

“EXPLORING THE DYNAMIC NEXUS BETWEEN DIGITAL FINANCE, ARTIFICIAL INTELLIGENCE AND GCC STOCK MARKETS: A WAVELET-BASED APPROACH.”

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ABSTRACT This paper analyzes the dynamic effect of cryptocurrencies (Bitcoin and Ethereum), KBW Nasdaq FinTech and Nasdaq Artificial intelligence Index on the financial market of the GCC countries: UAE, Saudi Arabia and Bahrain through the application of the wavelet methodology. The study used the CMWT on time-series data from 01 March 2020 to 28 Feb 2025, for the purpose of identifying multi-scale co-movements and volatility patterns between digital currency and regional financial stocks. Empirical findings demonstrate time-varying dependence the dependence was also found to be substantially stronger during bearish and bullish times also in technology booms. The paper draws attention to the increasing dominance of new technologies in the Gulf's financial markets and offers practical tips to policy makers as well as investors for creating flexible strategies and regulatory structures.

Key words: Cryptocurrencies, Wavelet, asymmetric, Fintech index, GCC, AI index.

INTRODUCTION

Accordingly, the fast development of technology which has transformed world's financial markets has in a like manner accelerated the growth of the FinTech sector. Its innovative capabilities that enhance efficiency, accessibility, and accountability and it are increasingly being seen as a viable option to the pitfalls of traditional financial systems. Conversely, the invention of block chain and increased popularity of digital currencies such as Bitcoin and Ethereum, received broad spectrum acknowledgment so that they have

become pivotal components of the modern financial environment (Allen et al.,

2022; Chowdhury et al., 2023; Naeem et al., 2023). The growing interest of the public sector, private sector, and academia to these changes has brought new research works on their macroeconomic and environmental consequences. AI, cryptocurrencies and fintech and especially what green assets may look like in the short term, and how they could serve sustainable finance (Takaishi, 2025). Considering the Gulf Cooperation Council's

(GCC) nations' strategic focus on green investment and economic diversification particularly in the United Arab Emirates, Saudi Arabia, and Bahrain it is essential to analyze these dynamic relationships. This study uses wavelet-based approaches to examine the time-frequency domain relationships between these technological developments and environmentally friendly asset markets in the GCC context.

One of the largest revolutions in the history of the financial services industry is the “FinTech Revolution,” where technology is used to enhance traditional financial methods. This transformation is primarily caused by information technology, which has deeply changed how financial services are produced, exchanged, and used. FinTech stands for financial technology and is a widespread all-encompassing term that is used to describe the progression of the provision of financial goods and services using information technology (Shakri, Yong, & Xiang, 2021). These developments are particularly notable in a way as new financial instruments are disrupting the old and driving new investment themes such as green and sustainable investments, say, cryptocurrencies and AI-driven platforms. With GCC countries such as UAE, Saudi and Bahrain wanting to develop more diversified and eco-conscious economies, understanding the impact of this FinTech driven shift becomes increasingly crucial.

The traditional financial ecosystem and the worldwide economy have been completely disrupted by the advent of FinTech, cryptocurrencies, and digital remittance. That the economy is being disrupted by technology is evident in the case of cryptocurrencies such as Bitcoin and

Ethereum. They are known as cryptocurrencies, because they have been offered as an alternative to traditional mediums of exchange and have been secured with advanced encryption protocols (B., & Kliber, A. (2022).

Digital financial transfers were ineffective, expensive, and dependent on multiple centralized outside parties until the introduction of Bitcoin. The adoption of digital

currency has reduced operating expenses and increased efficiency in market transactions. According to the International Monetary Fund (IMF), electronic digital currency is virtually identical to e-money without a physical representation since it significantly expands access and market inclusion (Yang et al., 2020). For countries in the Gulf Cooperation Council (GCC) like the UAE, Saudi Arabia and Bahrain, where it is increasingly important to align modern financial systems with sustainability objectives, such reforms are particularly significant. Additionally, the banking industry and the economies of several Gulf States have been influenced by the use of virtual currencies. Low transaction costs and improved security features appear to be the main advantages of digital currencies (Aneja, & Dygas 2022). For instance, given the significance of the Gulf Cooperation Council (GCC) in international remittances, the implementation of cryptocurrency integrated technology could provide major business advantages, including lower operating costs for foreign exchange firms (Abdeldayem, & Aldulaimi,

2024). However, there are obstacles for traditional banks and certain financial service companies as well. When autonomously ordered cryptocurrencies develop, the main worry is that financial inter mediation may be prevented. Technology needs to be carefully tackled when it comes to altering frameworks so that it continues to function with the existing economic systems. These initiatives compete with more traditional approaches to achieving sustainable, balanced economic growth because resource rich but technologically advanced nations like the United Arab Emirates, Saudi Arabia, and Bahrain represent difficulties for relevant problem solving

