	Ecobank	July 2016 - April 2022	9,235	5.84
	Heritage bank	January 2016 - April 2022	773	0.49
	Keystone Bank	January 2018 - April 2022	5,932	3.75
	Polaris Bank	August 2019 - April 2022	1,536	0.97
	Stanbic IBTC	November 2016 - April 2022	6,465	4.09
	Standard Chartered	June 2013 - April 2022	4,706	2.98
	Sterling Bank	May 2018 - April 2022	6,829	4.32
	Titan Trust Bank	November 2019 - April 2022	107	0.07
	Unity Bank	November 2013 - Aapril 2022	2,875	1.82
	Sub-total		***38,458***	***24.33***
Commercial Banks with Regional Authorisation (CBRA)	Globus Bank	November 2019 - April 2022	177	0.11
	Providus Bank	April 2019 - April 2022	168	0.11
	Suntrust Bank	September 2019 - April 2022	59	0.04
	Wema Bank	April 2017 - Apri 2022	5,341	3.38
	Sub-total		***5,745***	***3.63***
Non-Interest Banks (NIB)	Jaiz Bank	June 2015 - April 2022	811	0.51
	Lotus Bank	December 2021 - April 2022	44	0.03
	Taj Bank	November 2019 - April 2022	189	0.12
	Sub-total		*1,044*	*0.66*
Grand total			**158,047**	**100.00**

Source: Compiled by the authors

Fintech and Credit Risk in Nigeria: A Case Study of Neobanks

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Ernest O. Bosha [2]

The study investigates the impact of Fintechs on credit risk in Nigeria using panel data from 2018 to 2021. The study applies the Panel Autoregressive Distributed Lag (PARDL) framework using 6 neobanks, (with state (1) and unit (1) microfinance bank licenses) to carry out the study due to data availability. A Fintech index, which depicts improvement, was constructed using google trends data. Findings from the study empirically confirm that both bank-specific and macroeconomic factors determine the graduation of risks in these banks. Specifically, credit risk, proxied by the non-performing loans ratio, was aggravated by growth in size, rise in interest rates, and economic expansion. However, a negative relationship was observed between enhancements in operating efficiency and the fintech index. In addition, the study provides evidence of a negative relationship between size and z-scores of selected neobanks. However, from our disaggregated analysis, only the signaling hypothesis was found in the case of international banks, while the capital management hypothesis and a counter-intuitive income hypothesis were found for national banks. The findings of this paper are relevant to current concerns around the rapid growth of Fintechs in Nigeria and the attendant vulnerabilities and challenges to financial institutions they portend. In this regard, the study recommends that more robust macro-prudential policies bordering on capital, liquidity, and operational risk-

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management requirements should be designed to ensure financial stability specifically to mitigate credit risk amid the impressive growth in neobanks. Specifically, regulatory policies such as stipulating lending standards and robust governance schemes, as well as improving prudential guidelines, should be the focus of monetary and prudential authorities.

Keywords: *FinTech, Credit, Panel Data*
JEL Classification: *G2, G15, G28*

1.0 Background

Technology has consistently played a significant role in delivering financial services throughout history. This is evident from the introduction of the telegraph in the 1870s by Western Union for money transfers to the use of Blockchain and Distributed Ledger Technology for Cryptocurrencies in the 21st Century. The 2007-2009 global financial crisis resulted in a loss of confidence in the traditional modes of offering financial services. This led to a surge in interest in fintech — a new technology that seeks to improve and automate the delivery and use of financial services — (financial technology), leading to further development and adoption of innovative Fintech solutions.

The adoption and uses of fintech in the financial system range from traditional applications like backend operations for banks to information and data storage and processing infrastructure. From Automated Teller Machines (ATMs) to disruptive applications like peer-to-peer lending. Cryptocurrency, digital banking, machine learning algorithms, and data science perform all tasks, from processing credit risks to running hedge funds. Fintechs leverage their technology advantages to provide efficiency gains, lower costs, remove friction, improve financial inclusion for underserved and

unserved segments of the society, increase competition and spur further innovation in the financial sector (IMF, 2022).

Financial intermediation by banks is the centre of the modern financial system as it entails aggregating surplus resources and deploying the same to deficit units to create welfare-enhancing economic activity. This is effectively executed through credit creation in credit markets dominated by commercial banks, credit unions, and other traditional lenders. However, fintech offers new models of intermediation as well as new forms of intermediaries. Digital lending models such as peer-to-peer (P2P)/marketplace lending, buy now pay later (BNPL), invoice trading, and intermediaries like peer-to-peer lending platforms, digital banks, and neobanks have gained significant traction in many economies in the past decade. But are neobanks, digital banks, and fintech firms the same institutions?

According to Walden and Strohm (2022), neobanks, or "challenger banks," are fintech firms that offer apps, software, and other technologies to streamline mobile and online banking. Neobanks are fintech institutions specializing in financial products, like chequing and savings accounts. Neobanks are more spry and transparent than megabanks, even though many partners with such institutions in insuring their financial products. The literature supports the capacity of fintech to confer various benefits to participants in the financial system. For a panel of selected countries, for instance, Daud et al, (2021) showed that fintech promotes financial stability through the channels of artificial intelligence, cloud technology, and data technology by leveraging these to improve credit scoring and rating, backend operations, and data processing. Moreover, fintech and credit are expected to be higher and complementary to other sources of credit when existing banking services and rates are more expensive, thereby offering users cheaper credit with less friction (Cornelli et al., 2020). Additionally, using big data analytics and algorithms, fintech can

improve credit risk models by screening opaque borrowers, such as those with scant credit history (Branzoli and Supino, 2020).

Notwithstanding, some concerns remain around the pace, scope, and depth of the transformation of the financial system by Fintechs. Specifically, scholars argue that rapid expansion in credit and non-compliant creditworthiness assessment activities by Fintechs, especially neobanks, digital banks, and peer-to-peer lenders, gives rise to systemic risks and pose challenges to financial stability (Mild et al., 2015); (IMF, 2022). Likewise, risks such as the potential weakening of lending standards increased the procyclicality of credit provision and could affect incumbent financial institutions through revenue erosion or additional risk-taking. These have been identified as concerns about the impact of fintech on credit risk (CGFS-FSB, 2017; Vučinić, 2020).

Departing from these findings, the developments of Fintechs, especially those offering credit services such as peer-to-peer marketplaces and neobanks, is of interest to policymakers and regulators globally and in Nigeria. A fundamental reason is that these new models and intermediaries either do not fall within any existing regulatory framework or deploy credit through channels not covered by well-developed systems or official reporting standards. Recently, there have been efforts to improve access to Fintech credit data to the private sector. This is because central banks require such data to monitor economic and financial conditions, whichguide monetary policy decisions. Moreover, financial regulators need such information to set macroprudential policies like the countercyclical capital buffer. Yet, for fintech and big tech credit, authorities often rely on non-official sources (Dembiermont et al., 2013) and submissions by neobanks—fintech firms with banking licenses that offer banking services without physical branches.

Given the economic importance of credit creation, as Fintech credit becomes more economically relevant, it has become imperative to have accurate data on the size and growth of Fintech credit market and its impact on credit risk. This is useful for policymakers who monitor markets and set monetary and macroprudential policies based on credit aggregates. Similarly, it is sound science to understand the size, drivers, policy issues, and impact of Fintech lending activities on consumer credit and the possible impact on financial stability. A key contribution of this paper is to analyse the impact of Fintech credit on credit risk in Nigeria and provide insight for policy and research.

Against this background, this paper analyses development in the Fintech credit market in Nigeria using lending by neobanks as a proxy for Fintech credit and its impact on credit and solvency risks. In particular, the paper contributes to the scanty literature on the relationship between fintech and credit risks, particularly in developing economies such as Nigeria. The paper adopts a Panel Autoregressive Distributed Lag (PARDL) approach, using quarterly data spanning 2018 - 2021. The approach is appropriate as it provides an avenue to quantify the long-run and short-run dynamics in the Fintech-credit risk nexus.

Following this introductory section, section 2 explores conceptual issues around fintech, financial intermediation, and financial stability. Section 3 discusses the data and methodology employed in the study, while section 4 presents the empirical results from the analysis. analyses theoretical considerations and stylized facts, and then section 5 concludes the paper with policy recommendations.

2.0 Conceptual Issues

2.1 FinTechs, Financial Intermediation, and Financial Stability

Financial technology (Fintech) describes new technology that seeks to improve and automate the delivery and use of financial services. At its core, fintech is utilised to help companies, business owners, and consumers to better manage their financial operations, processes, and lives by utilizing specialised software and algorithms used on computers and smartphones. Fintech usually references an organisation where financial services are delivered using digital technologies to reduce costs, increase revenue and remove friction. It also refers to any business that uses technology to enhance or automate financial services and processes. The term is a broad and rapidly growing industry serving consumers and businesses.

Within credit markets, there has been a rapid transformation occasioned by the advent of fintech. Several new intermediation models have been offered and adopted, including marketplace lending models based on credit offerings directly matching lenders with borrowers. Marketplace lending models can be peer-to-peer—where lenders are retail consumers or business-to-business—one in which lenders are wholesale investors (banks or institutional investors). Most platforms combine both types of lenders and specialize either in consumer credit or in credit to small and medium enterprises (Branzoli and Supino, 2020).

Another model of fintech is neobanks, branchless digital banks licensed by the monetary authorities that serve customers primarily through digital touchpoints such as mobile apps. Neobanks offer credit to users through online channels using machine learning, big data analytics, and Application Programming Interfaces (APIs) for credit rating, scoring, and allocation. In recent times, neobanks have attained

an appreciable market share in the credit market by offering users lower transaction fees, higher interest rates on deposits, and convenience. They can afford this due to lower overhead costs, as they have no branches to maintain and are funded by venture capital geared towards rapid growth rather than profitability. As neobanks continue to grow, they attain systemic importance in their local markets and present several vulnerabilities, including excessive risk-taking in loan and securities portfolios without appropriate provisioning; underpricing of credit risk; and a relatively weak liquidity management framework (IMF, 2022).

Over the years, Fintechs have integrated into the financial intermediation chain of traditional banks through the provision of specialized services and competition. The IMF (2022) identifies three ways this could occur. For instance, Fintechs provide services related to loan application and collection, such as the provision of credit scores and debt collection. Secondly, they may also be involved in deposit-taking services using Customer Identity Verification, Bank as a Service solution, regulatory process solutions (KYC and AML/CFT processes), e.t.c. Thirdly, Fintechs may also be engaged directly in credit allocation through the provision of credit to SMEs, consumers (automobile and mortgage), supply chain financing and issuance of credit cards, on the one hand, and the deployment of savings products and "out-of-wallet tools," P2P payment tools, personal finances, e.t.c, on the other[3].

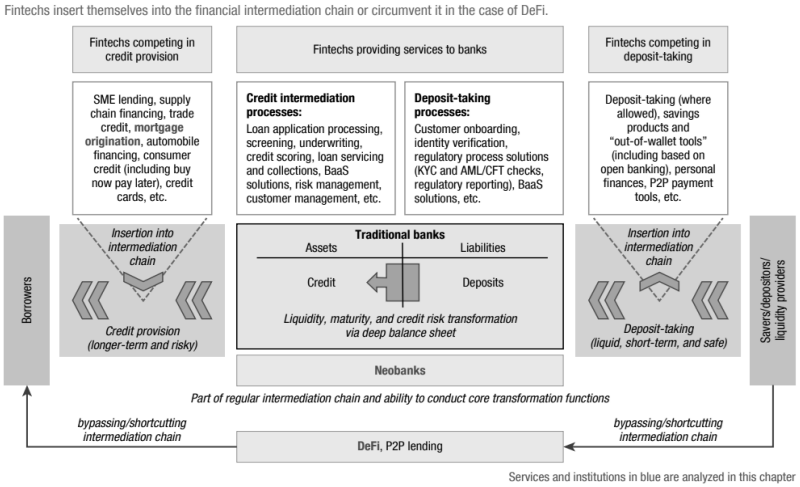
These developments have several implications for financial stability risks. For instance, in a case where several important banks outsource several integral processes, such as risk management, compliance, or fulfillment of regulatory requirements, to the same service providers,

[3] AMF/CLT = anti-money laundering/combating the financing of terrorism; BaaS = Banking as a Service; DeFi = decentralized finance; KYC = Know Your Customer; P2P = peer to peer; SME = small and medium enterprise.

outages and cyber incidents could bring about systemic risks. Another notable challenge arises from direct competition for the same services, particularly in jurisdictions where banks are less predominant in the financial systems (Boot et al., 2021). Of a truth, some large fintechs have grown very quickly in emerging markets, for example, M-Pesa in Africa, which offers credit to small and medium enterprises (SMEs). M-Pesa is a mobile phone-based money transfer service, payments, and micro-financing service, launched in 2007 by Vodafone and Safaricom, the largest mobile network operator in Kenya. It has since expanded to Tanzania, Mozambique, DRC, Lesotho, Ghana, Egypt, Afghanistan, and South Africa (Wikipedia, 2022).

With reference to regulation, financial stability risk may emerge when fintechs provide bank-like services while operating under less stringent regulations than banks. In such a case, coupled with the business model of fintechs, which relies heavily on rapid growth, excessive risk-taking may be the order of the day. This ultimately may result in capital erosion and higher systemic risk (Vives, 2019). Lastly, disruptions also arise when fintechs platforms that provide Peer-to-peer lending platforms, for instance, directly connecting savers and investors with borrowers. In this case, they shortcut the intermediation chain by removing the financial intermediary. Intuitively, investors on these platforms commit their funds for a given horizon and effectively assume credit and liquidity risks.

Figure 1: FinTechs in the Core Banking Intermediation Chain



Source: Global Financial Stability Report, April 2022.

