Effects of the Development of Central Bank Digital Currencies on Financial Markets amid the Pandemic

Mikhail Kosov [1, 2, 3]* , Lyudmila Borisova [4], Sergey Popkov [5], Tatyana Kiseleva [3], Vadim Ponkratov [3], Maria Volkova [6], Larisa Vatutina [7], Nikolay Kuznetsov [3] , Svetlana Dzusova [3], Florie Mazzorana [8]

[1] *National Research University Higher School of Economics, Russia.*

[2] *Plekhanov Russian University of Economics, Russia.*

[3] *Financial University under the Government of the Russian Federation, Russia.*

[4] *Don State Technical University, Russia.*

[5] *Moscow Metropolitan Governance University of Yury Luzhkov, Russia.*

[6] *Bauman Moscow State Technical University, Russia.*

[7] *Moscow Polytechnic University, Russia.*

[8] *International University of Monaco (OMNES Education), Monaco.*

Abstract

The study determined the influence of the Central Bank Digital Currency (CBDC) on the financial markets during the COVID-19 pandemic. It investigated if the CBDC had the potential to improve the efficiency and lending power of the financial system. The research relied on secondary data from a range of financial markets, such as the FTSE, MSCI, Gold Index, S&P 500, and Dow Jones, collected during the COVID-19 period. The quantitative approach was employed using the statistical software SPSS to perform descriptive statistics and regression analysis. The results revealed that the financial markets were negatively impacted by COVID-19, but the CBDC saw a higher level of development during the same period. The statistical analysis showed a positive and significant relationship between the CBDC Attention Index, the Uncertainty Index, and various financial market indices, with regression analysis indicating a significant impact of the CBDC Attention Index on all financial market indices except the Gold Index. However, this study has some limitations, including its limited scope of financial markets. Despite this, these results have important implications for academics and policymakers. It is recommended to increase the use of CBDC through well-crafted policies and legislation to fully realize its potential impact on the financial system.

1- Introduction

Digital currencies, especially those that embed decentralized mechanisms of payment and are based on DLT (Distributed Ledger Technology), have significantly impacted several aspects associated with financial markets as well as the wider economy [1]. The central banks have also considered issuing their own digital currencies, known as the Central Bank Digital Currency. CBDC is described as the liability of the central bank, which is developed and

recorded digitally on both decentralized and centralized ledgers [2]. Previously, many studies have discussed the role of CBDC during the pandemic COVID-19; for example, Lee et al. [3] mentioned that the central bank dominates this digital currency within an existing account unit and converts it into the money of a commercial bank, physical cash, and other money forms on the demand of the authorized entities. The COVID-19 pandemic has accelerated CBDCs' development as many people throughout the world have shifted toward cashless payments. As a noticeable innovation in financial services, CBDCs (Central Bank Digital Currencies) are playing a critical role in forming value transfer's future [4]. All around the world, central banks are in several stages of evaluation to launch digital currencies at a national level. In the past few years, it has been observed that the interest in CBDCs has increased exponentially in response to innovation within technology as well as payments and the disruption that the pandemic COVID-19 caused [5]. CBDCs, when issued in different nations, crowded out payment activities as well as bank deposits, which impaired financial stability and brought a reduction in lending to the economy.

Also, some studies have disclosed the impact of CBDCs on the financial markets, such as the research of Li et al. [2], which explored that CBDCs' issuance positively impacts the worldwide financial systems as it weakens the cash demand and ensures a prominent role for sovereign money in underpinning confidence in payments through the provision of a reference value for private money. Further, Jamet et al. [6] discussed that the capital allocation was improved by the CBDC as it reduced the costs of transactions and facilitated access to payments. This fostered competition within the funding markets of the banks as it reduced their market power. Auer et al. [4] have specified that bank intermediation is fostered by the CBDC. Moreover, due to the decline in cash use, an alternative is provided by a CBDC to deposits, which limited the monopoly profits of the banks and encouraged them to increase lending [7]. In addition, the study by Wang et al. [8] discussed that the coexistence of private and sovereign money could be preserved by the CBDC in the future within the digital world. This is considered a basis for monetary and financial stability that ensures efficiency and competition within the markets for payment.

However, the previous literature does not explore how CBDC has improved the lending power and efficiency of the financial markets, specifically in periods of uncertainty, such as COVID-19. This research aims to identify the impact of the Central Bank Digital Currency on the financial market during the COVID-19 pandemic. Specifically, the role of CBDC in improving the efficiency as well as the lending power of the financial system is explored in the research.

2- Literature Review

Steven [9] described digital currency as a currency that can be accessed with mobile phones or computers as it only exists in electronic form. A huge difference between cash and digital currency allowed the latter to enhance the process of money transactions. Also, the research on Pfister [10] disclosed that digital currency's technological rails have made the transfers of currencies faster and easier across borders compared with standard money. Zambalaeva & Yang [11] studied digital currency's influence on platform firms' activities. Mainly, the study's aim was to identify the projections for digital currency within the financial sector as well as on digital platforms. It was discovered that digital platforms are used by companies to enhance their efficiency, reduce costs, and establish relations between the corporation and its customers. Furthermore, the study revealed that a secure transaction payment environment is guaranteed by digital currencies, as the cost related to the currencies' creation is low compared to paper banknotes. Along with that, Legotin et al. [12] mentioned the prospects of using blockchain technology as a source of financial innovation. For this, the study theoretically interprets the occurrence of cryptocurrencies in relation to the services of virtual payment as well as electronic funds. Outstanding growth dynamics were represented by cryptocurrencies; however, due to the rapidly increasing interest of the public, demand was provoked within the marketplace. Moreover, this research clarified the cryptocurrency's growth factors, offering an evaluation of the forecasts and potential scenarios for developing the cryptocurrency system. On the basis of the financial market example, it was represented that the blockchain technology's probabilities are versatile and its development prospects are identified through the decentralization's requirements to enhance the security along with the sustainability of the business procedures.

CBDC or Central Bank Digital Currency is defined by the Bank of England as the electronic money of the central bank, which is easier to access more broadly compared with reserves [13]. Also, as compared to cash, this currency has possibly larger functionality for retail transactions and a unique operational structure than other money forms issued by the central bank. Further, the study by Ward & Rochemont [5] disclosed that CBDC is one of the forms of fiat currency that is centralized, which the monetary authorities of the unions or nations regulate. Auer & Bohme [14] signified the importance of issuing CBDC as they revealed that it improved the payment systems' efficiency. CBDC's issuance, together with its technology, has facilitated faster settlements as well as extended the hours of settlement because it does not need any compatibility with the interbank system of communication. In addition, Kiff et al. [15] identified that the issuance of CBDC has enhanced the day-to-day transactions in which online payment methods, peer-to-peer, and point-of-sale methods are used. Thus, Ward & Rochemont [5] have discovered that CBDC is extensively used along with an accepted system of digital payment that made a significant reduction in the expenditures related to the production and handling of the cash.

A number of researchers as well as regulators define CBDC as a "stablecoin" that is nationally issued and positively influences the financial stability and balance of the banking system [16–19]. Further, the research of Tong and Jiayou [20] evaluated the digital currencies' global competition and development from both practical and theoretical viewpoints and explored the CBDC's design in China. Specifically, they examined the influence of electronic payment or digital currency's issuance on economics by conducting quantitative analysis based on a DSGE model. The findings of the study disclosed that the DC/EP's substitution impact on the deposits of the banks is limited, whereas the rate of economic growth is possible to be enhanced by 0.15 percent. Overall, a positive economic effect and a reduction in the leverage ratio were discovered, which is helpful in reducing financial risk. Likewise, with the implementation of the Delphi method and a process of analytic networking, the study by Zams et al. [21] represented that the cash-like model of CBDCs is a preferable design for Indonesia due to the improvement it made in financial inclusion and the significant reduction in shadow banking.