This study mainly aims at new and traditional financial assets' interaction with each other, in particular, at how FinTech novelty, artificial intelligence, and eco-friendly investments coalescence with currencies like Bitcoin, Ethereum in Gulf Cooperation Council (GCC) countries, such as Saudi Arabia, Bahrain, and United Arab Emirates. By studying these

relationships, we hope to shed light on how investors invest in digital assets and figure out if cryptocurrencies can serve as a non-traditional asset that can help spread risk in times of economic inflation. The future looks bright for crypto, with many coins increasingly considered wise investments that'll surpass traditional investments in value. That said, shorter-term and medium-term volatility can result in some pain in tough economic periods. To achieve this, the study examines the connections among cryptocurrencies, green investments, and regional market indexes throughout time and at different frequencies, wavelet-based methods that are capable of lexicographical dissecting non-linear and complex dynamics. The data are based on indices of sustainable assets, cryptocurrency market, and GCC financial markets.

Problem of Statement:

With the increasing recognition and adoption of cryptocurrencies such as Bitcoin and Ethereum, concerns have emerged regarding their potential interconnection with other financial elements like stock markets and financial technologies. In the context of GCC countries (UAE, Saudi Arabia, and Bahrain), this growing interaction presents challenges for FinTech investors and policymakers, especially in formulating effective investment strategies and regulatory frameworks due to limited understanding of these evolving relationships. In this paper, dynamic interconnections within triplet consisting of FinTech innovations, cryptocurrencies and artificial intelligence (AI) in financial GCC markets are examined using wavelet approaches. The wavelet approach offers a more complete picture of how the assets co-move and influence one another over time, as compared to the existing literature that often ignores variations over different periods.

By uncovering these complex interdependencies, the study also seeks to fill a major void in the literature and provide market participants with practical guidance on how to navigate the digitalization of local financial services providers.

Research Question:

- How does the wavelet analysis show that the correlation between GCC Stock indices and the Cryptocurrencies changes over different time scales?
- How does the KBW NASDAQ Fintech impact on the GCC countries stock index?
- How does the NASDAQ AI Index on the GCC countries stock index?
- What correlations were found by using wavelet analysis between KBW NASDAQ Fintech Index, Nasdaq CTA Artificial Intelligence Stock, Cryptocurrencies and GCC countries Stock indices?

Purpose of study:

The main aim of this study is to provide evidence for a major literature gap, by adopting wavelet analysis for analyzing co-movement between commodities markets, Asian stock exchanges and cryptocurrencies across different time horizons. This technology provides a dynamic perspective, reflecting short-, medium- and long-term interactions that may have been missed by traditional methods. The study aims to help Fintech investors and policymakers by offering comprehensive understanding of the evolving relationships among heterogeneous financial assets.

A particular aim of the study is identify significant co-movement behavior and discrepancies that would contribute to the resources of investment planning and regulatory direction. Additionally, by illustrating the interactions of various assets across time, the study offers investors additional measurements to manage risk and optimize portfolio strategies. It also helps lawmakers in establishing smarter and more flexible regulatory structures.

The report also highlights the clear lack of policy relevant information on the link between traditional and digital assets. It tries to provide to policy makers globally and transitionally in particular in the GCC countries an informative view on how the co-movements of asset prices tend to affect financial stability and economic

resilience. The end goal of this research providing investors and regulators around the world a better understanding of how cryptocurrencies intersect with major financial institutions and other AI assets.

Signification of the Study:

The study has contributed with an investigation of Fintech, cryptocurrencies, and AI in a sample of handpicked financial markets in the GCC countries the United Arab Emirates, Saudi Arabia, and Bahrain. Through the use of wavelet techniques to attempt to identify time varying connections at a range of time scales the analysis offers a picture of the general context that is often overlooked in models based on linear methods.

For GCC fintech investors, regulators, and policy makers, the report also provides helpful lessons on the future of new technologies and their impact on asset co-movements and financial market dynamics. Insights into these relationships are important for good investment decisions, adaptive regulation and management of financial risk in a rapidly digitizing economy.

This study serves as a contribution to the existing knowledge by examining how digital innovation e.g. fintech, cryptocurrency, and AI is interacting with traditional financial institutions in the context of the Gulf stock exchange. Previous studies considered one or a few of these variables independently or in established markets, and this study provides further empirical evidence for the GCC region wherein digital financial services are expanding. And more generally, the study results can contribute to enriching our knowledge on the relationships between digital financial assets and technology developed around them and the regional financial markets. These contributions contribute to inform the GCC technology adoption strategy, investment planning, and financial stability, and it supports the institution and government policymakers.