3.0 Data and Methodology

3.1 Data

To achieve the objective of the study, six (6) relevant variables were used based on theoretical and past empirical findings (Cheng and Qu, 2020). The frequency of the data used was monthly, spanning 2018M12 to 2021M12. The scope of data was informed primarily by the availability of data and the need to capture the periods in which the selected neobanks had consistent data and uniform reporting periods. The Bank specific panel data were extracted from the Financial Analysis System (FinA) of the Central Bank of Nigeria. Data on macroeconomic variables were sourced from the Central Bank of Nigeria Statistical Bulletin and National Bureau of Statistics (NBS) database. Data used to construct the Fintech index was sourced from google trends. In particular, the index was constructed using principal component analysis (PCA) to compartmentalise statistics derived from

the google trend searches, comprising fintech, blockchain and artificial intelligence in the Nigerian economy.

3.2 Analytical Framework

To analyse the impact of FinTech on Credit risk in Nigeria, this study follows the specification of Cheng and Qu, (2020) with some augmentation regarding the Nigerian financial system and data availability. The structural form of the relationship is denoted as follows:

Non-performing loan ratio = f (Size, Operating efficiency, Interest Rate, Economic Activity, Fintech Index)

3.2.1 Econometric Method: Panel Auto-Regressive Distributed Lag (PARDL)

The study utilises a panel autoregressive distributed lag (PARDL) model to examine the FinTech-credit risk nexus in Nigeria. Specifically, the Pooled Mean Group (PMG) estimator was employed in a dynamic panel setting to elicit both the short- and long-run dynamics between the variables. The choice of the methodology stems from the fact that it provides consistent estimates of the parameters' averages despite the possible presence of endogeneity, as it includes and accounts for the lags of both dependent and independent variables. The autoregressive distributed lag (ARDL) model relates a dependent variable to its lags and contemporary and lag levels of all other variables in the model. A typical ARDL (p, q_1…, q_k) could be specified as:

$$y_{it} = \sum_{j=1}^{p} \lambda_{ij} y_{i,t-j} + \sum_{j=0}^{q} \boldsymbol{\delta}'_{it} \boldsymbol{x}_{it-j} + \mu_i + \varepsilon_{i,t} \quad \ldots\ldots\ldots\ldots \quad (1)$$

with the cross-sections $i = 1,2,\ldots,N$; the number of periods $t = 1,2,\ldots,T$; x_{it} is the $k\,x1$ vector of explanatory variables for the group, i, λ_{ij} and δ_{it} are scalars and $k\,x1$ coefficients; and μ_i is the cross-section-specific effects, which are expected to be correlated with individual cross-sections. The error term, $\varepsilon_{i,t}$, is expected to be

independently distributed across i and t, with expected zero means and constant variances. They are also independently distributed by the regressors, x_{it}-a requirement for consistent estimation of the short-run coefficients.

We assume that the relationship between fintech and credit risk, alongside other specified determinants, can be represented by the following equation:

$$Y_{i,t} = \alpha_{0i} + \alpha_{1i}X_{it} + \beta_{1i}K_{it} + e_{i,t};\ i = 1,2,\dots N;\ t = 1,2,\dots,T \quad (2)$$

where $Y_{i,t}$, is the dependent variable (credit risk), X and K are vectors of macroeconomic and bank-specific independent variables, respectively; and $e_{i,t}$ is a white noise error term. If the variables are a combination of $I(0)$ and $I(1)$ series and cointegrated, such that the error term, $e_{i,t}$, is an $I(0)$ process for all i; then, the relationship can be expressed by a dynamic ARDL model.

The dependent variable is bank ratio of non-performing loans to total loans (NPL_{it}) and Bank specific z-score (Z_{it}), respectively, for each model depicting credit and solvency risk, while the regressors include: bank-specific variables, including total assets ($Size_{it}$), operating self-efficiency ratio ($Efficiency_{it}$); macroeconomic variables including economic activity ($Econ_{it}$); and interest rate (Int_{it}) and Fintech Index (FIN_{it}). To cater for outliers, $Size_{it}$ and $Econ_{it}$ were transformed and fed into the model in log form. The definitions and *a priori* expectations of all variables in the model are presented in Table 2 above.

Table 2: Variable Definition

Variables	Definition	*a priori* Expectations (Credit Risk model)	*a priori* Expectations (Solvency Risk Model)
NPL_{it}	The ratio of Non-performing loans to total loans for bank i in month t	Dependent variable	N/A
$SIZE_{it}$	The logarithm of total assets for bank i in month t	-	+
FIN_{it}	Google trend searches on fintech	+/-	+/-
$ECON_{it}$	Economic activity proxied by Manufacturing PMI	-	+
INT_{it}	Maximum Lending Rate in the Banking System	+	+
$EFFICIENCY_{it}$	Operating Self-Efficiency proxied by ratio of Total Income to Total Expenditure for Bank i in month t	-	+
Z-$Score_{it}$[4]	Indicator of Financial Stability for bank i in month t	N/A	Dependent variable

Source: Authors' Compilation

[4] *The z-score was used to proxy financial stability, as it measures banking system stability. It is computed with three important financial soundness indicators: Equity/Assets ratio, the return on assets (ROA) and the standard deviation of return on assets – a proxy for return volatility. The computation could be denoted as follows:*

$$Z - score_{it} = \frac{ROA_{it} + EQA_{it}}{\sigma(ROA)_{it}}$$

4.0 Empirical Findings

4.1 Descriptive Statistics

Inferences from the descriptive statistics show that all the variables are not normally distributed as shown by the Jarque-Bera test for normality. Additionally, the standard deviation, which is used to measure the amount of variation or dispersion of a set of values from its mean, shows that most variables have a low standard deviation, which indicates that variables exhibit a low level of volatility.

In terms of skewness, all the variables except size and economic activity are found to be positively skewed. The kurtosis results show that only NPL, Efficiency, Economic activity, and FinTech Index variables are leptokurtic, implying that they have relatively long tails that might contain outliers and impede the accuracy of the model prediction. Conversely, others variables were found to be platykurtic.

Table 3: Descriptive Statistics

	NPL	Size	Efficiency	Interest Rate	Economic Activity	FinTech Index	Z-Score
Mean	0.11	14.24	1.38	29.01	50.62	56.66	8.10
Median	0.07	14.43	1.35	28.66	49.25	55.50	2.86
Maximum	0.95	17.32	5.61	31.43	62.30	100.00	38.49
Minimum	0.00	10.13	0.00	27.10	25.30	25.00	-1.53
Std. Dev.	0.17	2.27	0.87	1.19	8.01	14.93	9.99
Skewness	3.60	-0.22	0.93	0.57	-0.78	0.75	1.11
Kurtosis	17.29	1.51	5.70	2.35	4.11	3.83	2.91
Jarque-Bera	2091.10	19.57	87.68	14.06	30.08	23.96	40.64
Probability	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Source: Authors' Compilation using Eviews 11.0

4.2 Correlation Matrix

Table 4 presents the correlation between the various variables. For this analysis, the focus would be on the second column and the last row, which present the correlation coefficients between non-performing loans and Z-core, and other variables, respectively. A negative relationship is observed between the non-performing loan ratio and size, efficiency, and the FinTech index.

This suggests that increase in size, enhanced efficiency and increased Fintech awareness are associated with reduction in credit risk. However, a positive relationship is seen between the non-performing loan ratio, interest rate, and economic activity, thus, depicting the negative association between changes in interest rates and credit risk as well as the procyclicality between and economic activity and credit risk.

Similarly, the Z-score was negatively associated with size, efficiency, and the FinTech index over the review period. This suggests that the increase in the assets of neobanks as well as their enhanced efficiency and increased awareness are associated with deterioration of their financial buffers. The Z-score is also directly associated with interest rate and economic activity, thus, insinuating that rate hikes and economic expansion are associated with increased solvency levels of neobanks in Nigeria.

Table 4: Ordinary Correlation Coefficients between Credit Risk Indicators and Regressors

	NPL	Size	Efficiency	Interest Rate	Economic Activity	FinTech Index	Z-Score
NPL	1.00						
Size	-0.17	1.00					
Efficiency	-0.16	0.09	1.00				
Interest Rate	0.14	-0.32	-0.06	1.00			
Economic Activity	0.16	-0.25	0.03	0.57	1.00		
FinTech Index	-0.01	0.15	0.13	-0.41	-0.01	1.00	
Z-Score	0.04	**-0.82**	-0.04	0.29	0.28	-0.15	1.00

Source: Authors' Compilation using Eviews 11.0

4.3 Panel Unit Root Tests

The stationarity of the variables was investigated using unit root tests. Panel-based unit root tests are found to have higher power than individual time series unit root tests (Atoi, 2018). Three standard tests, namely, Levin, et al. (2002), Im, Pesaran, and Shin (IPS) (2003), ADF-Fisher Chi-Square, and Philip Peron (P-P) unit root tests, were employed. The null hypothesis of Levin, Lu, and Chu (LLC) technique assumes a common unit root process, while that of IPS, ADF, and P-P assumes an individual unit root process. The overall results show that all variables are of mixed order of integration. Specifically, all variables except interest rate were found to be integrated of order 0. The mixture of I(0) and I(1) variables suggests using panel ARDL methodology.

Table 5: Panel Unit Root Tests

Variables	Levin, Lu & Chu t*		Im, Pesaran and Shin W-stat		ADF – Fisher Chi-square		P-P – Fisher Chi-square		Order
	Level	First Difference	Level	First Difference	Level	First Difference	Level	First Difference	
NPL	-1.79**	N/A	-2.36***	N/A	32.35***	N/A	61.80***	N/A	I(0)
Size	-7.56***	N/A	-5.79***	N/A	35.37***	N/A	35.61***	N/A	I(0)
Int Rate	-0.45	-5.71***	1.25	-5.99***	6.23	57.99***	6.99	150.23***	I(1)
Efficiency	-1.66**	N/A	-0.21**	N/A	27.01**	N/A	59.07***	N/A	I(0)
Economic Activity	-0.93	N/A	-3.69***	N/A	30.11***	N/A	34.39***	N/A	I(0)
FinTech Index	-3.98***	N/A	-1.65**	N/A	27.08***	N/A	53.27***	N/A	I(0)
Z-Score	-16.84***	N/A	-10.89***	N/A	50.19***	N/A	44.40***	N/A	I(0)

Source: Authors' Compilation using Eviews 11.0

Note: ***, ** and * indicate statistical significance at 1%, 5% and 10%, respectively. Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.

4.4 Panel Co-integration Tests

Following the outcome of the panel unit root tests, which suggests different orders of integration, it is imperative to determine whether a long-run relationship exists among the variables. The Pedroni Residual Co-integration Test is applied to check for co-integration, and the results are presented in Table 6. Different types of statistics, weighted and their corresponding probability values, are examined. From the results, six out of eleven statistics are significant, indicating that the null hypothesis of no co-integration can be rejected at a 5 percent significance level; and conclude that the variables are cointegrated. These imply that the variables have a long-run association.

Table 6: Pedroni Residual Cointegration Test

Alternative Hypothesis common AR Coefs. (within-dimension)				
	Statistic	**Prob.**	**Weighted Statistic**	**Prob.**
Panel v-Statistic	1.2006	0.1149	0.5346	0.2965
Panel rho-Statistic	-1.0348	0.1504	-1.1429	0.1265
Panel PP-Statistic	-2.6215	0.0044	-2.4048	0.0081
Panel ADF-Statistic	-2.1319	0.0165	-2.2179	0.0133
Alternative Hypothesis individual AR Coefs. (between-dimension)				
Group rho-Statistic	-0.2434	0.4038		
Group PP-Statistic	-2.3278	0.0100		
Group ADF-Statistic	-2.0599	0.0197		

Source: Authors' Compilation using Eviews 11.0

4.5 Long-run Results

Sequel to establishing the evidence of the existence of cointegration between variables using the panel cointegration tests, the panel ARDL was estimated. With a focus on the PMG model, the error correction based on an autoregressive distributed lag ARDL (1,1,1,1,1,1) model and ARDL (1,1,1,1,1,1) models were used to identify the impact of FinTechs on credit and solvency risks, respectively, in Nigeria. The Akaike Information Criteria (AIC) was used to select the lag orders of the variables in the parsimonious models, given data availability. It is pertinent that 4 models were evaluated for credit risk model while just 1 model was evaluated for the solvency risk model.

The long-run results from the estimated panel autoregressive distributed lag (PARDL) models are presented in Table 5. From column (1), the measure of credit risk (non-performing loans ratio) is found to have a positive contemporaneous relationship with the size of the Bank. Thus, an increase in the size of Fintechs in terms of total assets leads to higher non-performing loans. This relationship is also found to be statistically significant, therefore, conforming to the theoretical proposition of positive inclusion-stability nexus. Conversely, the bank-specific variable, i.e., efficiency (proxied by operating self-efficiency ratio), is negatively related and significantly affects credit risk. This is in line with a priori expectations as enhanced operating efficiency improves the firm resilience against credit risks.

Furthermore, the interest rate is directly related to credit risk. This conforms to theory as an increase in the cost of borrowing heightens credit risks in the financial system. Specifically, a one percentage point increase in interest rates, ceteris paribus, will bring about 0.02 percentage point rise in the non-performing loan ratio. From the results, a positive relationship is observed between economic activity and credit risk of neobanks in Nigeria indicating that credit risk will intensify as the economy expands. This relationship, though

counterfactual, is statistically significant at 5.0 percent. On average, an increase in economic activity, proxied by manufacturing PMI, leads to 0.1 percentage point increase in non-performing loans. Lastly, the Fintech index, which reflects news bordering the emergence and developments of fintech in the country, is negatively associated with credit risk. This implies that credit risks related to neobanks decline as awareness improves. From column (2), the measure of solvency risk (Z-score) is found to have a contemporaneous negative relationship with the Fintech index, implying that increased awareness and emergence of Fintechs brings about the deterioration of financial buffers. This relationship was also found to be statistically significant. Similarly, an increase in the Size of Fintechs in terms of total assets is found to worsen solvency levels. Conversely, the bank-specific variable, i.e., efficiency (proxied by operating self-efficiency ratio), is positively related and significantly affects solvency risk. This is in line with a priori expectations as enhanced operating efficiency improves the firm resilience against risks.