In relation to the impact of CBDCs on the financial markets, Kumhof & Noone [22] revealed that financial inclusion is stimulated by CBDCs, as they are central to offering access to digital payments and do not require any bank account. Furthermore, Jamet et al. [6] identified that CBDC is seen by the central banks as a noteworthy tool for promoting financial inclusion. Andolfatto [7] evaluated the influence of CBDC on private banking institutions. The study focused on a model in which the banking sector was imperfectly competitive. It was discovered that the CBDC's introduction will not impact the activity of bank lending and might, in some conditions, serve to promote it. Moreover, the results found that the competitive pressure leads to a higher rate of monopoly deposits, which reduces profit, but at the same time expands funding of deposits with the help of desired savings and greater financial inclusion. Thus, an appeal toward available evidence and theory recommends that an effectively and accurately designed CBDC will not threaten financial stability. Similarly, Castren et al. [23] introduced, in their study, a digital currency, either a stable coin (financial crypto asset) or a CBDC (central bank digital currency), within the financial accounts' network. Stimulating deposits' shift by non-financial firms and households from the banking industry toward digital currency, distinct responses of the impacted institutional industries were modeled. It was identified that the digital currency's introduction caused noticeable adjustments within the sectors' balance sheets, induced variation within the network structure, and triggered big moves within the prices of securities. However, a change in the economic influence was noticed, which depended upon the deposit shift's size, digital innovation design, initiative timing, and the channels that were used for adjusting the balance sheet.

With the constant growth and development of blockchain technology and computers, digital currency gradually replaces some functions of legal tender. The study of Li & Huang [24] also explored the feasibility and influence of digital currencies on the financial market. With the combination of Milton Friedman and Karl Heinrich Marx's theory of money demand, cryptocurrencies and CBDC's impact on money circulation are evaluated. Then, with the help of empirical analysis, it was concluded that the digital currency in China impacts the current deposits. In addition, Virtanen [25] studied CBDC from the perspective of financial stability to evaluate how the literature on CBDC discussed payment systems as well as financial stability. The Swedish Riksbank and Bank of England were chosen as case studies within the given study because of their early developments and work within the CBDC. The assessment of the previous literature revealed the positive impacts of adopting the CBDC, specifically with respect to the process of monetary transmission. Also, the findings disclosed risks related to the CBDC introduction; however, they were possible to overcome depending on the CBDC adoption type. The progress in IT as well as its application toward the financial sector has inspired academics and central banks to examine the CBDC's merits. In this context, Bindseil [26] reviewed the risks along with the advantages of CBDC for the financial industry. Two main arguments were discussed in the paper against CBDC, including the facilitation of systematic risk and structural banks' disintermediation risk, together with the centralization of the procedure of credit allocation. CBDC's two-tiered remuneration was proposed as an effective strategy to deal with these issues. Also, the review compares the CBDC's implications for a financial account with stablecoins, cryptoassets, etc., within the international and domestic contexts.

3- Methods

To address the research aims, the secondary method selected is data gathering from already existing studies. According to the research by Kumar [27], secondary research is mainly conducted for addressing a specific issue or problem for which in-depth analysis is required and is executed by thorough desk-based research [28]. This study was conducted to explore the individual impact of the Central Bank Digital Currency on financial markets during the COVID-19 pandemic, thus selecting secondary data is appropriate.

The given research is based on a quantitative approach, which depends upon measuring variables with the use of a numerical system. These measurements are then analyzed by using different statistical models to report associations as well as relationships between the selected variables for the particular study [29]. The main aim of gathering

quantitative data is to understand, explain, and predict the phenomenon's nature, specifically by developing theories along with models. Further, Bauer et al. [30] discussed that the main goal of the researchers in conducting the quantitative study is to determine the association between an outcome variable and independent variables in a selected population. Moreover, the quantitative designs of the research are either experimental or descriptive, where an experimental study establishes causality and a descriptive study develops the association between variables. In this research, the independent variable is the Central Bank Digital Currency and the financial market is the dependent variable. It is conducted to evaluate the impact of CBDC on the financial markets during the COVID-19 pandemic, which means that the association between the variables is identified. Moreover, it is determined whether CBDC positively influenced the financial markets during COVID-19 in the form of improved efficiency as well as lending power. Thus, using a quantitative approach to the research is suitable.

The data for this study was collected with the help of secondary data, where the information was collected secondary to the market activity of the FTSE, MSCI, Gold Index, S&P 500, Dow Jones, CBDC Attention Index, and CBDC Uncertainty Index during COVID-19. Weekly data is selected from January 2020 to September 2022, in consideration of COVID-19. After the data collection, it was imported into SPSS, where the paper performed descriptive statistics, multivariate regression, etc. to achieve the objective. The overall scheme of the research methodology is presented in Figure 1.

Figure 1. Flowchart of the research

4- Results

4-1- CDBDC and Financial Markets: Insights

Most of the researchers used descriptive statistics to summarize the data. These statistics help in understanding and getting insights about the data. Specifically, it includes the mean, variance, mode, skewness, standard deviation, minimum, and maximum of the sample. Thus, for the collected data of this study, the statistics, including the mean, the number of observations, and the standard deviation, are shown in Table 1.

Table 1. Descriptive Statistics

Descriptive Statistics			
	Mean	Std. Deviation	N
FTSE Index	419.57	55.88	143
MSCI Index	636.46	84.98	143
Gold Index	1801.55	101.35	143
S&P 500	3865.64	575.12	143
Dow Jones Index	31167.32	3864.15	143

The above table depicts the mean values of the FTSE, MSCI, Gold Index, S&P 500, Dow Index, and Jones Index as being around 419.57, 636.46, 1801.55, 3865.64, and 31167.32, respectively. Similarly, the standard deviations of the FTSE, MSCI, Gold Index, S&P 500, and Dow Jones are around 55.88, 84.98, 101.35, 575.12, and 3864.15, respectively. This means that the daily price movement of 30 large American companies remained at an average of 31167.32 points for the selected period. Moreover, Figure 2 shows a sudden decline in the Dow Jones in the early months of 2022, whereby the COVID-19 outbreak had reached a peak. However, from December 2020, the market kept increasing, which can be attributed to the decline in the severity of the COVID-19 infection.
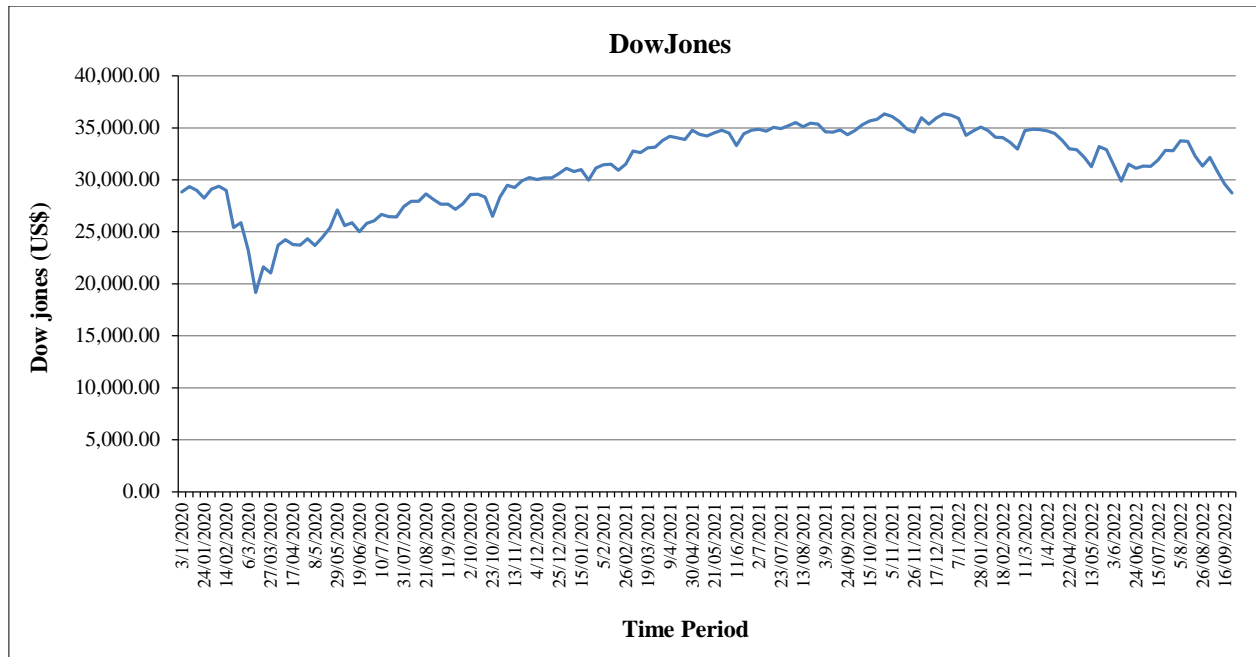
Figure 2. Dow Jones (2019–2022)