The Gulf States are embracing digital currencies for a variety of reasons, including low costs and secure transactions based on block chain. Virtual currencies are attractive because they could potentially cut reliance on conventional banking systems and simplify financial transactions. With the market for cryptocurrencies getting bigger and bigger, an increasing number of different GCC industries such as banking, retail or government are showing interest in possessing a virtual currency as a means to include them within their system (Ramachandran, N., & Al Hajri, J. A. 2024). The shift in approach toward fintech ideas is now also being felt at the institutional level Governments in places like the U.A.E., Saudi Arabia and Bahrain have already started to look into block chain technology for ledger keeping and oversight of digital transactions. Fintech companies also provide a wide range of financial services in the GCC, including capital formation, insurance, wealth management, deposits, loans, and payments (Kismawadi, 2025). The advantages of such progress may include lower transaction costs, more efficient processes, improved security and the ease of use of financial services across an array of e-channels. Incredibly, about half of the fintech businesses in the area focus on payments, specifically using retail solutions (Kismawadi, 2025). Amazon, Apple Pay and other international tech powerhouses have also made inroads into countries like the United Arab Emirates and Saudi Arabia. In addition, Visa, the world leader in digital payments, partnered with local companies in the UAE to build and grow new payment capabilities. An increasing number of empirical studies investigate the dynamic relationships between famous cryptocurrencies such as Bitcoin and Ethereum, especially regarding their contributions to financial diversification and risk-hedging. Academics have occasionally taken stock of how these digital coins act in troubled financial times and whether they are a good "safe haven" bet. Moreover much research has been conducted on the digital currencies' volatility and return transmissions and how these instruments perform in the international

LITERATURE REVIEW

environment (Ciaian & Rajcaniova, 2018; Corbet et al., 2018; Yi et al., 2018). A number of recent studies have explored the effect of Fintech and technological innovation in general on existing and emerging asset classes and cryptocurrencies. Global technology indices such as the Fintech Index and the Dow Jones global technology Index have become important for understanding asset correlations and volatility spillovers. For example, (Le et al. 2021) recorded intense connections of virtual currencies to the traditional markets as well as Fintech related assets. The effectiveness of investments based on AI in enhancing risk adjusted returns was also challenged by (Demiralay et al. 2021) who highlighted significant co-movements between the return series of AI-related stocks with traditional financial assets. In contrast, (Tiwari et al. 2021) revealed that due to their negative tail dependence between the return series, AI assets can offer hedging benefits to carbon price risk. These opposing findings should provoke more analysis of the dynamics of AI assets, especially concerning cryptocurrencies, Fintech shares and global tech indices. With the changing financial environment in the GCC countries, using the wavelet analysis, the paper investigates the time-varying correlations and co-movement across various investment horizons and provides new insights for the policy makers and investors in relation to the integration of AI within well diversified portfolios.

Empirical Review:

The correlation between new financial technologies, especially fintech, cryptocurrencies, and AI and the traditional financial markets is under the increasing attention in the empirical studies over the past years. Nevertheless, the studies on GCC are missing on a large scale, especially using sophisticated methodologies such as the wavelet method. Scholars have spent a great deal of time on cryptocurrencies such as Bitcoin and Ethereum for their volatility and potential diversification benefits. In certain market environments, Bitcoin could also act as a hedge

or safe haven against other asset classes, (Blau, Griffith, & Whitby, 2021).

Regarding Fintech's impact on the market, Le et al. found that when examining the volatility spillover between fintech stocks and traditional assets like gold and oil, there is a high degree of dependency between the two (Kumar et al., 2021). This demonstrates how fintech, as a type of financial assets, is becoming more and more systemic. However, research has rarely looked into these fintech indices in the GCC, which is growing more fintech aware, especially in the areas of payments, loans, and wealth management (Kismawadi, 2025).

In terms of fintech and market impact, (Le et al. 2021) investigated the volatility interdependence between fintech stocks and other assets e.g., gold, oil. They would find a fairly high degree of interconnection, particularly in periods of uncertainty in the market. This highlights that this type of financial asset fintech is increasingly becoming systemically important. However, in the GCC still at an early development stage of the fintech sector but rising popularity of fintech in areas such as wealth management, lending and payments, very little has been observed in terms of these studies with regard to adoptions of fintech indices (Abdeldayem, & Aldulaimi, 2024).

Research on the subject is still lacking but the potential for financial assets powered by AI is generating interest. When examining shares of these connected to robots and artificial intelligence, and especially during times of economic crises, (Demiralay et al. 2021 and Huynh et al. 2020) showed significant relationships with traditional financial resources. They demonstrate that the AI financial system assets are unlikely in the GCC to provide diversity when entering into traditional portfolios; more evidence to confirm this position is needed. Wavelet is an effective tool for studying the correlations of the financial data in the time frequency domain. Rua and Nunes (2009) supported wavelet coherence as a tool to examine the co-movements across investment horizons. Naeem

et al. (2021), Najeeb Kasir etc (2023), Noureen, M. (2024) showed that methods based on wavelets are of particular interest for the detection of time-varying correlations in financial time series, such as those between cryptocurrencies and stock indices that are often missed by standard techniques.