The macroeconomic variable block's interest rate is inversely related to solvency risk, and this insinuates that an increase in the cost of borrowing heightens solvency risks in the financial system. Specifically, a one percentage point increase in interest rates, ceteris paribus, will bring about -1.2 points reduction in the Z-score of selected neobanks on average. From the results, a negative and sizeable relationship was observed between economic activity and credit risk indicating that solvency risk will intensify as the economy expands. This relationship, though counterfactual, is statistically significant at 5.0 percent. On average, an index point increase in the manufacturing PMI leads to a -7.2-point decrease increase in the Z-score of selected banks.

Table 7: Long-Run Estimation Results

Variables	Model 1	Model 2
	NPL_{it} *[ARDL(1,1,1,1,1,1)]*	Z_{it}*[ARDL(1,1,1,1,1,1)]*
$Size_{it}$	**0.0776*** ** (0.0076)	**-2.5306*** ** (0.4592)
Fin_{it}	**-0.0006*** (0.0003)	**-0.0418*** ** (0.0144)
Int_{it}	**0.0206*** ** (0.0076)	**-1.2087*** ** (0.3147)
$Efficiency_{it}$	**-0.0575*** ** (0.0075)	**0.0457** (0.3293)
$Econ_{it}$	**0.1057**** (0.0312)	**-7.2811*** ** (1.5692)

Source: Authors' Compilation using Eviews 11.0

4.6 Short-Run Results

The results from the short-run dynamics indicate that the feedback coefficient is -0.5134 for the model with credit risk as the dependent variable and -0.1409 for the model with solvency risk as the dependent variable. This development suggests a fast speed of adjustment to equilibrium after experiencing shocks in the case of the former and a moderate speed of adjustment in the case of the latter. In other words, approximately 51.3 percent and 14.1 percent of the disequilibria from the previous month's shocks converge or adjust back to the long-run equilibrium in the current quarter. The short-run response of credit risk to size, fintech index, and efficiency is negative. At the same time, the macroeconomic variables, including the interest rate and economic activity, result in a positive response from credit risk. Intuitively, this implies that a rise in interest rates aggravates credit risk while counterfactually, the economic expansion also heightens credit risk.

Moreso, the short-run relationship between solvency risk and the size of neobank is negative and insignificant. Ceteris paribus, as the size of

the neobank increases, its solvency buffers deteriorate. This outcome somewhat corroborates the long-run results, revealing a negative relationship between variables. Efficiency, another bank-specific variable, is found to improve the solvency position of the banks in the short-run, albeit the association is found to be insignificant. Other variables, such as the fintech index – representing awareness and economic activity- are also positively related to the Z-score. This implies that solvency buffers of neobanks improve as the economy expands and the understanding of Fintechs improves. The relationship between interest rate and solvency is negative. Thus, as the cost of borrowing increases, the solvency positions of neobanks are found to deteriorate.

Table 8: Short-Run Estimation Results

Variables	**Model 1**	**Model 2**
	NPL_{it} [ARDL(1,1,1,1,1,1)]	***Z_{it}[ARDL(1,1,1,1,1,1)]***
ECTt	**-0.5134**** (0.2405)	**-0.1409*** (0.0795)
$Size_{it}$	**-0.0224** (0.0154)	**-2.0233** (1.3475)
Fin_{it}	**-0.0006*** (0.0003)	**0.0132** (0.0097)
Int_{it}	**0.0206***** (0.0076)	**-0.7814***** (0.2837)
$Efficiency_{it}$	**-0.0575***** (0.0075)	**1.4058** (1.1031)
$Econ_{it}$	**0.1057***** (0.0312)	**3.3488** (2.4771)
C	**-0.9337**** (0.4093)	**15.1517*** (8.5407)

Source: Authors' Compilation using Eviews 11.0

5.0 Summary and Conclusion

The paper examined the relationship between fintech and credit risk in Nigeria using the Panel Autoregressive Distributed Lag (PARDL) framework over the period 2018M12-2021M12. Six (6) neobanks, (with state (1) and unit (1) microfinance bank licenses) were examined due to data availability. Inferences from the long-run results show that operating efficiency positively impacts contemporaneous credit risk, implying that enhanced efficiency on the part of fintech led to lower credit risks.

Notably, the size of respective neobanks was detrimental to credit risks, as an increase in the size of neobanks appears inimical to credit risk. Furthermore, the interest rate was found to propel credit risks, which generally is in line with the theory. However, changes in macroeconomic variables, such as economic activity proxied by PMI, heightened credit risks, thus, heightening financial instability. This procyclical relationship between credit risk and economic activity raises some concern for authorities saddled with the task of financial stability.

Similarly, the size of neobanks was also found to be negatively related to solvency risk. Thus, growth in the size of neobanks tends to bring out depletion in the solvency buffers of neobanks. In addition, the fintech index, which represents the degree of awareness and development around the fintech space, and economic activity were also found to be positively related to the Z-score. This implies that solvency buffers of neobanks improve as the economy expands and as the awareness of Fintechs improves. Moreso, interest rate hikes were found to worsen the solvency positions of selected neobanks in Nigeria.

These findings have important implications as policy makers design and implement policy frameworks and measures geared towards

fintechs, particularly neobanks. The paper, therefore, recommends more proactive policies in the direction of fintech regulation, as size negatively affects credit risk. More robust macro-prudential policies around capital, liquidity and operational risk-management requirements should be designed to ensure financial stability and mitigate credit risk amid the impressive growth in neobanks. In addition, regulatory policies such as stipulating lending standards and robust governance schemes, as well as improving prudential guidelines, should be the focus of monetary and prudential authorities.

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Macroeconomic Variables and Bitcoin Volatility: A Direct and Reverse Causation Investigation

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Abstract

This study evaluated the interconnectedness of cryptocurrency volatility and selected macroeconomic variables covering a two year daily series 1/1/2020 to 31/12/2021 (730 observations). Using GARCH (1,1) to extract the volatility series for bitcoin, exchange rate, crude price and stock price, we tested for both linear association and causality of the volatility series. Evidence in favour of positive and significant linear association was found for the swing series of all the variables but a unidirectional causality was only found between crude price and bitcoin volatility. It can be inferred that bitcoin is yet to be fully domesticated precipitating its lack of causation with exchange rate and stock price. The causation with crude price can be explained by the hedging alignment with crude price that is being experimented by investors and traders of cryptocurrency. It is therefore recommended that financial regulators in Nigeria and other developing economies should devise policies to accentuate the economic benefits of cryptocurrencies like bitcoin and others while creating mitigants against its shortfalls.

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Keywords: Crude Price, Exchange rate, Stock Price, Bitcoin, Cryptocurrency and Nigeria.

1. Introduction – Overview of the Cryptocurrency and Blockchain technology

The evolution in the payment system has seen movement from the barter era, to the coinage, paper money, gold-backed issues, fiduciary issues to the prevailing use of electronic platforms and instruments. Cryptocurrency is a product of this evolution. Right from its advent, cryptocurrencies have remained a puzzle in the financial ecosystem from its makeup to the mode of use as well as their roles even in a fast changing financial world.

Following Allen, Gu and Jagtiani (2022), "cryptocurrencies are built on a blockchain, which is an open, distributed ledger technology that can record transactions between two parties efficiently and in a verifiable and permanent way" Allen, Gu and Jagtiani (2022), further highlights the three main types of blockchain to include: private, permissioned and public blockchains[3]. Several forms of cryptocurrencies exist mostly in coins and token[4]. Following Royal (2022) and Rossolillo (2022), a summary of some of the most popular cryptocurrencies and their market volumes are shown in table 1 below:

[3] Private Blockchain requires one gatekeeper, permissioned blockchain needs multiple gatekeepers while the public blockchain which is the platform for bitcoin and most digital currencies function through a consensus mechanism.

[4] Coins are built on its native blockchain whereas tokens are built on existing blockchains. Coins require significant resources and skills to create while tokens are relatively easier to create. Coins are distributed through mining while tokens are distributed through Initial Coin Offering (ICO). Coins are used to store and transfer money while tokens have variety of uses such as security and asset representation. Coins are valid with one merchant while tokens are valid with any merchant that uses them.

Table 1: Summary of Names, Prices and Market Values of Twelve Most Popular Cryptocurrencies

Coin	Price	Total Market Value
Bitcoin (BTC)	$45558	$829 billion
Ethereum (ETH)	$3219	$388 billion
Tether (USDT)	$1.00	$82 billion
Binance Coin (BNB)	$433.97	$72 billion
USD Coin (USDC)	$1.00	$51 billion
Solana (SOL)	$115.31	$38 billion
XRP (XRP)	$0.7771	$37 billion
Terra (LUNA)	$104.23	$37 billion
Cardano (ADA)	$1.08	$37 billion
Avalanche (AVAX)	$86.32	$23 billion
Polkadot (DOT)	$20.26	$20 billion
Dogecoin (DOGE)	$0.1436	$19 billion

Source: Authors' compilation following Royal (2022) and Rossolillo (2022)

It is evident that by market price and value, Bitcoin represents the most popular of the cryptocurrencies. Undoubtedly, most studies on cryptocurrencies have tended to interchangeably use Bitcoin and cryptocurrency. Also, studies on the price and process determination, utility, hedging and investment classification of bitcoin abound in literature on a cross country and country specific basis Xiong (2020). These studies are predominant in developed countries and very sparse in developing countries such as Nigeria. In addition, studies that evaluate the volatility profile of bitcoin is scarce and scarcer are the ones that have related such volatility profile to other seemingly volatile

macroeconomic variables like exchange rate and crude price[5], Halaburda, Haeringer, Gans and Gandal (2021)

Given the above conundrum, this study investigates, firstly, the volatility profile of bitcoin (alongside other volatility-prone macroeconomic variables) as the most popular cryptocurrency. Secondly, the study looks at the co-movement and causal interactions between bitcoin volatility series and those of the volatility-prone macroeconomic variables respectively.

This study has some value additions given that it adds to awareness creation on this emerging issue in the financial ecosystem of not just Nigeria but the world at large. Secondly, crypto evolution and the concomitant innovation to the payment system have the tendency to affect certain macroeconomic variables like oil price, stock prices, inflation and other traditionally volatile economic variables. These tendencies are worth investigating for research, social and policy purposes. Thirdly, the dynamics of the financial system from the global and domestic frontiers must be of interest to government, researchers and economic watchers. It is important to note that the Nigerian economy, like many economies of its ilk, is not estranged from the global financial system neither is it insulated against the shocks and vicissitudes emanating from the global financial environment. Global financialisation and interconnectedness make countries susceptible to activities in global economic spaces. An understanding of this dynamics helps to expose significant economic factors and their interactions in developing economies that have been hitherto neglected in prior empirical conclusions. In specific terms, studies such as this helps in domesticating the ongoing debate in this topical area and helps conclusions to become all-inclusive.

[5] *The price of crude as far as Nigeria is concerned represents a major influencer of key policy decisions especially those that relate to budgeting and appropriations.*

Aside the introduction, the rest of paper is divided as follows: section two reviews some important literature in this area, section three presents the adopted methodology for the study, the penultimate section presents results and some empirical discussions while section five concludes.

2. Review of Related Literature

Literature is replete with studies on cryptocurrencies and their interconnectedness with macroeconomic indicators. It is important to identify certain theoretical constructs that underpin the crypto market and also define its interaction with other market and macroeconomic variables. Factors such as potential bubbles, rampant speculation and volatility, transactions costs, network effect, informational friction, life cycle effects as well as time series momentum effects have been advanced at a time or the other as the drivers of cryptocurrency prices and the spill-over impact on other macroeconomic correlates (See Baumöhl, 2019). These factors tend to address the degree and direction of crypto and its volatility transmission on other traditional variables. Pursuant to this, Sockin and Xiong (2020) developed a model to analyse cryptocurrencies. The model sees cryptocurrency platforms as a constituent of membership established to enable transactions of some goods or services which creates a strong network effect among users with attendant firmness precipitated by market-clearing with token speculators. User appreciation is raised by user optimism of future price appreciation while the risk of breakdown and market fragility are triggered by speculator sentiment usually exacerbated by the tendency of crowding out users. The model goes further to hold that realistic information friction acts as mitigants to the breakdown of the market. In addition, the blockchain transactions are vulnerable to strategic attacks when transactions are recorded on it by miners and this becomes an inhibition to its use by potential miners. Sockin and Xiong (2020) further developed a model for several predictions of cryptocurrency price changes and this have been found to be consistent

with prior empirical documentations. Halaburda, Haeringer, Gans and Gandal (2021) unlike prior authors, looked at the microeconomics of cryptocurrencies with focus on drivers of their prices, supply, demand, and competitiveness. Like many other inventions, the study queried what technological properties allow it to operate, to what uses agents are putting it. The study finds that the market continues to evolve with difficulties in precisely identifying its place in the overall market space. It was further held that cryptocurrencies have evolved in ways that appear incredulous to many. Though it has relied on advances in cryptography, with such technologies as microprocessors, it has been observed that it has scaled some protocols in computer science and existing technology rather than relying upon them.

The findings conclude that though most research has been to explain how crypto work, predictability has been challenging and this disconnect is poised to govern future research in this area over some foreseeable period. Liu, Tsyvinski and Wu (2019) in evaluating the cross sectional expected cryptocurrency returns stressed the necessity of size and momentum of the cryptocurrency market. The study considered a comprehensive list of price- and market-related factors in a conventional market and constructed their cryptocurrency counterparts. Nine of the cryptocurrency factors produced long-term and short-term strategies that had substantial and significant excess returns. In stressing this three-factor model, it was shown that the cross-section of cryptocurrencies can be significantly analysed using standard asset pricing tools in similarity to other asset classes. The study further posited that a parsimonious three-factor model can be constructed with market information that can aid effective pricing strategies for cryptocurrency. Liu and Tsyvinski (2018) conclude that there is no strong connectedness between cryptocurrency returns and those of traditional asset classes like stocks, currencies, and commodities. This erases doubt about the linkage between cryptocurrency and macroeconomic indicators including asset classes

as influencers. Liu and Tsyvinski (2018) held that momentum and investor's behaviour instead of the macroeconomic factors, are the predictors of the returns and volatility of cryptocurrencies.