Similarly, it is observed that MSCI, which represents the large and mid-cap equity performance of 23 developed market countries, remained at an average index of around 636.46 points for the same period. The following graph depicts a sudden decline in the points of FTSE and MSCI in the early months of 2020, which can be attributed to the COVID-19 outbreak. The outbreak adversely impacted the markets, as shown clearly in the trend lines. However, unlike Dow Jones, both of these indices kept increasing at a higher rate after the beginning of 2021 (Figure 3).
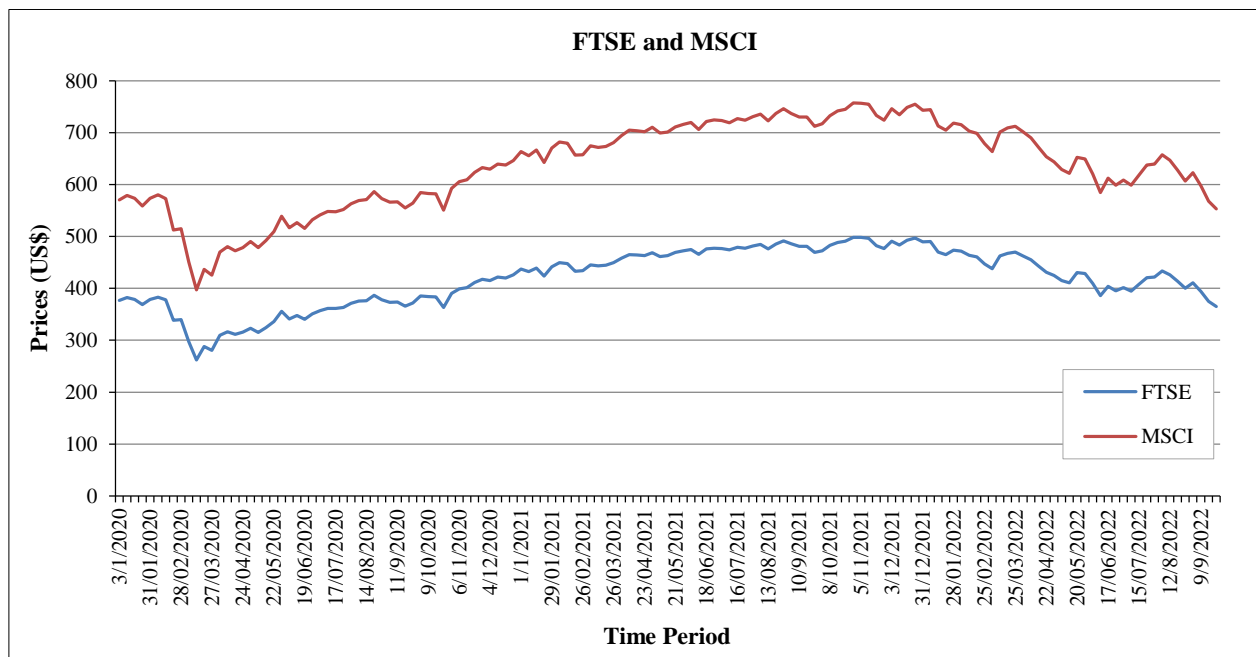

Figure 3. FTSE and MSCI Indices

Moreover, the average means of the Gold, S&P, and FTSE indexes remained at 1801.55, 3865.64, and 419.57 points, respectively. Interestingly, the variation in the prices was noticed to be between $0 and $100. This looks like a normal movement. However, the Dow Jones index was highly dispersed from the average value, as the standard deviation was much higher.

The adverse effects of COVID-19 on the S&P 500 are visible in 2020 (Figure 4). However, this market also noticed a performance improvement.
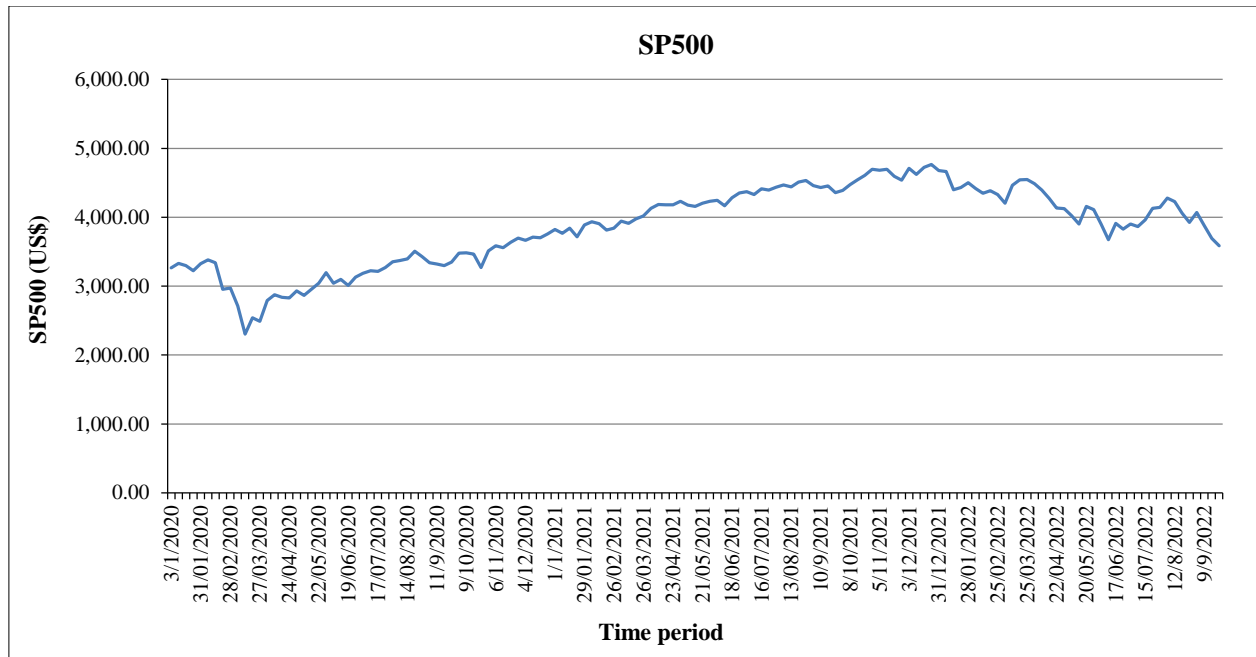
Figure 4. S&P 500 Index