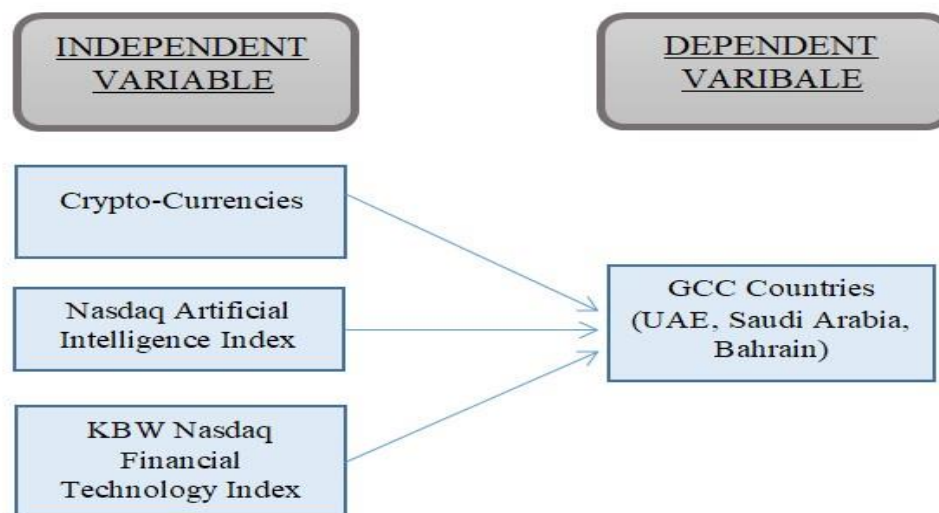
Contrary to the above, this study in relatively few empirical works combines in an AI, block chain technology, cryptocurrencies, fintech indices, and tech-oriented stocks using a wavelet approach given the rising popularity globally in the context of the GCC (UAE, Saudi and Bahrain). This discrepancy underscores the importance of studying the dynamics of the co-movements of these assets at different

frequencies as a contribution to understanding the risk transmission, portfolio formation, and effects of financial policy in GCC countries.

Hypothesis:

- H1: Significant associations between GCC (UAE, Saudi & Bahrain) Stock Index and the cryptocurrencies.
- H2: Significant relationship between the Nasdaq Artificial intelligence index and GCC (UAE, Saudi & Bahrain) Stock Index
- H3: Significant relationship between the KBW Nasdaq Financial Technology Index and GCC (UAE, Saudi & Bahrain) Stock Index

Research Framework: (Figure 1)



RESEARCH METHODOLOGY

The study employs a quantitative research methodology to examine dynamic associations among cryptocurrencies Bitcoin (BTC), Ethereum (ETH), the Fintech Index, artificial intelligence (AI) assets and stock indices traded on the GCC markets namely, United Arab Emirates (UAE), Saudi Arabia and Bahrain.

With a view to offer insights to investors and policy makers on risk patterns, correlation change and the potential of diversification in the digital financial era, the paper aims to study how these factors co-move at different time horizons. Because wavelet analysis can monitor the time and frequency domain dynamics of non-stationary financial data, it is selected as the

primary analytical tool. The series was subsequently decomposed utilizing the Continuous Wavelet Transform (CWT) and Wavelet Coherence methods, so that co-movement and correlation levels could be analyzed at short, medium and long-term intervals.

The wavelet approach is a powerful tool for discovering financial co-movement pattern in a more effective way from the traditional time-series perspective. It focuses on when and under what circumstances different assets interact, helping identify when and where localized changes in volatility and correlation can be found. These findings are important for regulators to understand how emerging technologies such as artificial intelligence and cryptocurrencies affect financial markets and for asset managers to improve their asset allocation. Given the transition of the financial environment in the GCC, this step-by-step technique ensures accuracy and reliability of findings.

Research Objective:

The main objective of this study is to examine and to understand the dynamic co-movement between new digital assets Bitcoin and Ethereum, Fintech and AI Index, GCC series stock indices i.e., UAE, Saudi Arabia and Bahrain index main and innovation based indices. We apply wavelet analysis to measure this relationship at different time horizons and frequencies which is of interest to both investors in fintech and policy makers. Further, this study aims to identify more temporal and regional patterns, that have yet to be discovered or been ignored in the literature. The investigation examines how changes or shocks in one variable can impact the others, owing to the complex and dynamic interconnections among cryptocurrencies, advanced technology indexes, and traditional financial instruments of GCC countries. On account of wavelet analysis, the analysis is able to consider time-varying co-movements which are often neglected by traditional econometric methods. This is an exploratory study as the relations tested have not been empirically deriving here,

especially in the GCC context. To overcome this lack of information, we are using time series information collected from various reliable financial sources. The study aims to bring the new issues to the attention and offer insightful reasons to enable improved decision making on regional economic strategy, portfolio management issues and financial regulation.

Data Collection Procedure:

This section outlines the procedures followed to collect the data for the study titled "Exploring the Dynamic Nexus between Digital Finance Digital Finance, Artificial Intelligence and GCC Stock Markets: A Wavelet-Based Approach". The data collection process was carefully structured to ensure relevance, accuracy, and alignment with the study's core objectives.

Study Variables:-

The data was collected for the following financial variables:

- Cryptocurrencies: Bitcoin (BTC) and Ethereum (ETH)
- Fintech Index and AI Index: Representing technological innovation in finance and artificial intelligence.
- GCC Stock Indices: Major stock market indices from UAE, Saudi Arabia, and Bahrain.