Aside the theoretical relationships as discussed above, questions have been raised as to what drives bitcoin's returns. It has been argued that it is speculation and some argue that it is motivated by illicit activities (See, Foley, Karlsen, & Putniņš, 2019).

There have also been arguments on the real uses and classifications of bitcoins, some argue that it functions as synthetic money while Selgin (2015) and others flatly disregard it as traditional fiat money. Dyhrberg (2016a) held that cryptocurrency is a mixture of commodity and currency. So many studies have linked movement in exchange rate to the volatility in bitcoin. Several studies have however linked interest rate, movement in crude price and gold prices stock indexes, commodity index as macroeconomic determinants of bitcoin volatility (Corelli, 2018; Trabelsi, 2018; Bianchi, 2018; Kim et al., 2016; Lamon, Nielsen & Redondo, 2017)

In terms of functionality, Urquhart and Zhang (2019) opine that bitcoin has hedging capability and can be used by currency investors for intraday hedging, Dyhrberg (2016b)). Carrick (2016) argued that bitcoin can minimize risk in complementarity with emerging market currencies. This obviously presents it as a new class of financial assets Yermack (2015), Goczek and Skliarov (2019), Glaser, Zimmermann, Haferkorn, Weber and Siering (2014)) Arguments have also been advanced on the ineffectiveness of hedging between cryptocurrencies, exchange rates and other macroeconomic indicators. Kristjanpoller and Bouri (2019). Wu and Pandey (2014) regarded bitcoin as an asset that could strengthen investors' portfolios efficiency and that its highly volatile behaviour and low correlation with other assets can enhance its ability to aid risk-return trade-off in a well-diversified portfolio. (Brière, Oosterlinck, & Szafarz, 2015; Eisl, Gasser, & Weinmayer, 2015).

3. Methodology

Research Design and Data

This study follows the ex-post facto research design. This is a type of research design that is not experimental but focuses on the analyses of pre-concluded events for the purpose of establishing trends and future outcomes. Documented daily bitcoin prices and stock price were obtained from yahoo finance *(coinmarketcap.currency in USD)* and crude prices and exchange rates from the Central Bank of Nigeria Statistical Database, were used for the empirical estimations. The data sets cover the 01/01/2020 to 31/12/2021 making a total of 730 observations. The choice of daily data is based on the fact that daily observations are best measure of volatility given that it does not smoothen out the movement pattern in the series just like low frequency observations do. The data used for this research work was mainly secondary data, quantitative and daily time series. Time series are data sets that follow a natural time ordering or a regular frequency.

Estimation Procedure

Firstly, GARCH (1.1) was used for the extraction of the volatility series with which the core estimation techniques were premised. In addition, the GARCH approach aided the confirmation of the volatility profile of the investigated series. Bitcoin daily series represent the proxy for cryptocurrency given its position as the most popular in terms of volume, value and activity level, macroeconomic variables used include crude price, exchange rate and stock price. The choice of these series was premised on their established volatile nature.

Secondly, the distributional properties of the volatility series were evaluated through the basic descriptive statistics.

The aggregates of interest include the mean, standard deviation, coefficient of variation including skewness and kurtosis[6] which are useful in further showing the volatility properties of the series.

Next, we evaluate the linear association of the volatility series using a bivariate directionless correlation matrix. This is with the aim of determining the possible co-movement between cryptocurrency volatility and crude price volatility, exchange rate volatility and stock price volatility respectively. The test for linear association follows the form specified in equation 1 below:

The second estimation method is the test for linear association following the bivariate pairwise correlation matrix of the form stated below:

$$\frac{N\sum xy - (\sum x)(\sum y)}{\sqrt{\left[N\sum x^2 - (\sum x)^2\right]\left[N\sum Y^2 - (\sum Y)^2\right]}} \qquad Eq.1$$

Where:

N=Number of Pairs; $\sum$xy = Sum of the Product of the pairs; $\sum$x = Sum of the x scores

$\sum$y = Sum of the y scores; $\sum x^2$= Sum of the squares of x scores and $\sum y^2$ = Sum of the squares of y scores

Given that the test is bivariate, x and y will at every turn represent a pair of bitcoin volatility and crude price volatility; bitcoin volatility and stock price volatility; and, bitcoin volatility and exchange rate volatility. The direction and size of the linear association is shown by the correlation coefficient while its magnitude is shown by the t-statistics and the relative p-value.

[6] *While skewness measures the degree of symmetry or departure from symmetry, kurtosis measures the degree of peakedness. We test for a normal skewness as (S=0) and a normal kurtosis of (k=3) with a likely outcome of mesokurtosis (normal distribution), platykurtosis (fat tailed to the left) and leptokurtosis (fat tailed to the right). Essentially, leptokurtosis is a feature of most volatility series.*

Lastly, an estimation of the causal relationship between bitcoin volatility and the investigated macroeconomic variables is done. Following Granger (1969), a causal relationship would exist between bitcoin volatility and the investigated macroeconomic indicators if previous values of bitcoin volatility series determine the current values of exchange rate, crude price and stock price volatility series respectively. In this wise, a bi-directional causality will be said to exist if there is a feedback from the caused variables to the causal variables. In the absence of such a feedback or reverse causation, a unidirectional causality is said to exist. Also, if the lagged values of bitcoin volatility series does not create a causal impact on the macroeconomic series, the conclusion will be in favour of no causality. The test for causality is adopted and the equation follows the form stated below:

$$yt = \sum_{i=j}^{m} \alpha_1 y_{t-1} + \sum_{j=1}^{n} \beta_1 \mu_{t-1} + \varepsilon_t \qquad Eq.2$$

Where y= variable (bitcoin volatility series)
y_{t-1} = lagged values of bitcoin volatility series
The causality test is based on the testing for $\beta_1 = 0$ for every I
For the x variable, the reverse causation is stated thus:

$$Xt = \sum_{i=j}^{m} \alpha_1 x_{t-1} + \sum_{j=1}^{n} \beta_1 \mu_{t-1} + \varepsilon_t \qquad Eq.3$$

Where x= variable (crude price volatility, stock price volatility and exchange rate volatility)
x_{t-1} = lagged values of crude price volatility, stock price volatility and exchange rate volatility
The causality test is based on the testing for $\beta_1 = 0$ for every I

4. Results

From the distributional characteristics of the series, we observe a high degree of variability. As shown in table 2, the coefficient of variation which is the relative standard deviation for all the series are found to be greater than unity (1). This is the first pointer to high spread and variation. This goes to justify our choice of the bitcoin, crude price, stock market and exchange rate series as volatility-prone series.

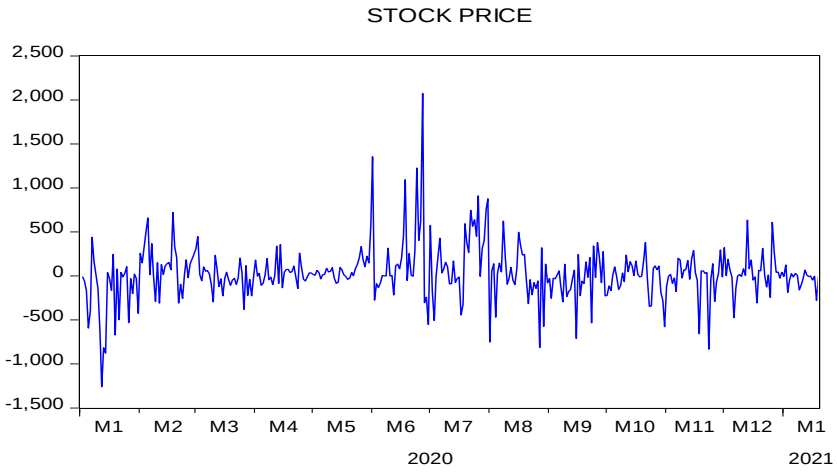
Table 2 – Summary of the Basic Descriptive Statistics of the Investigated Series

Volatility Series	μ	$\mu_{\frac{1}{2}}$	σ	S	K	$\frac{\sigma}{\mu}$
BITCOINVOL	627000000	578000000	132000000	1.80	5.11	0.21
CRUDEVOL	2.44	0.45	7.72	8.55	96.35	3.16
EXRATEVOL	1842.04	4.84	15748.11	9.88	106.00	8.55
STOCKVOL	105996.60	65563.42	123723.20	3.32	18.35	1.17

μ=mean of the volatility series, $\mu_{\frac{1}{2}}$ median of the volatility series; σ standard deviation of the series;
S and K are Skewness and Kurtosis respectively and σ/μ stands for the relative standard deviation or the coefficient of variation.

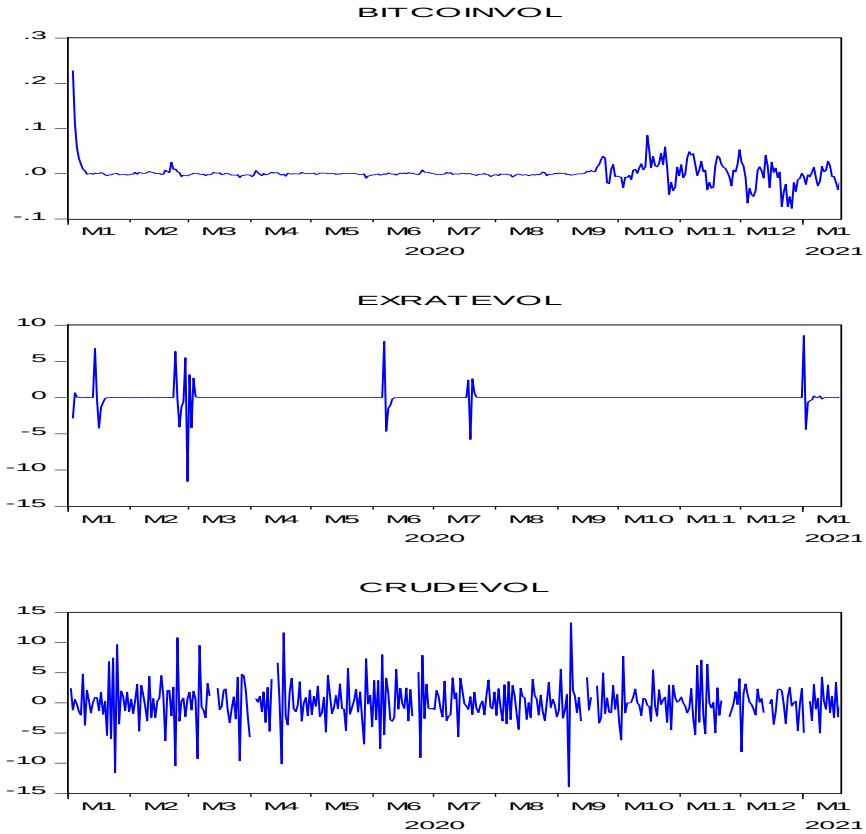
Source: Authors' Estimation

In addition, there is positive skewness (> 0) as well as excess kurtosis (>3) for all the series. This is a sign of volatility as it shows that the distributions are fat-tailed to the right and are leptokurtic. For stock price, Fig. 1 further illustrates the volatility propensity.



Source: Authors' Graph and Chart

It is clear that periods of low volatility (M1 – M5, 2020) are succeeded by periods of low volatility and volatility clustering is further confirmed as periods of high volatility and are succeeded by periods of high volatility (M6 – M8, 2020). Fig. 2 provides supportive evidence of volatility of the investigated series.



Source: Authors' Graph and Charts

Crude price shows greater volatility clustering than exchange rate, bitcoin and stock price. This helps to presume that these assets are in the risk class that should be of investigative interest.

Having established the volatility of bitcoin, the next pertinent question which this study is poised to answer include: Do bitcoins, exchange rate, crude price and stock price co-move? Can causality be established amongst them and what are the likely directions of causality? What are the policy implications of these questions?

Table 3 presents the results of the bivariate correlational matrix of the investigated series which is indicative of their co-movement over the studied period.

Table 3 Summary of Bivariate Correlational Matrix

Volatility Series	BITCOIN	CRUDEPRICE	STKPRICE
BITCOIN	1.000000		

CRUDEPRICE	0.715052	1.000000	
	19.72823	-----	
	0.0000	-----	
STKPRICE	0.687212	0.480086	1.000000
	18.24534	10.55556	-----
	0.0000	0.0000	-----
EXRATE	0.491054	0.152501	0.748603
	10.87223	2.976146	21.77697
	0.0000	0.0031	0.0000

Source: Authors' Estimation

Our results show positively significant co-movement between bitcoin volatility and those of crude price, stock price and exchange rate respectively. While the correlation coefficients for each of the pairs are reported to be negative, the t-statistics and the associated p-value all fall within the region that we can reject the null of no significant correlation in favour of the alternative of significant correlation. It is further observed that crude price shares the higher degree of linear association with bitcoin positing a correlation coefficient of 71%. This is followed by stock price with 69% and lastly with exchange rate at 49%. Though this does not suggest impact of bitcoin on the

investigated series, it is however, symptomatic of the series being in the same risk and volatility class that arguably accentuates their positive and significant co-movement.

Having found some evidence of linear association, a summary of the causality test that seeks to show the presence and direction of causality amongst the series is shown in table

Table 4: Summary of Pairwise Granger Causality Results

Null Hypothesis:		F-Statistic	Prob.
CRUDEPRICE does not Granger Cause BITCOIN		0.10676	0.8988
BITCOIN does not Granger Cause CRUDEPRICE		5.22569	0.0058
STKPRICE does not Granger Cause BITCOIN		1.77541	0.1708
BITCOIN does not Granger Cause STKPRICE		1.24583	0.2889
EXRATE does not Granger Cause BITCOIN		0.38890	0.6781
BITCOIN does not Granger Cause EXRATE		0.68311	0.5057
STKPRICE does not Granger Cause CRUDEPRICE		4.32528	0.0139
CRUDEPRICE does not Granger Cause STKPRICE		1.97201	0.1407
EXRATE does not Granger Cause CRUDEPRICE		8.20003	0.0003
CRUDEPRICE does not Granger Cause EXRATE		1.20722	0.3003
EXRATE does not Granger Cause STKPRICE		4.78561	0.0089
STKPRICE does not Granger Cause EXRATE		3.35306	0.0360

Source: Authors' Estimation

We found evidence in favour of a unidirectional causality emanating from bitcoin volatility to crude price without feedback (F-stat=5.23, p-value0.0058). All the other series share no causal relationship with bitcoin volatility whether of unidirectional or bidirectional dimensions (all their F-stats and p-values are insignificant). Conversely, evidence of causal relationship among the macroeconomic variables are documented[7]. This creates asset class distinction between bitcoin and other traditional financial/economic assets as studied.