Regarding the development of digital currencies during the pandemic, a higher and more positive movement was noticed in its development (Figure 5).
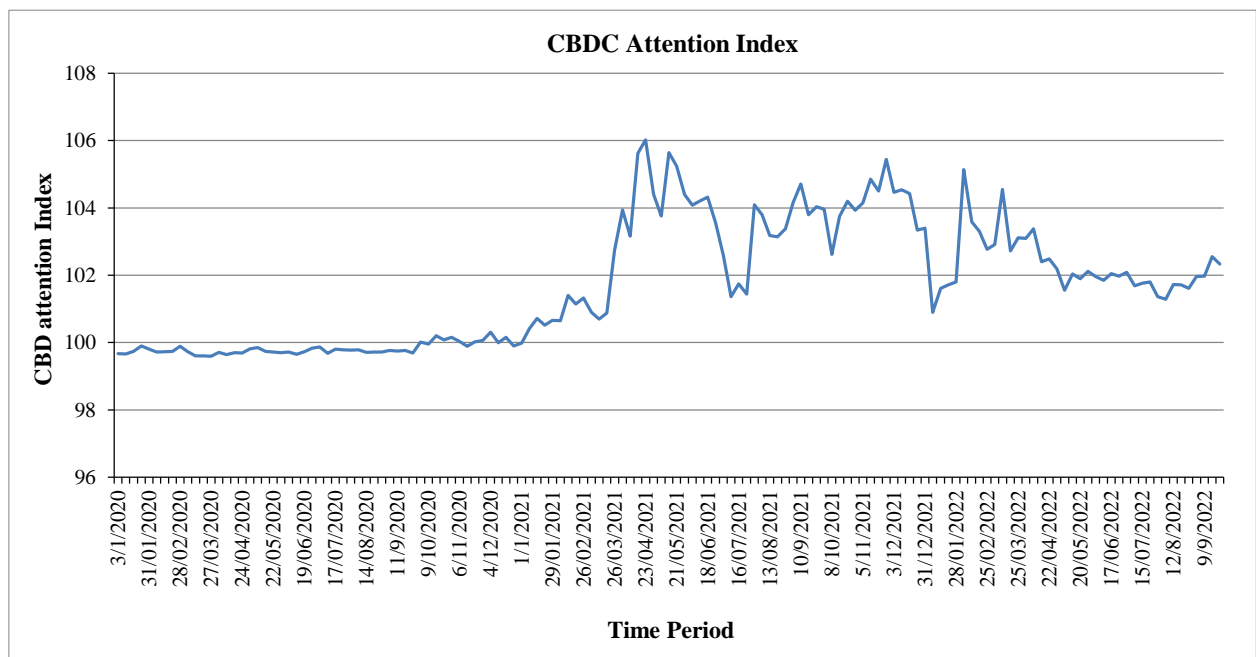

Figure 5. CBDC Attention Index

The trend line in the graph depicts a higher and more positive movement in the attention of central bank digital currencies (CBDC Index) during the COVID-19 pandemic. Specifically, from mid of 2021, the attention significantly increased, which may mean a higher focus on its development by central banks.

Similarly, the trend of CBDC uncertainty also shows the ups and downs of the uncertainties of the central bank's digital currency. This shows a significant increase from the fourth quarter of 2021. However, in the starting period of COVID-19 (2020), central bank digital currencies (CBDC) had a small fluctuation. Thus, it can be stated that COVID-19 affected the uncertainty index for a long period.

The association of the CBDC uncertainty index and CBDC attention index with the FTSE index, MSCI index, Gold Index, S&P 500 index, and the Pearson correlation coefficient show the Dow Jones index is n by (Figure 6).
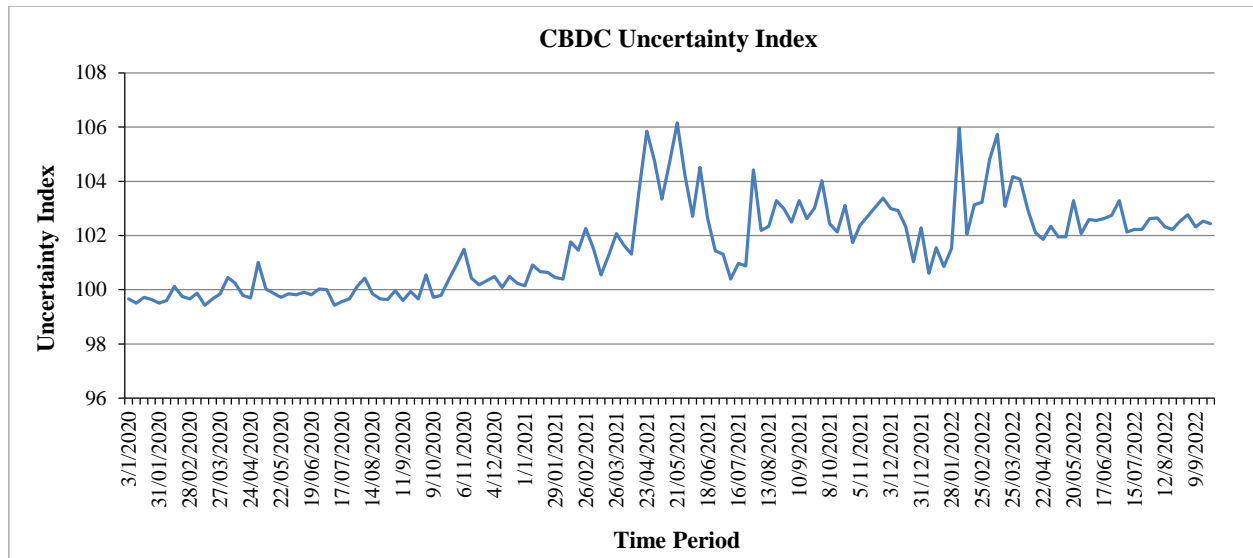
Figure 6. CBDC Uncertainty Index

The result of the correlation analysis of the CBDC Uncertainty Index with the FTSE is highly significant (r=0.656, sig=<0.01), which shows a strong and positive association between the CBDC Uncertainty Index with FTSE. Similarly, a high value of the correlation coefficient is found for the CBDC Uncertainty Index and S&P 500 index (r=0.718, sig=<0.01) and for the CBDC Uncertainty Index and Dow Jones index (r=0.709, sig=<0.01). However, a moderate value of the correlation coefficient is found between the CBDC Uncertainty Index and the MSCI Index (r=0.655, sig=<0.01). Moreover, the CBDC attention index has also attained a high value of the correlation coefficient for the S&P 500 index and the Dow Jones index (r=0.823, sig=<0.01 and r=0.810, sig=<0.01, respectively). Moreover, the central bank digital currencies (CBDC) Attention Index also has a highly positive and significant correlation with the FTSE Index, MSCI Index, and Gold index (r=0.795, sig=<0.01, and r=0.794, sig=<0.01 respectively). However, a small but significant correlation is found between the central bank digital currencies (CBDC) Attention Index and the Gold Index. Overall correlation analysis shows a significant and positive association of the central bank digital currencies (CBDC) uncertainty index and the central bank digital currencies (CBDC) attention index with the FTSE index, MSCI index, Gold Index, S&P 500 index, and Dow Jones index. This indicates the positive relationship of the CBDC Uncertainty Index and the CBDC Attention Index with the top financial markets in the world. Overall results provide a good association between independent variables and depend on variables (see Table 2).