Geographical Scope:

The geographical area is made with the GCC countries, namely United Arab Emirates, Saudi Arabia and Bahrain emerging as the financial center of the region. The choice of these territories offers a regional perspective in order to examine the coupling of new digital assets with conventional financial markets.

Data For this study we utilized the following data sources:

Official Destination or Pre Existing Data: The www.investing.com has the official or existing data of the various types of market. Cryptocurrency Data and GCC Stock Market index, fintech & Artificial Technology e were extracted from this source.

VARIABLE	MEASUREMENT	VARIABLE ADOPTION
IN DEPENDENT VARIABLE		
KBW Nasdaq Financial Technology Index	Fintech Index	Abakah, E. J. A., Tiwari, A. K., Lee, C. C., & Ntow-Gyamfi, M. (2023). Quantile price convergence and spillover effects among Bitcoin, Fintech, and artificial intelligence stocks. <i>International Review of Finance</i> , 23(1), 187-205.
Nasdaq Artificial Intelligence Index	AI Index	Abakah, E. J. A., Tiwari, A. K., Lee, C. C., & Ntow-Gyamfi, M. (2023). Quantile price convergence and spillover effects among Bitcoin, Fintech, and artificial intelligence stocks. <i>International Review of Finance</i> , 23(1), 187-205.
Cryptocurrencies	Bitcoin, Ethereum	Singh, P. K., Pandey, A. K., & Bose, S. C. (2023). A new grey system approach to forecast closing price of Bitcoin, Bionic, Cardano, Dogecoin, Ethereum, XRP Cryptocurrencies. <i>Quality & Quantity</i> , 57(3), 2429-2446.
DEPENDENT VARIABLE		
GCC Countries	UAE, Saudi Arabia, Bahrain	Othman, A. H. A., Alhabshi, S. M., Kassim, S., & Sharofiddin, A. (2020). The impact of cryptocurrencies market development on banks' deposits variability in the GCC region. <i>Journal of Financial Economic Policy</i> , 12(2), 161-184.

Secondary Data Analysis:

This study adopts secondary data analysis, and relies on existing and well-established data to investigate the dynamic dependencies among cryptocurrencies (Bitcoin, Ethereum), the Fintech Index, Artificial Intelligence (AI) assets, and financial indices of the GCC members (UAE, Saudi Arabia, and Bahrain). This data was supplied by Investing.com. Historical series data available was for the previous 5 years. The data were selected based on its importance, availability, and uniformity of monitoring of the performance of assets in regional and global markets.

Upon assembly, the data was subjected to wavelet based multi-resolution analysis- a method that dissects time series data to

different frequency components. Such an approach ensures variation in the co-movement pattern between the selected variables is captured in the form of short- and long-run co-movement.

Wavelet analysis is especially well-suited to such a study, since it allows us to observe how linkages across financial assets take place temporally across various market environments and imparting insights that the more straightforward time domain analyses tend to miss.

Statistics of the spectra have been performed by the means of R and Python, which already have the adequate libraries for advanced. Wavelet transformations and time series treatment. We used these platforms to import, clean, and perform time-scale decomposition of data. Through the interpretation of the wavelet-transformed outputs, the study was able to examine the structures of interactions between Bitcoin, Ethereum, Fintech and AI commodities and GCC financial markets, and such findings may help in the process of investment decision and macro-financial policy analysis.

The CMWT (Continuous Morlet Wavelet Transform)

In addition, the Continuous Morlet Wavelet Transform (CMWT) is applied in this study as the main method to investigate the co-movements and the dependence of financial assets, which include cryptocurrencies such as Bitcoin, Ethereum, Fintech indices; a set of AI related assets and GCC stock market indices. CMWT can help to identify temporal and frequency patterns by decomposing the time series into different scales. It extracts the short term dynamics as well as the long-term co-movement and hence provides a richer description of financial dynamics.

The CMWT based wavelet coherence, cross spectrum, and variance are very helpful tools in investigating their strength and phase synchronization properties of these financial assets. This enables the study to identify phases of strong or weak co-movement and examine the way Fintech and digital assets relate with traditional markets in the GCC region across different economic states.

As noted by In and Kim (2013), the Continuous Morlet Wavelet Transform (CMWT) involves computing the convolution between the original signal and a set of wavelet functions that have been scaled and translated across time by φ :

$C(\text{scale}, \text{position}) =$

$$\int_{-\infty}^{\infty} X_t(\text{scale}, \text{position}, t) dt \quad \text{equation 1}$$

The Continuous Morlet Wavelet Transform (CMWT) produces a series of wavelet coefficients, denoted as CCC, which represent the localized values of a time series based on both scale and time position.

Foundational work by Gabor (1946), Grossmann and Morlet (1984), and Burrus et al. (1998) have defined the CMWT in the context of continuous-time signals involving two variable scale and translation.

$$F(a,b) = \int \left(\frac{1}{\sqrt{a}} \right) \left(\frac{1}{\sqrt{b}} \right) \quad \text{equation 2}$$

The Morlet wavelet can be simplified

$$\varphi(\omega) = \pi^{-\frac{1}{4}} e^{i\omega\psi} e^{-\frac{\omega^2}{2}}$$

Where, ω is a non-dimensional "time" parameter.