Conclusions and Implications of the Study

This study investigated the volatility profile of bitcoin along with other selected volatility-prone macroeconomic variables with the aim of further checking their co-movement and causal linkages. The volatility series were extracted from GARCH (1, 1) process and the simple correlational matrix was used to test the linear association of the series. Also, the pairwise Granger Causality test was adopted to confirm the existence and direction of causality of the volatility series.

Evidence in favour a positive and significant linear association between bitcoin and exchange rate volatility, crude price volatility and stock price volatility, was respectively found. On the other hand, in agreement with Chang, Lo, Cheng, Chen , Chi and Chen(2012) we found no convincing evidence of causality between bitcoin volatility and the other macroeconomic variables except for crude price volatility with a unidirectional causality running from bitcoin volatility with feedback from crude oil price swing.

One key implication of our finding is that the correlation between bitcoin and the macroeconomic indicators may be adjudged coincidental and cannot guide an informed conclusion on bitcoin,

[7] *There is a unidirectional causality between stock price and crude price; exchange rate and crude price; respectively. A bidirectional causality is documented for exchange rate and stock price (See table 4)*

crude price, stock price and exchange rate, being in the same risk class or having the same adjustment tendencies. This largely may be the underdevelopment of the Nigerian financial system unlike the developed system where bitcoins have been used for intraday hedging as observed by Urquhart and Zhang (2019) and Dyhrberg (2016a). There is also less universality of this position as Kristjanpoller and Bouri (2019) argued that traditional hedging between cryptocurrencies and such variables as exchange rates could be ineffective.

On the other hand, the result of the causality tests shows that bitcoin and its volatility does not currently exert causal impact on the exchange rate and stock price of the Nigerian economy. The unidirectional causality found in respect of crude price can be linked to the growing influence of bitcoin in the global market with a likely interconnectedness with such globalised commodities like oil. This is consistent with Jare˜no, Gonz´alez, L´opez and Ramos (2021) whose results show that there is a high degree of interconnection between oil price shocks and cryptocurrency returns especially in periods of crisis. The observed absence of causal relationship with stock price and exchange rate as it relates to Nigeria can be blamed on the dimensionless nature of cryptocurrency and its concomitant activities in the Nigerian financial ecosystem. Though cryptocurrency is being touted and traded in the Nigerian financial environment, there are no regulations and channels to clearly transmit its effects to core and traditional macroeconomic indicators. It is also worthy of note that the government expressed concern over the form and style of cryptocurrency activities in Nigeria, for which reason, its trade and activities were officially banned and formal banking institutions bared from financing it and its related activities.

Generally, this study presents significant implications for market participants across both traditional currencies/stock markets and cryptocurrency markets alike. A firm understanding of the

interconnectedness of different assets and markets, essentially guides investors in determining the appropriate hedging disposition in optimal portfolio construction. This will also provide international portfolio risk managers with the appropriate guidance for more informed and beneficial portfolio diversification.

It is clear that the waves and tides of cryptocurrency is getting stronger and weightier globally, but its impact and transmission effects in developing countries such as Nigeria have remained subdued. This calls for a more deliberate and strategic assessment of this emerging financial trend on the part of the financial regulators, with the aim of creating mitigants against its shortfalls and accentuating its financial and economic benefits. The introduction of central bank form of electronic currencies, stable coins and proper regulation can be the mitigants against the shortfalls of the cryptocurrency evolution.

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Fintech and the Changing Structure of Financial Inclusion: Evidence from Sub-Saharan Africa

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Abstract
Fintech is increasingly changing the structure of financial inclusion, particularly in developing countries, including sub-Saharan Africa (SSA) countries. This study uses the Global Findex Database to assess trends in fintech and the changing structure of financial inclusion in SSA, using content descriptive statistics. The findings indicate that fintech continues to promote financial inclusion by increasing access to financial services through the provision of digital and mobile options for easy conduct of financial operations. However, evidence also showed that increasing access is not directly translating into more usage of financial services, especially among vulnerable population. The findings are compelling to prompt the need for policy actions to take advantage of fintech ecosystems in improving the structure of financial inclusion.

Keywords: Fintech, Changing structure, Financial Inclusion, Sub-Saharan Africa

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1. Introduction

The extent to which financial technology has aided financial inclusion has captivated policymakers, particularly in developing economies, prompting them to embrace technologically induced financial inclusion as a crucial element to economic empowerment and vital in reducing poverty levels. Financial technology, also known as Fintech has resulted in an increase in the number of digital payment platforms, allowing poor people to connect with savings, credit, and insurance providers (McKee *et al.*, 2015; Choi & Ozkan, 2019). While technological advancements are not new to financial service providers, the rate of change in the industry appears to be increasing, as does the pressure on the industry to respond to demands. Beyond reducing the costs of financial service provision, technological advancements have enabled the penetration of financial services to new nonfinancial users. (Beck, 2020). As the importance of financial inclusion to economic prosperity becomes increasingly vital, concerted efforts to remove or at least reduce the obstacles and barriers to formal banking services are required. Likewise, fintech innovation has continued to stimulate efficient provision of financial services, thus paving way for significant financial inclusion, even in developing countries (IFC, 2018). Hence, a Fintech-led approach to financial inclusion has significantly increased the penetration and adoption of financial services, particularly in emerging economies (Ozili, 2021).

In the recent time, financial technology has become a vital factor that is stimulating the expansion of the financial industry in sub-Sahara Africa (SSA). Although, SSA has trailed behind other regions of the world in terms of financial access, the region has emerged ahead of others in mobile money transfer and widespread access to financial services (IMF, 2018).

SSA region now prides itself in similar manner as its comparators in terms of account ownership, access to loan facilities, ATMs usage, and sending and receiving remittances through financial institutions.

Fintech's influence on the market is increasing, and its long-term potential has begun to be explored. Before digital technologies, Sub-Saharan Africa is characterised with an underdeveloped financial sector, with approximately 60% of the adult population lacking access to traditional financial services (IFC, 2018; Ernst & Young, 2019). The high percentage of unbanked and underbanked citizens, combined with a 44 per cent mobile penetration rate, has created fertile ground for Fintech expansion in SSA, making it a major driver of financial inclusion (Ernst & Young, 2019). Fintech is now establishing itself as an enabler of financial inclusion in SSA and an innovation catalyst in other sectors by increasing efficiency in the financial services value chain (IMF, 2018). As a result, the introduction and expansion of digital financial services have allowed an increase in population access to financial services. Overall, Africa now has the world's most digital financial services deployments, accounting for nearly half of the world's nearly 700 million individual users (IFC, 2018).

Despite the leapfrogging that has been seen in financial technology in SSA, from traditional to technology-based banking, and the resulting significant gains of better financial inclusion, the provision of technology in finance services involves the participation and interactions of various players, as well as the regulatory environment, which pose complexities to all participants and thus negate the gains in financial inclusion. Furthermore, because technology is a versatile and ever-changing phenomenon, it necessitates ongoing re-evaluation to ensure that empirical evidence remains relevant. Given the foregoing, the purpose of this research is to provide an overview of the fintech environment and the changing pattern of financial inclusion in SSA. It also highlights recent progress in the literature on financial inclusion and the nexus between fintech and financial inclusion. This lays the groundwork for understanding how fintech companies has fared in terms enabling financial inclusion, ultimately, the structure of financial inclusion in SSA.

Including the introduction, the paper has 5 sections. Section 2 focuses on the review of literature on waves of development in financial inclusion and financial technology. Section 3 describes the data and methodology. Section 4 presents and discusses the findings, while section 5 concludes.

2. Review of Literature

Several pieces of literature on the financial sector and how it has aided financial inclusion have been examined. However, the sector is undergoing a rapid transformation shaped by fintech, which presents a significant window of opportunity to expand financial inclusion, making it apt for discussion. This section, in view of that summarized literature on various definitions and findings related to financial inclusion, financial technology, and the interrelationship between financial technology and financial inclusion.

2.1 Financial Inclusion

2.1.1 Conceptual Definition

The problem of financial exclusion is a common problem among the low-income group of the population (Koku, 2015). Financial exclusion, more specifically, connotes having very limited or lack of access to financial services. This has turned to be a source of concern for both individuals and small and medium businesses, especially in developing countries (Manyika *et al*., 2016). Financial inclusion is the flip-side of financial exclusion. Despite the fact that a plethora of studies have emerged in the field since the early 2000s, the area still remains under-researched (Demirguc-Kunt *et al*., 2017).

In term of definitions, financial inclusion is defined as having access to a basic bank account, which serves a foundation for other financial services (Neelamegam, 2016). According to the World Bank (2017), financial inclusion is ‘the process by which individuals and businesses have access to sustainable financial services for the purpose of transactions, payments, savings, credit, and insurance. Akingbola

(2006) defines financial inclusion as the extension of banking services to the excluded. The term "financial inclusion" refers to the process of making the total and partial financially excluded to have access to formal financial services (CBN, 2013). In a similar vein, Ene (2019) defined financial inclusion as the provision of banking services at an affordable cost, particularly to the disadvantaged who are largely outside the formal banking system. Accordingly, Diniz *et al.* (2012) define financial inclusion as more than just having access to and using financial services. However, access alone to financial services is insufficient to improve consumers' lives (Murthy et al 2019). This is because the expansion of digital credit elsewhere has resulted in late payments, high indebtedness, and payment defaults, particularly among the most vulnerable.

2.1.2 Determinants of Financial Inclusion

Various factors are recognised as determining factors of financial inclusion in the literature. Sahoo (2017) posits that income of the individuals or households is one of the factors that determine financial inclusion. When individuals have regular income, they will be able to operate bank accounts. Individuals with regular incomes tend to own bank accounts, and as such, their incomes become channels of accessing and owning formal bank accounts. Thus, individuals with regular income have higher tendency to own and operate formal bank accounts than those with irregular source of income. Ahmed and Jianguo (2014), found that collateral and high rates of interest inhibit access to financial banking. Lapukeni (2015) also found that penetration of information and communication technology (ICT) increases financial access due to reduced transaction costs and coverage.

Oyaro, (2019) established that both demand-side and supply-side factors determine financial inclusion. The demand-side factors are related to income, level of education, employment, gender, etc. The supply-side factors are high rates of interest, level of innovation, bank

spread, sensitisation of financial products, etc. Wang and Guan (2017) also discovered that mobile phone ownership and an internet access have an impact on financial inclusion while literacy rates also play an important role in achieving financial inclusion. Financial inclusion, as stated by Okorie (2017), goes beyond traditional financial intermediation. According to the study, several elements were involved, including: savings products tailored to the income pattern of the poor; financial transfer services; platform for the mobilization of savings; and credit provision, among others.

Different researchers have come up with different findings and conclusions on the determinants of financial inclusion in Africa. Olaniyi and Adeoye (2016) look into the factors that influence financial inclusion in Africa. The study found that income per capita, wealth (percent of GDP), literacy, access to internet, and Islamic banking influence financial inclusion. In contrast, the study discovered that domestic credit by financial sector, deposit interest rates, inflation rate, and population have no impact on financial inclusion. A study (Chikalipah, 2017) found that illiteracy is the most significant barrier to financial inclusion in the SSA. Assuming *et al.*, (2019) analysed the determinants of financial inclusion in 31 SSA countries with data from 2005 to 2014 from the global Findex database. Wealth, age, gender, the growth rate of GDP growth rate, financial institutions presence, and Business Freedom, have impacts on financial inclusion.

2.2 Financial Technology (Fintech)

2.2.1 Conceptual Definitions

The concept of Financial Technology is arguably the most significant development that occurred to the banking industry of the twenty-first century. It has enabled banking to take place outside of traditional banking locations. Technical and smart devices such as mobile phones, ATMs, point-of-sale systems, computers, and tablets, among other electronic devices, are now used to conduct banking transactions such

as fund transfers and receipts, balance inquiries, airtime purchases, bill payment, and account opening (Moddibo, 2018).

The term financial technology (fintech) is widely credited with being coined in a Citigroup project in the early 1990s (Gimpel *et al.,* 2018). Until today, the exact definition of Fintech has remained ambiguous, and there does not appear to be a general agreement on what it is. Gabor & Brooks (2017) defined fintech as companies that use modern technologies to run a business model in the financial services field, whereas others use the term to refer to the entire industry (Kim *et al.,* 2016). New digital technologies will level up the new financial products and cost-effective products. After analyzing various definitions, Schueffel (2016) proposes to define it as a new financial industry that applies technology to improve financial activities. Gimpel *et al* (2018) characterises fintech as "digital technologies such as the internet, mobile computing, and data analytics used in innovating or disrupting financial services. Also, the emergence of big technology firms into the financial market is added to the concept (AFI, 2018).

2.2.2 Traditional Financial Institutions and FinTech Actors

Having come up with a different definition of Fintech, researchers have also differentiated it from the traditional financial institutions. Traditional financial institutions are distinguished by Siering *et al.,* (2017) from Fintech companies as start-ups and IT companies in the financial service industry. Nicoletti (2017) goes on to say that the inefficiencies found in traditional institutions are driving the creation of Fintech companies. Fintech companies, in comparison to conventional financial institutions, have a greater ability to enable the adoption of financial services, allowing for flexibility across a range of financial services (Lee & Shin, 2018).