Table 2. The correlation coefficient between the CBDC Uncertainty Index and CBDC Attention Index other financial Market

	CBDC Uncertainty Index	CBDC Attention Index	FTSE Index	MSCI index	Gold Index	S&P 500 index	Dow Jones index
CBDC Uncertainty Index	1						
CBDC Attention Index	0.880**	1					
FTSE Index	0.656**	0.795**	1				
MSCI Index	0.655**	0.794**	1.000**	1			
Gold Index	0.252**	0.173*	0.331**	0.332**	1		
S&P 500 index	0.718**	0.823**	0.970**	0.970**	0.341**	1	
Dow Jones index	0.709**	0.810**	0.978**	0.978**	0.296**	0.987**	1

4-2- Multivariate linear Regression Result

To examine the impact of the CBDC on the financial market, two measurements of the CBDC are selected: the first is the CBDC uncertainty index, and the second is the CBDC attention index. The selected independent variables represent major financial markets and are truly representative of the global financial situation. These variables include the FTSE index, MSCI index, Gold Index, S&P 500 index, and Dow Jones index.

The results of the Multivariate linear Regression analysis are shown in Table 4. The values of all four general statistics (Pillai's Trace, Wilks' Lambda, Hotelling's Trace, and Roy's Largest Root) of the multivariate test are statistically significant, as the p-value is less than 0.05 for both independent variables. Using Wilks' criterion, the combined-dependent variables are significantly different by levels of the CBDC Attention Index (Wilk's Λ =0.51, F= 49.05, p = 0.000, partial $\eta2$ = 0.643). Similarly, for the second independent variable (CBDC Uncertainty Index), the

Wilks' Lambda test is also significantly different (Wilk's Λ =0.70, F= 11.86, p = 0.00, partial $\eta2$ = 0.49). Likewise, the value of the combined-dependent variable is also significantly different for the intercept form (Wilk's Λ =0.36, F= 49.05, p = 0.00, partial $\eta2$ = 0.643).

Table 3. Multivariate Regression Analysis diagnostic test results

Multivariate Tests							
Effect		**Value**	**F**	**Hypothesis df**	**Error df**	**Sig.**	**Partial Eta-Squared**
Intercept	Pillai's Trace	0.64	49.05	5	136	0.00	0.643
	Wilks' Lambda	0.36	49.05	5	136	0.00	0.643
	Hotelling's Trace	1.80	49.05	5	136	0.00	0.643
	Roy's Largest Root	1.80	49.05	5	136	0.00	0.643
CBDC Attention Index	Pillai's Trace	0.49	26.13	5	136	0.00	0.49
	Wilks' Lambda	0.51	26.13	5	136	0.00	0.49
	Hotelling's Trace	0.96	26.13	5	136	0.00	0.49
	Roy's Largest Root	0.96	26.13	5	136	0.00	0.49
CBDC Uncertainty Index	Pillai's Trace	0.30	11.86	5	136	0.00	0.304
	Wilks' Lambda	0.70	11.86	5	136	0.00	0.304
	Hotelling's Trace	0.44	11.86	5	136	0.00	0.304
	Roy's Largest Root	0.44	11.86	5	136	0.00	0.304

Consequently, it can be concluded that the CBDC Attention Index and the CBDC Uncertainty Index both have a statistically significant interaction effect on a select financial market, including the FTSE index, MSCI index, Gold Index, S&P 500 index, and the Dow Jones index.

Table 4 below shows the details of the effect. Regarding the CBDC Attention Index, it was found that the CBDC Attention Index has a significant impact on all dependent variables (FTSE index, MSCI index, S&P 500 index, and Dow Jones index) except the Gold Index, where the CBDC Attention Index has no significant impact on the Gold Index (F=1.57, Sig=0.21). Moreover, regarding the CBDC Uncertainty Index, it is found that it has a significant impact on the Gold Index; however, there is no significant impact found on the FTSE index, MSCI index, S&P 500 index, and Dow Jones index (p-value>0.05). Moreover, the value of the partial eta square, which represents the strength related to a main or interaction effect, shows that the Partial Eta Squared for the CBDC Attention Index is greater than 0.3 except for the Gold Index. Therefore, a large effect of the FTSE index, MSCI index, S&P 500 index, and Dow Jones index is found. However, a small effect is found for the Gold Index. However, a large impact of the large effect of the CBDC Uncertainty Index is found for the Gold Index. The other value of Hotelling's trace and Roy's Largest Root also shows the same result as the Wilks' Lambda test. The overall multivariate result shows that the selected variables are significantly different, and the model is efficient in representing the corresponding effect.

Table 4. Between subject effect result

Tests of Between-Subjects Effects								
Source	**Dependent Variable**	**Type III Sum of Squares**	**Mean Square**	**F**	**Sig.**	**Partial Eta-Squared**	**Noncent. Parameter**	**Observed Power**
CBDC Attention Index	FTSE Index	93087.8	93087.8	81.70	0.00	0.37	81.70	1.00
	MSCI Index	216551.2	216551.2	82.09	0.00	0.37	82.09	1.00
	Gold Index	15164.7	15164.7	1.57	0.21	0.01	1.57	0.24
	S&P 500 Index	7574759.6	7574759.6	70.01	0.00	0.33	70.01	1.00
	Dow Jones Index	327521211.9	327521211.9	63.01	0.00	0.31	63.01	1.00
CBDC Uncertainty Index	FTSE Index	3729.7	3729.7	3.27	0.07	0.02	3.27	0.44
	MSCI Index	8966.1	8966.1	3.40	0.07	0.02	3.40	0.45
	Gold Index	63890.9	63890.9	6.62	0.01	0.05	6.62	0.72
	S&P 500 Index	6989.5	6989.5	0.07	0.80	0.00	0.07	0.06
	Dow Jones Index	183226.7	183226.7	0.04	0.85	0.00	0.04	0.05