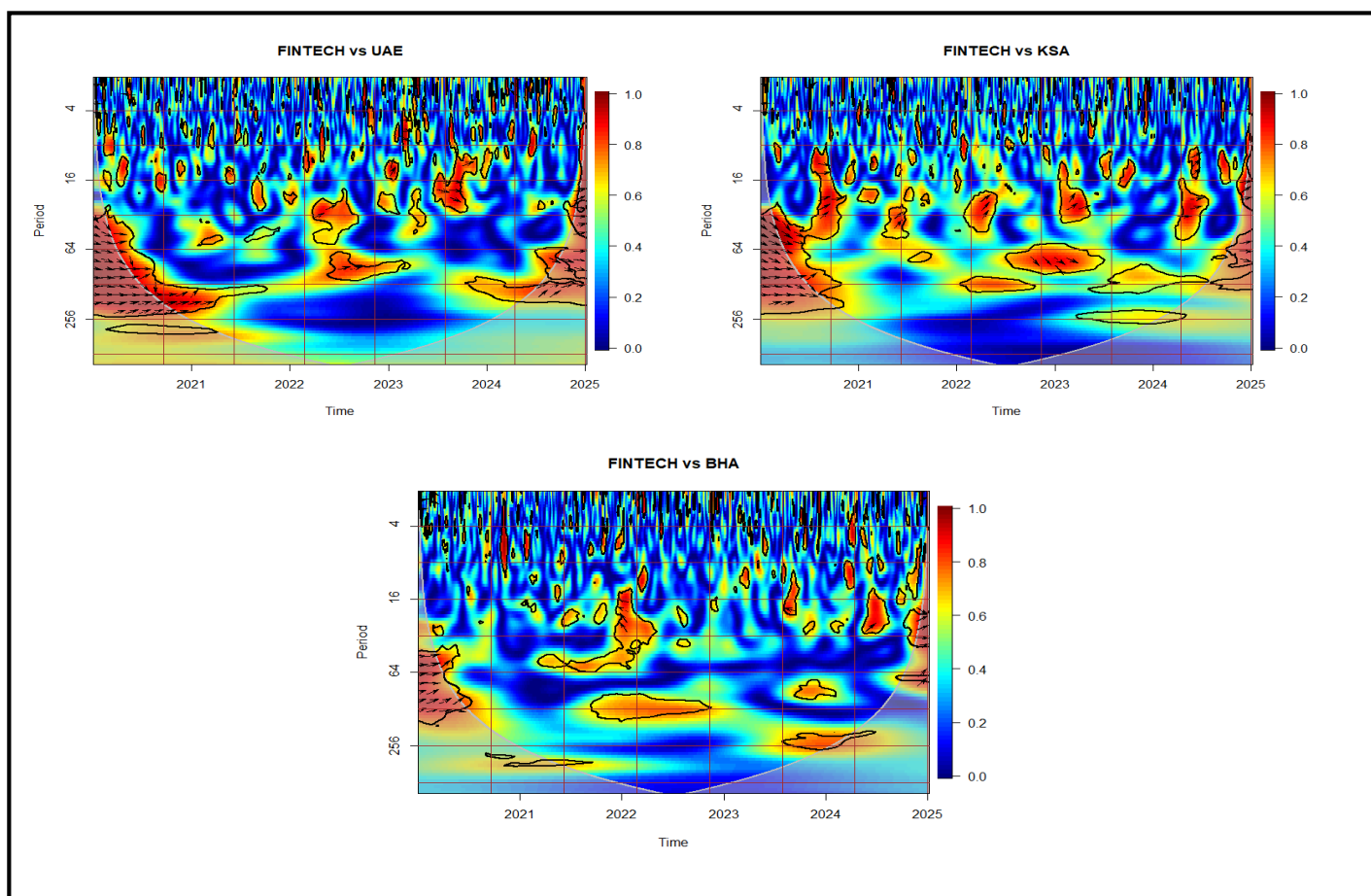
RESULTS AND DECISIONS:

The Continuous Morelt Wavelet Transform:-

(CMWT) Analysis and Result

Fintech Index and GCC Stock Indices:
Figure 2

16 in 2021 to 2022 there is positive relationship
shows that fintech index



In figure 2 (Fintech vs UAE) at period 256 to 64 which occurs just before 2021 and in year 2022 to 2023 shows measure in variable vector arrows heading diagonally upward side, suggestion the fintech index is dominating and have positively impacted in UAE market. A positive correlation seen from 2020 to mid of 2023 then on mid of 2023 on period 16 is shows diagonally down right arrow which indicate fintech index decrease same on the point it again shows the diagonal arrow revealing the positive correlation. In picture (fintech vs KSA) just before 2021 there was a decrease in the variables and the vector arrows pointed diagonally downward to the right signifying that the fintech have not much impact on the KSA market. Around periods 64 to