Leong *et al.,* (2017) examined the development of a Fintech amidst financial turmoil and their findings show that digital technology

provides a company with the strategic ability to occupy the financial market and create financial inclusion for formerly exempted sectors of the market. Excessive guidelines and requirements, risk management, amongst others have caused financial industries to provide services at higher costs, resulting in deteriorating customer relationships. All these barriers, coupled with the emergence of technological innovations prompted the need for alternatives to the traditional financial services (Gulamhuseinwala, *et al.,* 2017; Kagan, 2020). Fintech companies have identified ineffective parts of the financial industry value chain that provide inferior services in the traditional system and leveraged on these to provide innovative services (Ghahroud, Jafari and Maghsoodi, 2021).

In another development, researchers have also examined the development of a Fintech company by analysing the various actors who make up the industry. Fintech companies, according to Seiring *et al.*, (2017), primarily operate in digital financing, investments, digital advice and digital money. Fintech firms also adopts a variety of technologies like, blockchain technology, big data analytics, and social media networks to enable their financial activities (Siering *et al.*, 2017). Internet of Things (IoT), cloud computing, artificial intelligence (AI), and robotics are also important technologies for Fintech companies, Nicoletti (2017). Security, intuitive user interfaces, and mobile device technologies are all important for enabling the deployment of these key technologies (Siering *et al.*, 2017). As analysed in Ghahroud, Jafari and Maghsoodi (2021), all fintech companies are categorised into seven (7): digital lending, digital payments, digital money transfer, digital personal finance, digital equity financing, digital consumer banking and insurance. According to them, financial technology companies are changing the lending process by making loans directly to customers, allowing people send money to one another without needing to turn to banks, offering faster, less expensive international money transfers, offering financial advice and helping customers with budgeting. Today,

financial technology companies are transforming equity financing, making it flexible for businesses to generate capital. These businesses can also reach underbanked customers and provide insurance services by utilizing new technologies such as apps to reach customers who are underserved by insurance.

2.3 Fintech and Financial Inclusion

A review of digital financial services literature revealed that Fintech can influence financial inclusion, depending on a variety of factors such as the type of technology, infrastructure, target market, and geographic location. Fintech's effects on financial inclusion, on the other hand, are more pronounced in developing countries due to significant population of the unbanked or underbanked. Using Brazil as a proxy, Joia and Cordeirov (2021) investigate the potential of fintech to enable financial inclusion in emerging markets using a Delphi approach involving fintech professionals. According to the analysis, there are three domains where Fintech can have potential impact on financial inclusion. First, fintech can capture the cohorts of people without a bank account in the traditional financial market. Second, fintech can reduce costs of financial services due to increased competition. Financial inclusion in an economy is influenced by innovations, according to Yawe and Prabhu (2017) and both financial and telecommunications innovations were investigated. Agent banking and mobile banking, in particular, have been identified as financial inclusion facilitators.

Furthermore, innovative services are being accelerated by ICT the way ICT infrastructure is making innovative services possible at a faster rate than ever before (Joia and Cordeirov, 2021). The increased penetration of mobile phones is one aspect of ICT in the context of Fintech. As more people acquire mobile phones and internet access, a variety of fintech solutions have emerged, including mobile money, which allows users to send money, save money, and make payments using their phone (Gabor and Brooks 2017).

3. Data and Methodology

The focus of this study is to analyse trends in financial inclusion in sub-Saharan Africa, and how Fintech is contributing to its changing structure over time. As such, the study used a descriptive analytical approach leveraging on available survey data on the subject matter. The most comprehensive available secondary dataset for examining trends in financial inclusion is the Global Findex data sets collected by the World Bank. The data sets consist of survey data collected in three rounds of survey in 2011, 2014 and 2017. However, the latest round, conducted in 2017, consists of indicators that better capture the extent of usage of digital financial services, a proxy for financial technologies (Fintech). The data sets also capture financial inclusion variables such as the ownership of financial account. Others include, the extent of usage of these accounts, measured by formal/informal savings and borrowings indicators, and channels used to send and receive remittances. Respondents who reported having no financial account were further asked to provide reason for not owning an account.

Furthermore, indicators for capturing respondents' usage of digital financial services cover using phones or internet to perform basic financial transactions such as to monitor their financial accounts or check account balance, send money online, payments of bills or making purchases online, and digital payment of utility bills. These statistics were also provided across a wide range of demographic characteristics.

We explored this data set deeply and identified indicators that better captures our research interest. We relied on average statistics across the countries for our discussion on SSA. The averages were derived from 41 sub-Saharan countries with available indicators. Our measure of financial inclusion covers both accessibility and usability of financial services. Access was captured using level of ownership of financial accounts including both traditional bank accounts and mobile money accounts. Indicators for usage of financial services include

respondents' savings and borrowing behaviours (whether they save and borrow money using formal and informal channels) as well as usage of financial technology services (access account using phone or internet, send money online, pay bills or buy something online). These statistics were analysed using content descriptive statistics. This is because the Global Findex data sets were made publicly available in processed form and not in its original raw form. The data collected through the survey had gone through some processing, and percentages of responses were reported. We present these statistics using tables and charts, focusing on trends across the years covered, and discussed extensively.

4. Discussion of Results

4.1 Pattern of Financial Inclusion in sub-Saharan Africa

In the course of discussing how Fintech has contributed to the changing structure of financial inclusion from the sub-Saharan Africa experience, it is important to begin with a synopsis of the financial inclusion pattern in the region. Table 1 therefore presents the highlights of the pattern of financial inclusion for the sub-Saharan Africa average for 2011, 2014 and 2017. The table gives the first clear evidence regarding the level and pace at which citizens and businesses who hitherto have been excluded from financial system are being integrated into it. Indeed, inclusiveness in SSA countries financial system provides opportunities for connecting with their local economies as well as the global one. By extension, this has ample implications for growing businesses, improving livelihoods, employment generation as well as poverty eradication.

Undoubtedly, one of the first basic steps in getting included in the financial system is registering and owning a financial account. Owning an account is a prerequisite to being able to operate in the financial space to save money, access credit, save and receive money, pay utility bills and perform all other financial transactions outside the traditional physical monetary exchange. The account could be a financial account

in regular banks and other financial institutions, and it could be a mobile money account made possible by the advent of financial technologies. Therefore, in terms of account ownership, the result showed that 23% of respondents in SSA reported to have opened an account in a bank or other financial institutions in 2011. This figure increased to 34% in 2014 and further rose to 43% in 2017 which includes ownership of mobile money accounts, showing a clear upward trend in account ownership in the region. Between 2014 and 2017, ownership of accounts in banks and other financial institutions increased from 29% to 33%, while ownership of mobile money accounts also rose from 12% to 21%. The 2017 account ownership figure which stands at 43%, although impressive, but still appears low, especially in comparison with other regions of the world, because it implies that more than half of the population in SSA still do not have any form of financial account.

However, in terms of usage of the financial accounts to save and borrow money, there is still much reliance on informal methods and channels. Respondents in SSA who reported to have saved money through formal and informal sources stood at 14% and 19% respectively in 2011. This figure had risen to 15% and 25% respectively in 2017. Although the proportion of respondents who accessed informal credits dropped from 40% in 2011 to 31% in 2017, this did not translate into significant increase in the usage of formal channels for sourcing credits, as borrowing from formal sources only increased marginally from 5% to 7% within the period. These findings give an indication that while there has been more ownership of financial accounts as a result of fintech, the same cannot be said of operating the account especially to save and borrow money. This further reinforces the increased reliance on traditional informal arrangements for saving and borrowing in developing countries. Also, 51% of respondents in SSA reported in 2014 that it was possible for them to raise emergency funds when the need arose, but the figure dropped to 43% in 2017. As regards remittances, the figures for 2014

and 2017 are not markedly different, although there were slight drops. 37% of respondents had received remittances in 2014, while 33% received in 2017. Of those who had received remittances in 2014 in SSA, 70% got it in cash, only 21% received it in a financial institution account while none of them got it through a mobile money account. Furthermore, only 7% of respondents had received transfer payment from government in both 2014 and 2017.

Regarding comparisons across countries in SSA, Mauritius had the highest rate of account ownership. The country boasts of 90% of its respondents reported to own any form of financial account in 2017, up from 80% in 2011. Disaggregating account ownership by type of account, 89% of respondents in Mauritius own a financial institution account while only 6% own a mobile money account in 2017. Kenya and Namibia complete the top-three countries with the highest rate of financial inclusion in SSA with 82% and 81% account ownership respectively (Global Findex, 2017). Uganda and Zimbabwe sit at distant fourth and fifth with respective 66% and 55% account ownership. However, Kenya leads the way in mobile money account ownership with 70% in 2017, followed by Uganda with 59% mobile money account ownership and further followed by Gabon and Namibia with 44% and 43% respectively.

Table 1: Financial Inclusion Pattern in Sub-Saharan Africa (2011, 2014 & 2017)

Year	Own an Account			Saved Money		Borrowed Money		Emergency Funds		Sent Remittances	Received Remittances	Received Government Transfer
	All	FA	MMA	Formal	Informal	Formal	Informal	Possible	Not Possible			
2011	23	23	-	14	19	5	40	-	-	-	-	-
2014	34	29	12	16	24	6	42	51	47	25	37	7
2017	43	33	21	15	25	7	31	43	54	24	33	7

Note: - means missing data, FA means accounts in banks and other financial institutions, MMA means mobile money account
All data in share of respondents (%)

Source: 2017 Global Findex Database

Respondents who reported having no account were further asked to provide reasons for not having any form of financial account (see Figure

1). Cost-related issues rank highest among the reasons provided, as 73% of respondents in sub-Saharan Africa (on average) reported that they do not have an account because of insufficient funds while 27% reported that financial services are too expensive. About 27% of respondents also ascribed their non-ownership of financial account to the far distance of their houses to financial institutions, 25% do not have an account because they do not have the required documents, while 14% noted that they do not have an account because they have no trust in financial institutions. Another reason for not having financial account in sub-Saharan Africa is related to lack of knowledge and exposure as well as religious beliefs. 11% of respondents do not have an account because someone in the household already has one, some do not have any account because of religious beliefs (6%) while others belief they do not need any financial account (1%).

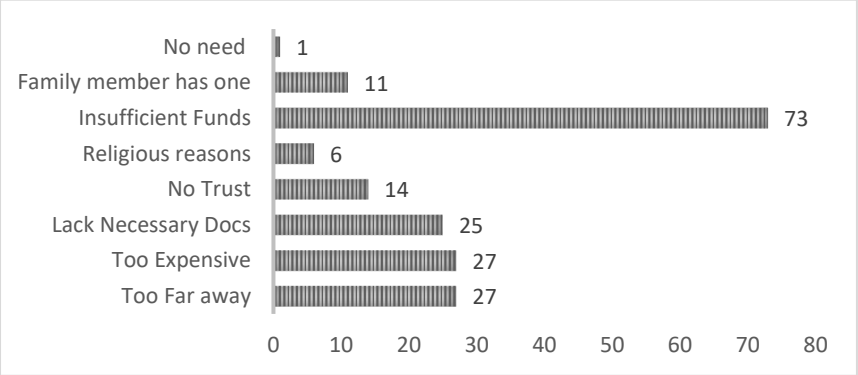

Figure 1: Reasons for not having a Financial Account[1] (2017)

[1] conditioned on not having an account

All data in share of respondents (%)

Source: 2017 Global Findex Database

4.3 Pattern of Usage of Financial Technology (Fintech) Services in Sub-Saharan Africa

Table 2 presents the pattern of usage of financial technology services in sub-Saharan Africa. Specifically, the table showed the extent of usage of digital channels to perform basic financial transactions such as accessing accounts on phone, online purchase or payment of bills, receiving remittances into account instead of in cash and making withdrawals using the ATM instead of bank teller. In sub-Saharan Africa generally, the results showed increasing usage of financial technology services. The percentage of respondents who reported to have made an online payment increased from 23% in 2014 to 39% in 2017, while those who either paid bills or bought something online also increased from 2% to 8% between 2014 and 2017. The share of respondents who reported receipt of remittances into account also increased from 37% in 2014 to 51% in 2017 while those who got remittances in cash fell from 39% to 22% within the period. Usage of bank tellers to make withdrawals is also becoming less popular in the region as respondents who reported using bank tellers for withdrawal

dropped from 43% in 2011 to 35% in 2014, while usage of Automated Teller Machine (ATM) increased, although marginally, from 51% to 54% between 2011 and 2014. Although there are missing data for some countries, but respondents in Kenya have the highest rates of usage of financial technology services in SSA (Global Findex, 2017). They are the most likely to connect with their financial accounts using phone or the internet. They also have the highest likelihood of making online payments or purchases. Furthermore, respondents in Kenya also receive remittances into their account more frequently. Coincidentally, the country also has one of the highest rates of national identity card ownership, a strong requirement for opening financial accounts, both in regular banks and on mobile money devices. Across all the countries, it is not unexpected that online purchases and payment of bills recorded the least usage of fintech services. It goes to underscore that there is still higher preference for physical shopping and in-person payment of bills in sub-Saharan Africa.

Unsurprisingly, countries with the least account ownership statistics such as Burundi, Central African Republic and Madagascar are also the least likely to use financial technology services (Global Findex, 2017). They are the least likely to make digital money transfer, online purchases and payment of bills and receipt of remittances into financial accounts. It is however surprising to find that Madagascar has one of the highest rates of ownership of national identity cards but lowest access and usage of financial accounts, which means that these countries are still underserved in terms of financial technology services.

Overall, the results provide visible and relatable affirmation that while advanced fintech ecosystems engender higher financial inclusion by increasing accessibility to financial technology services, it may not directly lead to adoption and usage of those services. This is relatable with the findings of Kumar *et al.,* (2019) that demand-side issues that affect adoption and usage of financial services are more critical than

supply-side efforts to ensure availability of and accessibility to financial services.