Figures 7 to 11 below are presented to show the graphical presentation of the result, where the marginal for each dependent variable is explained by each independent variable.
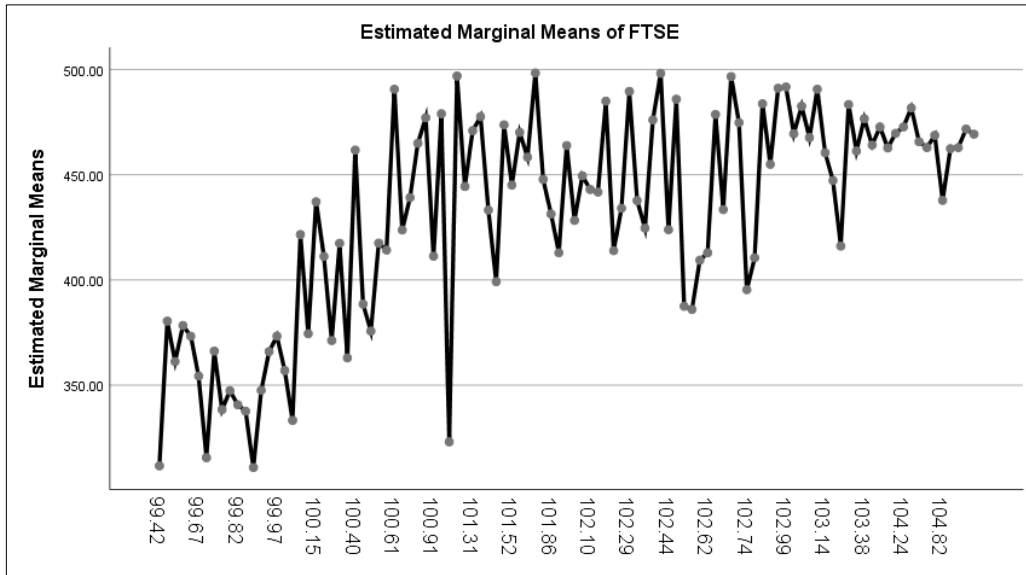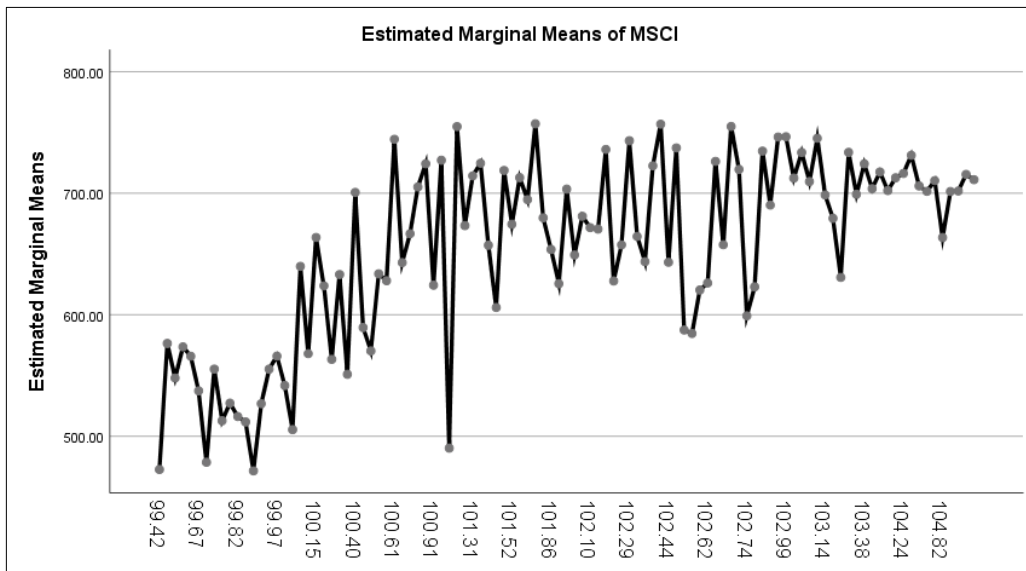
Figure 7. Estimated marginal for the FTSE

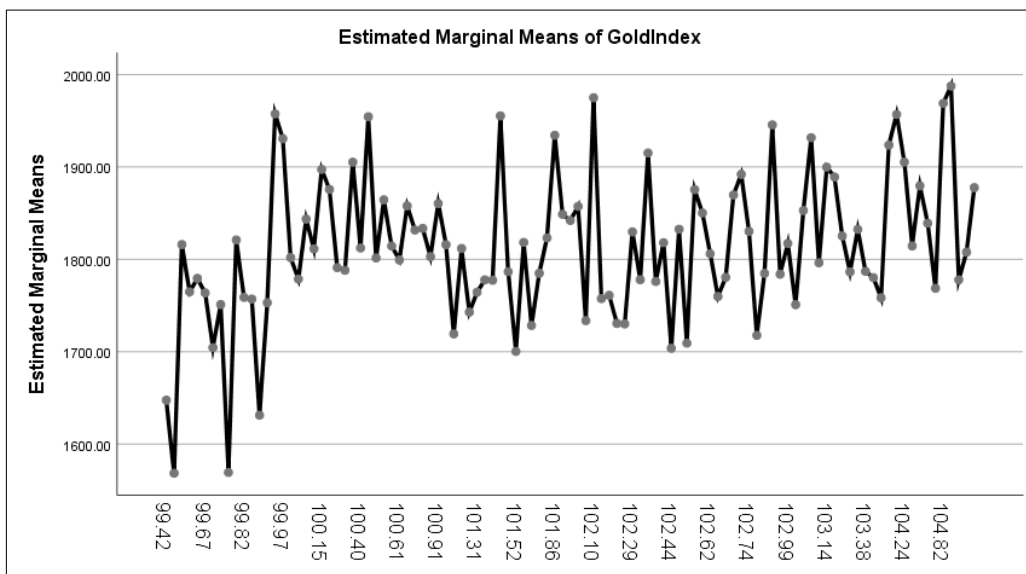**Figure 8. Estimated marginal for the MSCI**

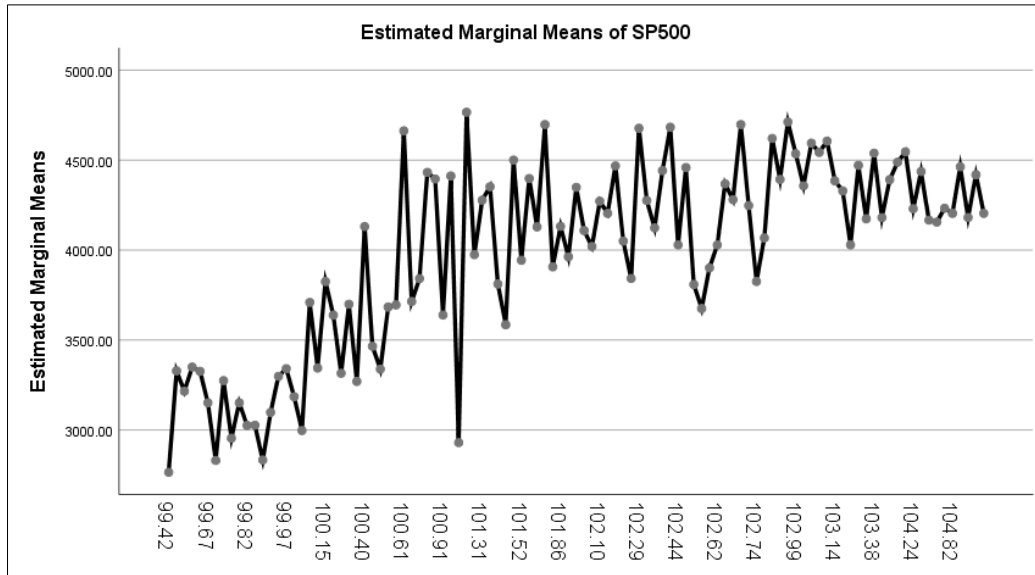**Figure 9. Estimated marginal for the Gold Index**

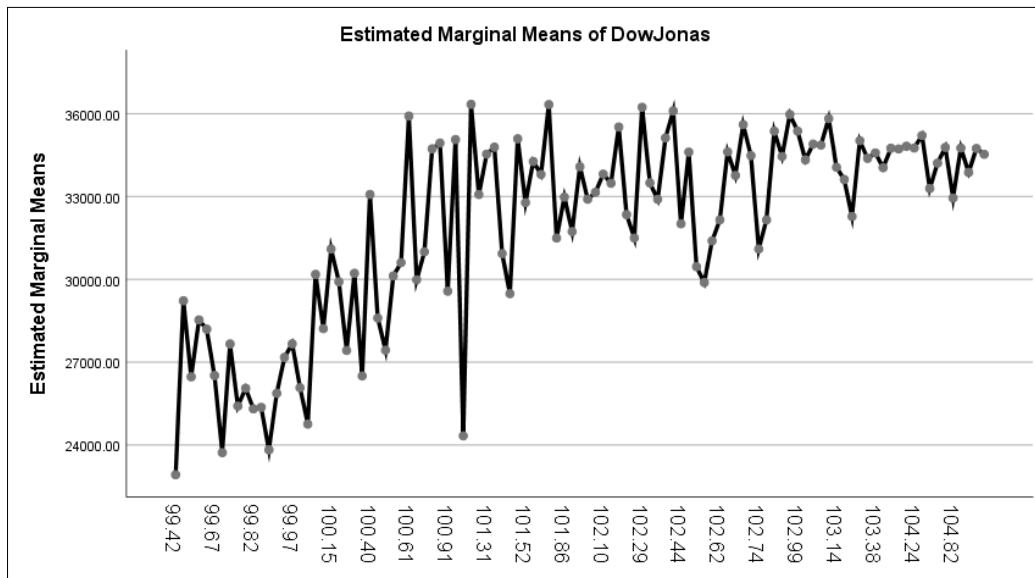**Figure 10. Estimated marginal for the SP500**