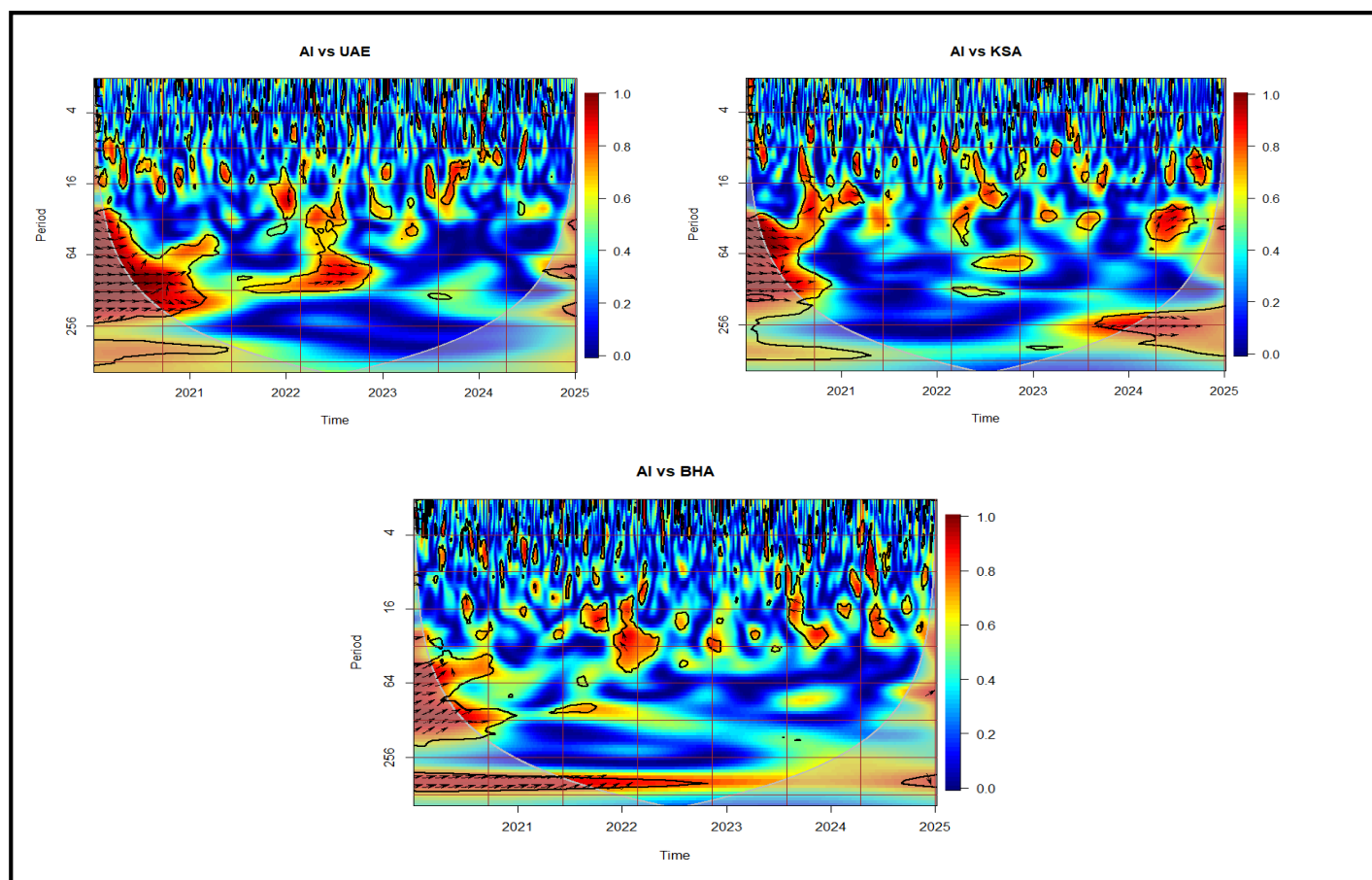
have positively impacted on KSA stock market but at Period 64 in 2023 suggesting the negative

connections appear where indicating the fintech market is more leading. A positive connection appears from 2023 to 2025 roughly around period 64 to 16 where vectors arrows moving diagonally upward right suggesting that fintech in driving the market. In picture (fintech vs BH) there was positive correlation between fintech index and Bahrain stock index on period 64 before 2021 suggesting that both variables have increased over the time. The variables shows negative

connection at period 16 in 2022 to 2024 with vector arrows heading diagonally upward to the left side suggesting that the Bahrain stock market is leading and fintech stock index is lagging. The variables vector in

2024 at period 16 arrows point diagonally upward to the right side implying that the fintech index and Bahrain stock market are positively linked.