Table 2: Pattern of usage of Financial Technology Services in SSA (2011, 2014 & 2017)

Year	Has a national identity card	Use phone or internet to access financial account	Made online payments	Use internet to pay bills or buy something online	Received Remittances		Main mode of withdrawal	
					Account	Cash	ATM	Bank Teller
2011	-	-	-	-	-	-	51	43
2014	-	-	23	2	37	39	54	35
2017	69	24	39	8	51	22	-	-

Note: - means missing data
All data in share of respondents (%)
Source: 2017 Global Findex Database

4.4 Pattern of usage of Financial Technology (Fintech) Services in Sub-Saharan Africa across Vulnerable Populations

In Table 3, the financial inclusion indicators and usage of financial technology services for vulnerable groups are compared with those of less vulnerable population to digital financial services. As expected, older people (aged 25years and above), males, more educated (above primary education) and the richest people have higher chances of being financially included than their respective counterparts across all indicators of inclusion. They have greater likelihood of owning and operating bank and mobile money accounts, to have savings, be able to raise emergency fund, have more access to credits, and to send remittances. This result is the same with the findings of other studies that richer and more educated adults are more likely to be financially included (Fungáčová & Weill, 2015; Zins & Weill, 2016; Allen *et al.*, 2016; Datta & Singh, 2019). Table 4 also shows that the less educated and the poorest are more disadvantaged in using fintech services. They are less likely to access their financial accounts on mobile phones, to

make digital payments, to make online purchases and to receive digital payments. The poor and the less educated are less likely to send and receive remittances, explainable by the fact that they have less finances and possess less human capital. The younger population match up well with their older counterparts in usage of fintech services explainable by their exposure to information and communication technology, but the gender gap remains across all access and usage measures of financial inclusion and financial technology services, which is in agreement with the findings of Fungáčová and Weill (2015) and Zins and Weill (2016).

Table 3: Pattern of usage of Financial Technology Services in SSA by Demographic Characteristics (2011, 2014 & 2017)

Indicators	Young popn (15-24 years)			Older popn (25+)			Male			Female			Less Educated (pry or less)			Better Educated (sec or more)			Poorest 40%			Richest 60%			Rural Dwellers		
	11	14	17	11	14	17	11	14	17	11	14	17	11	14	17	11	14	17	11	14	17	11	14	17	11	14	17
Financial Inclusion																											
Owns a Bank Account	17	20	26	23	36	37	23	36	38	21	25	27	11	17	22	34	46	50	11	13	23	23	36	39	13	20	30
Saved money in the last year	-	50	55	-	67	57	-	65	57	-	55	57	-	57	48	-	66	66	-	59	47	-	66	59	-	55	55
Has borrowed in the last year	-	48	44	-	58	46	-	54	48	-	54	43	-	53	43	-	57	49	-	54	43	-	54	47	-	54	46
Can raise emergency fund	-	44	41	-	55	45	-	54	49	-	43	38	-	43	33	-	55	55	-	43	32	-	55	51	-	44	44
Received remittances	-	33	34	-	38	33	-	33	33	-	33	32	-	32	25	-	44	44	-	33	27	-	43	31	-	33	33
Sent remittances	-	22	25	-	33	30	-	32	34	-	22	24	-	22	20	-	34	40	-	22	20	-	33	34	-	22	22
Digital Financial Inclusion																											
Owns MMA	-	10	20	-	31	21	-	30	23	-	10	18	-	19	15	-	13	30	-	8	15	-	14	25	-	11	19
Received Digital Payments	-	15	22	-	24	27	-	23	29	-	18	21	-	12	18	-	33	39	-	13	18	-	26	30	-	18	23
Digital Financial Services Usage																											
Access mobile or online banking	-	-	20	-	-	21	-	-	24	-	-	18	-	-	14	-	-	31	-	-	15	-	-	25	-	-	19
Made digital payments	-	17	26	-	26	31	-	26	34	-	19	25	-	14	18	-	34	45	-	14	20	-	29	35	-	20	26
Use internet to pay bills or buy something online	-	28	37	-	37	40	-	31	40	-	25	34	-	14	24	-	41	53	-	14	24	-	33	40	-	26	36
No deposit/withdrawal from an account	-	55	56	-	66	65	-	65	65	-	56	56	-	55	55	-	76	66	-	66	55	-	66	66	-	55	55
Debit card ownership	11	12	14	16	21	20	16	21	22	13	15	14	5	7	8	23	37	32	7	10	11	19	32	22	12	15	16

Note: - means missing data
11, 14 17, means 2011, 2014 & 2017 respectively
All data in share of respondents (%)
Source: 2017 Global Findex Database

5. Conclusion

This study used the 2017 Global Findex data to explain trends in fintech and the changing structure of financial inclusion in sub-Saharan Africa. We acknowledge limitation in the data to cover latest developments, especially the COVID-19 pandemic, but the data gives clear evidence of the dynamics of financial inclusion in the region.

Overall, we found evidence that fintech is positively changing the pattern of financial inclusion in sub-Saharan Africa, especially in providing digital platforms for easy conduct of financial services. Indeed, the results show that the emergence of fintech is contributing positively to increasing financial inclusion through improving access, but it is not directly translating into adoption and usage. This is even more pronounced among disadvantaged and vulnerable groups who are shown to be less likely to benefit from the financial inclusion opportunities offered by fintech ecosystems. Although many of the barriers to financial inclusion have been addressed by financial technologies, however, some demand-side issues keep hampering the level at which these financial technologies improve adoption and use of financial services. This underscores the important need for urgent robust policy intervention measures that will address these bottlenecks especially as regards issues of trust, cost and knowledge.

In many sub-Saharan African countries, lack of trust in the conventional system of banking remains a serious factor accounting for low levels of account ownership and usage of already opened accounts. For instance, countries like Mauritius, Namibia, South Africa and Zimbabwe have high levels of account ownership but low levels of formal savings, attributable to low level of trust and confidence in the financial system. There is persistent usage of cash as the major channel of delivering remittances rather than through financial accounts. Also, people in these countries continue to rely on informal channels for borrowings, which could be attributed to high cost of borrowing and maintenance of financial accounts. Furthermore,

personal and religious beliefs also deter people from operating financial accounts.

Policy interventions will have to take these heterogeneities into account in developing measures to improve and deepen financial inclusion in the region. From the perspective of cost, a plausible option is to increase competition among providers of financial services by enabling entrance of new players in the financial space. Reducing entry barriers will ensure easy entry of new financial service providers which will result in increased competition and broader range of innovative financial services which will have a wider reach, even at reduced cost.

In addition to diversification of financial service providers, interventions should also include stronger safety measures for increased consumer protection to improve trust in the financial system by ensuring that information and assets of customers are kept safe. This is important to protect those who are very susceptible to fraud and scam. This can also include the involvement of financial service providers in organizing financial literacy programs for customers about the usage of digital financial services. Such programs should target improving ability to make sound and objective financial decisions, choosing appropriate financial service products to improve financial security and resilience. This would also be particularly useful for the less educated and other disadvantaged groups in overcoming their trust issues in the financial system and in dropping some of their personal and religious beliefs against the use of financial services.

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Synthetical Evaluation of the Evolution of Crypto and Digital Currency in Global Payment Platforms

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Abstract

This study was set with the purpose of tracing the evolution of the payment system from barter era to the current dispensation of digital currencies and signposting the impact of such developments in managing the contemporary payment system. T*he study adopted the review approach with the aim of taking a position on the cryptocurrency and currency digitisation revolution. It follows the synthesis review research design as it merged several subtopics in the process of arriving at a position on the place of the digital payment system. It is discovered that the regulatory and other challenges of cryptocurrency have triggered a tidal wave of Central Bank Digital Currency (CBDC) across the world with the view to mainstreaming digital currencies and assets for the imperatives of monetary system control and management. It is therefore recommended that the perception dichotomy about cryptocurrencies be bridged, and due regulation put in place to maximise the benefits of the cryptocurrency evolution while checking its negativities.*

Keywords: Bitcoin, Cryptocurrency, CBDC, Payment System and Digital Currency

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1. Barter to Commodity Money, Paper Money and Digital Currency

There is currently an estimated $40 trillion volume of money in circulation in the current fiat issue or paper money globally (Scotts, 2022). That has not always been this way, money has transitioned from one form to the other and arguably no invention or commodity has experienced as much evolution as money has done over the centuries. It has been from barter to commodity money, bank notes and then the nascent digital money under which bitcoin is categorised. Money always has value. Beattie (2022) opines that money, regardless of the form (seashell, metallic, paper, or electronically mined computer code), has an assigned value. It all depends on the importance attached to it as a medium of exchange, a unit of account, store of value and measure of value.

Money in one form or the other has been part of man's existential journey for not less than 5000 years (Zeitlin, 2020). Before the advent of money, goods and services were exchanged for goods and services and this is popularly known as trade by barter. This medium of exchange was discarded as a result of some difficulties[4] that were associated with it.

The need to address the difficulties associated with barter trade led to the search for alternative media of exchange. Deliberately, one form of currency or other emerged over the centuries. These included such items as cowrie shells, manila, animal skins, salt, etc (NOVA Online, 2022). Over time, such other precious metals like gold, silver and brass joined as some forms of media of exchange (NOVA Online, 2022). Though their introduction greatly ameliorated the challenges associated with barter, they also had such issues as not being portable, of indivisibility, difficulty in creating units of accounts etc (Serge and Clement, 2019).

[4]*Notable amongst the difficulties were measurement problems, coincidence of wants, indivisibility of transactions and others.*

Some efforts at addressing this conundrum brought in coinage as the first attempt at officially minted currency. In the turn of the century, a group of Chinese archaeologists from the State University of Zhengzhou made an intriguing discovery about the world's oldest dated coins minting site in Guanzhuang in Henan Province, China, allegedly traced to periods around 640 BCE. Another account ascribes the first metal coinage to the Lydians which was known as the "Lydian Skater" around sixth century BC. The Greek poet, Xenophanes, held that Lydia's King Alyattes minted what is arguably described as the first official currency (Global Times, 2021)[5].

Owing to difficulties associated with portability and ease of carriage, the need to transit to paper money became even obvious. The Chinese were also touted to be the first to move from coins to paper money around 700 CE. An account has it that Marco Polo—the Venetian merchant and explorer, in around 1271 and 1295 CE on a visit to China, saw the Emperor of China with varied denominations of paper money (Arslanian, 2022). There was threat of counterfeiting as the notes bore warnings against currency counterfeiters in a manner similar to the US dollars inscription of "In God We Trust" (Arslanian, 2022).

While China had then transited to paper money, Europe largely kept to the use of metallic money until the 16th century. The enabler for the sustained use of coinage in Europe was the acquisition of new colonial territories that made new sources of precious metals continually available. The issuance of promissory notes as was the case with the

[5]*Electrum which is a mixture of silver and gold, was used in minting the coins. The coins were denominated and provided a trade stronghold for Lydia which made the country one of the richest in Asian minor then.*

London Goldsmiths[6] enhanced the use of paper banknotes for depositors and borrowers which were used for exchange and ultimately proxied for coins (Arslanian, 2022). These notes became progenitors for currencies as it is in the modern world. The notes and coins were issued by private institutions with non-existent regulatory formations. This made unhealthy rivalry inevitable and lack of control a pervasive feature of the payment system.

The newfound payment/exchange system intensified the development of trade across the borders. Banks and the ruling classes started intra-national and international trading on currencies which birthed the first currency market. The political, social and economic stability and dominance of kings, queens or emperors and even governments shaped the value of the country's currency including the trade advantages of such countries in the international market. International manoeuvring and competition among nations led to currency wars. Challenging countries could manipulate the value of another country's currency by undue upward valuation aimed at making the enemy's goods too dear, reducing the enemy's buying power by driving the currency too low or by eliminating the currency completely. With the increasing spate of currency wars, the need to harmonise the payment systems on a global scale led to the emergence of such international payment systems/agreements as the gold standards, the Bretton Wood Agreements and others (Schwartz, 1987).

Prior to World War I, the international monetary system followed the preferences of the relative countries. Whether it was metallic money, bimetallic monetary system, commodity standard, use of gold or silver, all depended on what the individual country wanted.

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[6]*Around 17th Century when the London Goldsmith started express acceptance of deposits for the purposes of relending. The notes they issued later became assignable instruments which were used as notes for the purposes of exchange.*

In the closing stages of the nineteenth century, came the gold standard where currencies were backed by specific weight of gold reserves. The major benefit of the gold standard included access to capital markets in London, Paris, or Berlin. This represented a vital source of funds for emerging countries. Conversely, acquiring sufficient gold backing for currency issues created some form of insurmountable cost for the countries. Many countries had to borrow locally and internationally to get gold. The cost of borrowing created a debt standing that eroded the benefits of accessing funds through the capital market (Schwartz, 1987).

The defects of the gold standard led to the 1944 Bretton Woods Conference that presented professional views on remediating the shortcomings of the gold standards and other subsisting payment systems.

The aims included, among other things, the following:

- Avoidance of the protectionist trade policies.
- Exchange controls.
- Checking competitive currency depreciation.

These were to be achieved through:

- Trade liberalisation using fixed exchange rates system which will help adjustment of parities and contain fundamental disequilibrium.
- Addressing temporary balance of payments deficits using lending facilities of the International Monetary Fund. (IMF).
- Supplementing IMF members' gold and foreign exchange reserves by providing international liquidity.

The United States served as the reserve currency country with other currencies pegged against the dollar. Stable economic policy in the United States was to be the denominator for stable economic policy worldwide (Paul & Lehrman, 1982; Mundell, 2000).

Given the explosive development in information and communication technology, the 21st century has given rise to two developments of interest in the payment and currency systems. These are mobile payments and virtual currency. While mobile payments are described as broad based electronic payment platforms such as the use of Automatic Teller Machines, Web platforms, Point of Sales terminals, money transfers platforms and other integrated internet based payment systems, virtual currency has come to take centre-stage since the release of the Bitcoin in 2009 by Satoshi Nakamoto, and others following it, like the stable coins, and Central Bank Digital Currencies (CBDC). In November 2021, the total value of bitcoin stood at $1 trillion, or about 3% of all of the world's official money (Beikverdi and Song, 2015). Virtual currencies are not physical but their appeal lies in lower transaction fees (costs) unlike traditional online payment channels. Their operations are decentralised unlike government-issued currencies (Beikverdi and Song, 2015). Evidently, the history of money continues to unfold from barter to manilas, cowrie shells and animal skins to coins, printed paper money, and today, we have on our hands, digital and virtual currencies such as Bitcoin, stable coins and CBDCs.