Figure 11. Estimated marginal for the Dow Jones

Table 5 below shows the values of the R squared and adjusted R squared. This indicates that the maximum variations in the S&P 500 are explained by the CBDC Uncertainty Index and the CBDC Attention Index. As the value of the R squared is 0.677 and the adjusted R squared is 0.473, indicating that 67.7% of the variation in the S&P 500 is explained by the CBDC Uncertainty Index and the CBDC Attention Index. Similarly, 65.7% of variations in the Dow Jones Index are explained by the CBDC Uncertainty Index and the CBDC Attention Index. Moreover, a 64% variation in the FTSE Index and MSCI Index is explained by the CBDC Uncertainty Index and CBDC Attention Index. The least variations (only 7.4%) in the Gold Index are explained by the CBDC Uncertainty Index and the CBDC Attention Index. Moreover, the value of the adjusted R squared also indicates evidence of a well-fitted model.

Table 5. R squared result

Dependent Variables	R Squared	Adjusted R Squared
FTSE Index	0.64	0.635
MSCI Index	0.64	0.635
Gold Index	0.074	0.061
S&P 500 Index	0.677	0.473
Dow Jones Index	0.657	0.652

The overall result of the multivariate linear regression analysis showed a significant difference in impact of the CBDC Uncertainty Index and the CBDC Attention Index on selected financial markets (FTSE Index, MSCI Index, Gold Index, S&P 500 Index, and Dow Jones Index). Except for the insignificant effect of the CBDC Attention Index on the Gold index, the Gold Index is also affected only by the CBDC Uncertainty index. Moreover, the value of the correlation analysis showed a positive correlation between the CBDC Uncertainty Index and CBDC Attention Index and selected financial markets (FTSE Index, MSCI Index, Gold Index, S&P 500 Index, and Dow Jones Index). Therefore, from the statistical analysis of the data, it is found that during COVID-19, the central bank digital currency (CBDC) has significantly affected some of the major global financial indices. Overall results from the multivariate approach indicate the positive impact of the CBDC on the world's largest financial market.

5- Discussion

Financial markets depend on different components, including political stability, interest rates, economic growth in a region, and many more. Misbalancing between the supply and demand of financial instruments can adversely affect the financial performance of the financial markets. Financial markets provide a platform where buyers and sellers of financial instruments (including bonds, international currencies, and equities) can interlink with each other. The CBDC plays a crucial role in this regard. Digital currencies provide the quickest way of transforming money. The results of the presented study indicate that during the initial stages of the COVID-19 pandemic, the financial markets faced a decline in their growth. The mean values of the TSE, MSCI, Gold Index, S&P 500, and Dow Jones Index are 419.57, 636.46, 1801.55, 3865.64, and 31167.32, respectively. However, when compared to the peak time of COVID-19, the Dow Jones falls in the early months of 2020. However, it somehow improved from December 2020, and the market kept increasing, which can be attributed to the decline in the strictness of COVID-19 infection. Wang & Enilov [31] also supported that, noting that the lifting of the operational restriction proved to be beneficial for the different players in the financial markets as it regained trust and reduced uncertainty. The main reason behind the declining financial performance of the financial market is the concern of the trading parties regarding their assets. Due to this, the role of digital currencies, specifically during the COVID-19 outbreak, is unavoidable.

The findings of the presented research assume that with the development of digital currencies during the pandemic, a higher and more positive movement was noticed in the financial market's development. Besides, a decline in the points of MSCI and FTSE was found at the start of 2020. Thus, the outbreak of COVID-19 negatively impacted the market, as the average index was noted to be around 636.49 points. Nevertheless, unlike Dow Jones, these indices kept increasing at a higher rate after the beginning of 2021. Every organization was facing the issue of the availability of cash; there was a need to adopt a method that could lead to positive impacts on the working operations. It was also supported by the findings of Kumhof & Noone [22] that financial inclusion is stimulated by CBDCs, as they are central to offering access to digital payments and do not require any bank account.

The analysis of the relationship between the CBDC uncertainty index and the FTSE is crucial in this regard, as the findings indicate a significant relationship between each other. On the other side, the rest of the elements, including the FTSE index, the MSCI index, the Gold index, the S&P 500 index, and the Dow Jones index, have a positive and significant association with the CBDC attention index. The findings showed that the CBCD uncertainty trend was uncertain; however, it increased from the 4th quarter of 2021, but at the start of the COVID-19 pandemic, CBDC had an insignificant fluctuation. Hence, it is noted that COVID-19 affected the uncertainty index for a long period. These indexes generally start going up when the volume of financial transactions increases. The global financial crisis provided different lessons that proved beneficial during the COVID-19 outbreak. The development of the central banks' digital currency was one of them. The findings also supported the literature, as Auer & Bohme [14] signified the importance of issuing CBDC as they revealed that it improved the payment systems' efficiency. The advantages of the development of the CBDC are not limited; it improves the overall efficiency of the transaction, ensures public access to the legal tender, and creates a competitive environment for e-money. Technological advancement changed the way different operations were used in the older era. Most people do not prioritize the use of cash, and it is gradually decreasing. Different other mediums that are occurring instead of the payment of cash, such as the use of apps, cards, and contactless payment, are increasing day by day. Several legal issues also arise with the payment of cash, enhancing the importance of the development of the CBDC. It is a relatively challenging task to track the record of the cash, specifically by the monitoring authorities, and can lead to a security risk. During the COVID-19 pandemic, most people shifted toward the use of CBDC, which enhanced demand and consequently increased activities in the financial market.

Security risk always exists regarding cash transactions; it can also enhance the crime rate. Due to this, it can be a good option for the Central Banks to offer two ways to conduct transactions. However, it can be an expensive approach. The growth trends of the different financial markets, including the FTSE, MSCI, Gold index and S&P, demonstrate the diverse effect of the development of CBDC on the financial market. It is difficult to only access the impacts of the CBDC on the growth of the financial markets; there are several other economic and regional factors and components that relate to the financial performance, which also supports the results of the previous studies. Tong & Jiayou [20] proposed that some functional and technological mismanagement can have a negative impact on the

financial markets. The world is seeing the COVID-19 pandemic as a challenge that is a fact and cannot be ignored in that it impacted negatively different aspects of the life of an individual. On the other side, it also created new opportunities and approaches for the individual to think extraordinarily about growing more, and CBDC was one of them. The crises also emphasize the adoption of these types of developments as people find the best alternatives.

The findings of the presented paper indicate the positive impact of the COVID-19 pandemic on the development of the CBDC. In addition to this, the CBDC Attention Index has a significant impact on all dependent variables, including the FTSE index, MSCI index, S&P 500 index, and Dow Jones index. The development of the CBDC kept the quickest upward movement during these periods. It is also supported by Tan & Xue [32]: according to their analysis, the development of the CBDC and the COVID-19 outbreak have a close association with each other. All these financial marketplaces directly or indirectly have an association with the stock market; on the other side, the banking sector's role cannot be eliminated. Banks are one of the important pillars of the financial markets, and due to the development of the CBDC, it can be negatively impacted, as previous studies have suggested that due to the recent trends of online transactions and digital currency transactions, lead to a drop in the average deposits by 10%. On one side, it is creating ease, but on the other side, it is creating challenges for the banking sector. Due to this, the banks can face the issue of liquidity and cash. However, every sector and field required some quick development as well. In this regard, by taking quick and necessary measures, this issue can be resolved. The development and adoption of digital currency by the banks and providing users with the best digital medium to ensure a fast and safe approach can play a significant role in the overall growth of the firms.

The uncertainty index has a closed association and is driven by the uncertainty in the economic policies, the higher fluctuation in the stock prices of the different companies, and the increase in market risk. In terms of correlation, analysis, the findings showed that the results derived from the correlation show that the CBDC Uncertainty Index with FTSE is highly significant ($r=0.656$, $sig=<0.01$), implying that a positive and strong association exists between FTSE and CBDC. Overall, the correlation analysis showed a positive and significant association between the CBDC uncertainty index and the CBDC attention index with the FTSE index, MSCI index, Gold Index, S&P 500 index, and Dow Jones index. In addition to this, the lower GDP of a country has a close linkage and relation with this index. According to the findings of the presented research, the CBDC Uncertainty Index has a significant impact on the Gold Index. However, the impact of the CBDC Uncertainty Index was found to be insignificant on the FTSE index, MSCI index, S&P 500 index, and Dow Jones index. The gold index is one of the world's exchanges for the trading of gold and can be used for monitoring and tracking the trends of gold prices. These findings indicate that Wang et al. [8] were on the right track, and their results were based on the actual findings, as they believed that the financial markets are relatively more sensitive and complex than the CBDC uncertainty. This is mainly due to the substitution of these indices. However, Wang et al. [8] demonstrated a negative view and relation of the CBDC uncertainty on the different financial markets, including the World Bank Indices, FTSE, and MSCI. Furthermore, the development of the CBDC can lead to an uptrend movement of the cryptocurrency market. The success of cryptocurrencies cannot be ignored in this regard, and it is one of the major financial markets for trades of digital assets. One of the negative things about cryptocurrencies is that their values are highly volatile and contain a higher probability of risk and reward.

In addition to this, there is a clear difference between the CBDC and the cryptocurrencies. Cryptocurrencies are based on blockchain technology, which does not require any type of approval for operations due to their higher level of risk. On the other side, the CBDC uses the permission-based blockchain network, which is used to transact digital currency. It is comparatively less risky and is most likely considered the safe model. This is the reason most economies give preference to CBDC compared to cryptocurrencies. In addition to this, the equity market is also one of the biggest financial markets, and the findings of the presented research indicate that the CBDC Uncertainty Index and the CBDC Attention Index have the potential to bring 67.7% variation in the S&P 500 index, as has happened in the past. It also provides access to digital payments, which is also supported by Kumhof and Noone [22], who argue that financial inclusion is stimulated by CBDCs. Besides, based on the regression analysis, it is observed that the CBDC uncertainty index and the CBDC Attention Index have a statistically positive and significant interaction impact on the selected financial market, such as the Dow Jones index, the P 500 index, Gold index, the MSCI index, and the FTSE index. Moreover, related to the CBDC attention index, the CBDC attention index has a significant impact on the FTSE, Dow Jones index, P 500 index, and MSCI index, except the Gold index, and no significant impact was observed between the CBDC Attention index and Gold index ($F=1.57$, $Sig=0.21$). Moreover, regarding the CBDC Uncertainty Index, it is found that it has a significant impact on the Gold Index; however, there is no significant impact found on the FTSE index, MSCI index, S&P 500 index, and Dow Jones index (p-value>0.05). Hence, Jamet et al. [6] showed that CBDC is observed by central banks as the key instrument to promote financial inclusion, hence supporting the findings of this study in the context of the CDBC. However, CBDC's development is still in its initial stages, and therefore, quantitative studies from this perspective are less likely to argue how it can impact the financial markets, particularly during a crisis period like COVID-19.

6- Conclusions

6-1- Summary

The COVID-19 pandemic has increased the development of CBDC, which as a consequence, has attracted people globally to move to cashless payments. CBDC has facilitated access to payments and reduced the costs of transactions. This study examines the impact of CBDC on the financial markets during COVID-19, particularly the role of CBDC in improving the efficiency as well as the lending power of the financial system. The study considered secondary data using the quantitative method. The information linked to the FTSE, MSCI, Gold Index, S&P 500, Dow Jones, CBDC Attention Index, and CBDC Uncertainty Index during COVID-19 was collected from January 2020 to September 2022 and analyzed using SPSS, descriptive statistics, and correlation. The findings showed a decline in the Dow Jones at the start of the COVID-19 pandemic; however, post-December 2020, the market increased. COVID-19 was found to adversely impact the financial markets; still, unlike Dow Jones, indices have kept rising since the start of COVID-19. In terms of the development of digital currencies during the pandemic, a higher positive movement was found in its development. Based on the correlation analysis, the finding showed that a positive and strong correlation exists between the FTSE and the CBDC uncertainty index. Precisely, the correlation analysis showed a positive and significant link between the CBDC attention and uncertainty indices (FTSE index, MSCI index, Gold Index, S&P 500 index, and Dow Jones index). Likewise, the regression analysis showed that the CBDC Attention Index has a significant impact on all variables (FTSE index, MSCI index, S&P 500 index, and Dow Jones index) except Gold Index. Overall, it was observed that CBDC positively impacted the financial markets during the COVID-19 pandemic, and its development during the crisis period shows its potential and its use in the future.

6-2- Implications

This study has implications for academics to consider investigating the CBDC and its impact on financial markets. The recent literature is insufficient in the perspective; hence, the present study can work as guidance to explore further this subject area. Other than that, the study has implications for policymakers to consider testing the use of CBDC in a financial transaction and evaluate the long-term benefit and potential risks involved.

6-3- Limitations and Recommendations for Future Research

Based on the findings, these recommendations can be useful for the policymakers and professionals involved in dealing with the CBDC. It is proposed to develop policies or legislation in support of the CBDC to be used as an alternative tool in financial markets. The use of CBDC increased during the pandemic period; however, its application is still not seen as widespread in financial dealings and transactions. Therefore, addressing the hurdles in the implementation of CBDC can help evaluate the true potential of CBDC as a possible alternative to a cash-based system. Overall, the study has limitations in terms of its scope and the selection of limited financial markets. Therefore, increasing the size of financial markets to assess the impact of CBDC can help increase the generalizability of the findings.

7- Declarations

7-1- Author Contributions

Conceptualization, M.K.; methodology, S.P.; software, M.V.; validation, S.D.; formal analysis, T.K.; investigation, M.K.; resources, V.P. and F.M.; data curation, F.M.; writing—original draft preparation, L.V.; writing—review and editing, V.P.; visualization, M.V.; supervision, L.B.; project administration, N.K. All authors have read and agreed to the published version of the manuscript.

7-2- Data Availability Statement

The data presented in this study are available in the article.

7-3- Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

7-4- Institutional Review Board Statement

Not applicable.

7-5- Informed Consent Statement

Not applicable.

7-6- Conflicts of Interest

The authors declare that there is no conflict of interests regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies have been completely observed by the authors.

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