2. Materials and Methods

This review is set to address certain questions that have arisen from the above evolutionary journey in the payment system. The study raised the following questions:

- Does the world need cryptocurrencies?
- How imperative is the emergence of the Central Bank Digital Currencies (CBDC)? Are the CBDCs planned policy directions or are they regulatory reactions to the cryptocurrency evolution?
- If cryptocurrencies and their concomitances have come to stay, what regulatory challenges do they pose and what does

the future hold for the world payment system given the digital evolution?

Finding answers to the above questions represent the main thrust of this study.

In terms of method, this study is an opinion paper and follows a conventional synthesis approach to literature review. This approach according to Cooper (2017) is different from the integrative and systematic review approach which identify problems and tend to reconceptualise them through a review. The conventional synthesis tend to carry out review to increase the depth of knowledge of the area under review. This study adopts this approach as it is a movement from the known facts to an ending with a futuristic conclusion about what is not known (See, Schirmer, 2018).

3. Do We Need the Cryptos?

Right from its introduction and gradual and steady entry, several arguments and discussions have continued to pervade the financial ecosystem with respect to the makeup, functions and necessity/ justification for cryptocurrency. There have also been arguments on the asset classification that are best suited for cryptocurrencies. There have also been arguments on the real uses and classifications of bitcoins. Some argue that they function as synthetic money while others such as Selgin(2015) disregard them as traditional fiat money. Dyhrberg (2016a) sees it as a combination of commodity and currency. Urquhart and Zhang (2019), and Dyhrberg (2016b) have classified it as that hedging instrument by currency investors [Yermack (2015), Goczek & Skliarov (2019), Glaser, Zimmermann, Haferkorn, Weber & Siering (2014)]. Carrick (2016) argues that it can aid in portfolio construction and risk minimization. Wu & Pandey, (2014); Brière, Oosterlinck, &Szafarz, (2015); Eisl, Gasser, & Weinmayer, (2015).

Kristjanpoller and Bouri (2019) disagrees with the hedging capabilities of cryptocurrencies.

Digital currencies, based on the use of a distributed ledger, represent a genuinely new development in the payments landscape and several arguments have been advanced as per the desirability or otherwise of this innovation in the payment system. The allure of the innovation, the experimental inventiveness, reduced cost and increased speed, suitability for e-commerce and cross-border transactions and a host of factors have been paraded as the reason for the incursion into this new payment arena. However, a range of factors also exist that are more idiosyncratic to digital currencies based on distributed ledgers – especially as they relate to their decentralised attributes.

Literature has polarised the drivers, motives and restraining factors to the development of cryptocurrency into the supply side factors and the demand side factors.
Fragmentation, scalability and efficiency, pseudonymity, technical and security concerns, business model sustainability[7] have been advanced as supply side factors that aided the development and continuing development of cryptocurrencies in the payment system (Andoni, Robu, Flynn, Abram, Geach, Jenkins, McCallum, Peacock, 2019). It is argued that enhancement of this model can be achieved through the upscaling of the benefits from these factors while a deterioration in their management can constitute inhibitions to the use of this technology.

[7]*Over 600 digital currencies are in circulation, with different protocols. processing and confirmation and this over fragmentation and excessive decentralisation obviously creates acceptance problems and perception difficulties.*

Conversely, in order to increase acceptance and use, digital currencies based on distributed ledgers have to provide end users with benefits over traditional services and some potentials, demand side enhancers have been presented in literature. These include Security: cost, usability, volatility and risk of loss, irrevocability, processing speed, cross-border reach, and data privacy/pseudonymity (Andoni, Robu, Flynn, Abram, Geach, Jenkins, McCallum, Peacock, 2019).

3. Crypto problems and the Necessities of the Stable Coin and Central Bank Digital Currencies (CBDC)

As industry watchers and players see the emergence and growth of cryptocurrencies and the associated benefits or justification for their advent, two major issues have been advanced as sore points in this emerging payment technology. Cryptocurrencies have been challenged and criticised on the grounds that they are unregulated and volatile in terms of price and volume. What drives the prices and value of cryptocurrencies have remained a financial wonder. Aside the case of diverging regulation, cryptocurrency price volatility lacks economic explanations. It has even been argued that cryptocurrencies provide safety nets and covers for crime-related activities. It is on the basis of this that the Central Bank of Nigeria in 2017 issued a circular warning banks and other economic agents against the use of cryptocurrencies and later on, officially cracked down on cryptocurrencies. The crackdown by Nigeria's central bank on crypto currency has provoked public outcry largely due to the fact that virtual currency activities flourished and boomed in the last five years. The crackdown was symptomatic of the struggle by financial regulators to keep a hold on the digital currency space which seems to be spiralling out of their control. There have been insinuations that the ban on cryptocurrency was due to associated regulatory challenge, may be as a result of lack of clarity on how it works hence an advocacy for awareness creation (see, Amarasinghe, Boyen & McKague, 2019). While this will overcome apathy about cryptocurrencies, there is still the need to make

the regulatory environment more adaptive to their introduction and use.

It is true that there are diverging regulations for cryptocurrencies and the fear of over regulation but some identifiable types of regime exist the world over. The closed regulation system is used for the Chinese market, open and liberal regulatory system for the Switzerland market, and the US adopts the open and strict system for its market (Amarasinghe, Boyen & McKague, 2019). The creation of the regulatory structures shows that governments are bracing up to the need to not only allow the trend of cryptocurrencies and the likes, but also are building towards ensuring they are properly regulated.

Given the volatility and regulatory challenges that have been identified with cryptocurrencies, stable coins and Central Bank Digital Currencies emerged and are continuing to emerge as response measure. Stable coins follow the crypto technology but are collaterised by the value of an underlying asset or a fiat currency such as the US Dollars. Stable coins can be pegged and collaterised to such precious metals like gold. Stable coins, on the other hand, take advantage of the benefits of cryptocurrencies — such as transparency, security, immutability, digital wallets, fast transactions, low fees, and privacy while also making effort to keep the benefits of traditional currencies in the area of stability and trust (Chiu and Koeppl, 2017).

Four types of stable coins have been identified: fiat-collateralized stable coins, commodity-collateralized stable coins, cryptocurrency-collateralized stable coins and non-collaterised stable coins.[8]

[8]*The most common type of stable coins are collateralized — or backed — by fiat currency like USD, EUR, or GBP. Another class is backed by oil, real estate, and various precious metals. The third class is backed by other cryptocurrencies. The last class are non-collateralized stable coins which are not backed by anything, which might seem contradictory given what stable coins are.*

Regardless of its advantages and how it remediates the problems of cryptocurrency by checking volatility and the speculative nature of cryptocurrencies, stable coins still face regulatory challenges and are still not formal/fiat currencies. Stable coins still face limited acceptance regardless of the assurances and guarantees of stability. More so, cryptocurrency-collaterised stable coins are more complex and demanding to handle than the regular cryptocurrencies, in terms of conversion, volatility and other operational glitches.

With the increasing regulatory challenges of cryptocurrencies and stable coins and the fact that monetary system has become a complementarity of private money with public money – which is available for retail payments in the form of banknotes, this has made a good number of Central Banks to begin issuing the government version of digital currencies (Panetta, 2022). This type of digital currency is known and referred to as Central Bank Digital Currency (CBDC). It has been argued that the issuance of CBDC is reactionary as government is responding to the growing popularity of cryptocurrencies or even has decided to offer a public backed cryptocurrencies alternative. One sure thing is that privacy represents one of the major elements that drive cryptocurrency but lost through the use of CBDC.

For decades, the complementarity of public money and private money has guaranteed stability, competition and innovation. The digitalisation of payments cannot be ignored by central banks, which have so far provided their money only in physical form. Central banks cannot escape these transformations, nor should they underestimate the potential for far-reaching shifts that may occur.
On the home front, the eNaira is the digital form of the Naira, issued by the CBN in October 2021, in line with Section 19 of the CBN Act. It is a direct liability of the Bank, a virtual legal tender which forms part of the currency-in-circulation and has equal value as the physical

Naira (CBN, 2021). Following CBN (2021) sources, the eNaira has a complementary role with the physical naira and less costly, more efficient, generally acceptable, safe and trusted means of payment and an enhancer of monetary policy effectiveness.

The eNaira since its launch has as at the last quarter of 2022 made some appreciable progress with the performance statistics as contained in table 2 below:

Table 2: Summary of the eNaira Performance Statisitcs Q1, 2022

Average Download per Day	DPD	7,300
Person to Person Deals	P2P	10% of total transaction volume
Person to Bank; Bank to Bank Deals	P2B & B2B	90% of total transaction volume
Global Reach	Global Reach	North America to Australia, South America, Europe, Asia and all over Africa

Source: CBN

The eNaira has some participants and institutions with distinctive roles. These include the Central Bank of Nigeria[9], Financial

[9]*The CBN mint, issue, distribute, redeem and destroy the eNaira; determine the technical, regulatory and operational standards for the eNaira; manage unresolved eNaira issues and complaints as well as monitor compliance with applicable regulations; and isue directives and review Guidelines on eNaira periodically as may be required.*

Institutions[10], Merchants[11], Ministries, Departments and Agencies of government as well as Consumers[12].

Nigeria, though the first country in Africa to issue a CBDC, the country is not alone in this globally. An excerpt of some of the countries that have definitively introduced or are close to doing so are presented in table 3:

Table 3: Some CBDC countries

Country	CBDC	Year of Issue
Russia	Digital Ruble	Test completed in February 2022, full scale introduction being awaited
Sweden	e-Krona	Test and trial ongoing.
India	Digital Rupee	To be introduced 2022-23
The Bahamas	Sand Dollar	2020
China	e-CNY, or digital yuan	Trial done to become effectively used in 2022
Nigeria	eNaira	2021

Source: CBDC Tracker (2022).

Aside the named countries, over 87 countries are at different stages of introducing CBDC (CBDC Tracker (2022). This is symptomatic of the wave of digitisation of currencies triggered by the cryptocurrency innovation. Cost, convenience, amenability to e-commerce and other

[10]*Facilitate onboarding and appropriate sensitization, integrating the eNaira into the e-payment channels, requesting the eNaira for self and for customers, managing the eNaira, providing KYC and receiving and resolving customers complaints.*
[11]*Merchants are to provide customers with eNaria as an alternative payment channels, provide cashback services, create awareness about the use of the digital currency and protect the wallet credentials.*
[12]*Ministries are to make and receive payments in eNaira while consumers create the wallet, use the eNaira as alternative payment platforms for legitimate transactions; protect the ewallet's access and report suspicious activities to the authorities. (CBN, 2021)*

benefits are making the introduction of CBDC a trending issue for payment system managers across the globe.

4. What does the Future Hold?

The advocacy for cryptocurrency has been premised on its digitisation and ease of use, lower cost, decentralization and its acting as a vanguard for Fintech. The disincentive on the other hand has come from such issues as volatility, regulatory difficulties and its acting as a safety net for criminal activities. It is believed that the future of cryptocurrencies will be shaped by the need to ameliorate its challenges while optimizing its benefits.

It is obvious that the future of cryptocurrency will be shaped and influenced by regulation. It is important, however, not to lose sight of the role of investors and the brands that continue to make entry into the market. Technology and innovations that relate to payment and the payment system are expected to play significant roles in redefining the cryptocurrency evolution. Also, there seems to be a generational dichotomy in perception when it comes to the acceptance of cryptocurrency. While the younger and more technology savvy ones are embracing and running faster with it, the older, more reticent and conservative ones are seeing it as a subversion of what an ideal payment system should represent.

One important and notable reactionary policy is the issuing of CBDC by conventional monetary authorities. As pointed out, countries like USA, UK, Canada, Mexico, India, China and several others are carrying out research leading to the adoption digital currency (CBDC) while some others have already adopted. It is evident that cryptocurrency innovation is being modified for the purpose of mainstreaming it into the conventional payment system.

The mainstreaming of cryptocurrency into the conventional transaction and payment system has been ongoing at different circles. In October 2013, the world's first bitcoin ATM was setup in Vancouver, Canada; Europe's first bitcoin ATM in Bratislava; some restaurant owner in the United States set up a bitcoin-only services; even in Switzerland, a consulting firm connects people for the purchase and sale of real estate using bitcoin only (Macmillan, 2013). Buying and selling of such things as basketball tickets, fast food, luxury watches, mattresses, beer, coffee, taxis, airline tickets plus others with bitcoins are continually on the increase.

In addition, the increasing degree of research interest and awareness that cryptocurrency is receiving goes to show the steady and unfettered advancement of the cryptocurrency revolution. It remains to be seen whether at any point in the nearest or distant future, that bitcoin and other digital currencies will completely takeover fiat currencies.

5. **Conclusion and Policy Implications**

This study is motivated by the desire to synthesize the evolution in the payment system from the barter economy to the digitalised payment system. Evidently, there has been movement from borderless payments and decentralized finance ("DeFi") to machine-to-machine transactions. With each passing day, cryptocurrencies are becoming a global phenomenon (Kwon, Kim, Shin and Kim, 2019). People move on with the cryptocurrency revolution with cautious optimism even as many are only prepared to invest what they are ready to lose while everyone watches to see as history unfolds in this direction. As the world continues to evolve in the direction of digitalisation, from our review, it is evident that the crypto revolution is such that does not seem to abate.

The policy implication becomes a call to strengthen the regulatory environment with the aim of mainstreaming cryptocurrencies and

other digital assets with such similitude. This is an important first step in protecting the investing public against risky financial exposures.

In developed and developing economies alike, evidence abound that cryptocurrencies can provide safety nets and shield for illicit financial and economic transactions. This places a responsibility on the managers of the financial system to create mitigants against such exposures. Creation of awareness and change of perception of the system to the direction of taking advantage of the benefits that cryptocurrencies offers while guarding against the negativities will be a better approach than being apathetic to its development and operations.

Much as this study does not claim to be exhaustive due to spatial and temporal limitations, it is considered a necessary step in awakening the consciousness of practitioners and operators of the financial system to the effect that the wave of the cryptocurrency and digital assets evolution is too tidal to be ignored.

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