Figure 3
AI Index and GCC Stock Indices

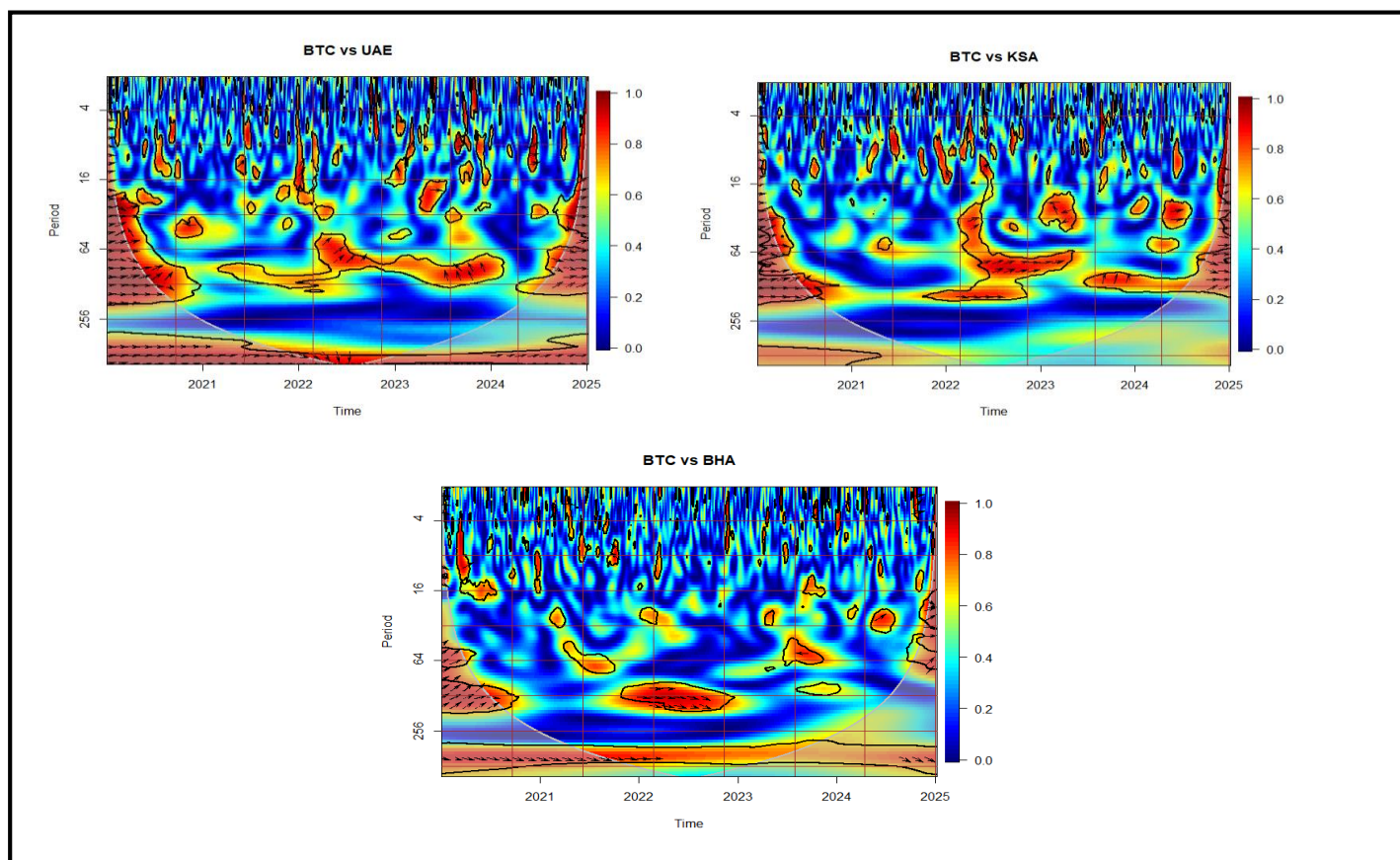


In picture 3 (AI vs UAE) showed a positive connection before 2021 between period 64 to 16. The arrows point diagonally upward and the right side suggesting that AI stock index is heading in the market. Vectors arrow moving diagonally upward right indicate the connection of the positive correlation from 2021 to 2025 roughly around period 64 to 16 that suggested AI stock index have a great impact in the market and both variables have strong relationship. In picture 2 (AI vs KSA) the relationship these variable shows positive association but a fall earlier in 2021 at around period 64 the vectors arrows go diagonally downward right explaining that AI is leading in the market. These two variables show slightly increase in 2022 to 2025

at period 64 to 16 diagonally arrows pointing right direction on upward side showing that AI is dominating and have a positive correlation with KSA stock index. In picture 3 (AI vs BH) at the start of 2021 to 2022 they have strong positive correlation during period 64 to 16 by vector arrows pointing diagonally upward right side demonstrating that AI has boosted the Bahrain market. The variables show a negative connection from 2023 to 2024 with vector arrows heading diagonally upward to the left suggesting that the Bahrain market is leading and AI stock index have less impacted. A slightly positive connection between the variables diagonally arrows pointing right direction on upward side in 2025

between the period 16 suggesting that AI have slightly impacted positive on Bahrain stock index.

Figure 4
BTC and GCC Stock Indices

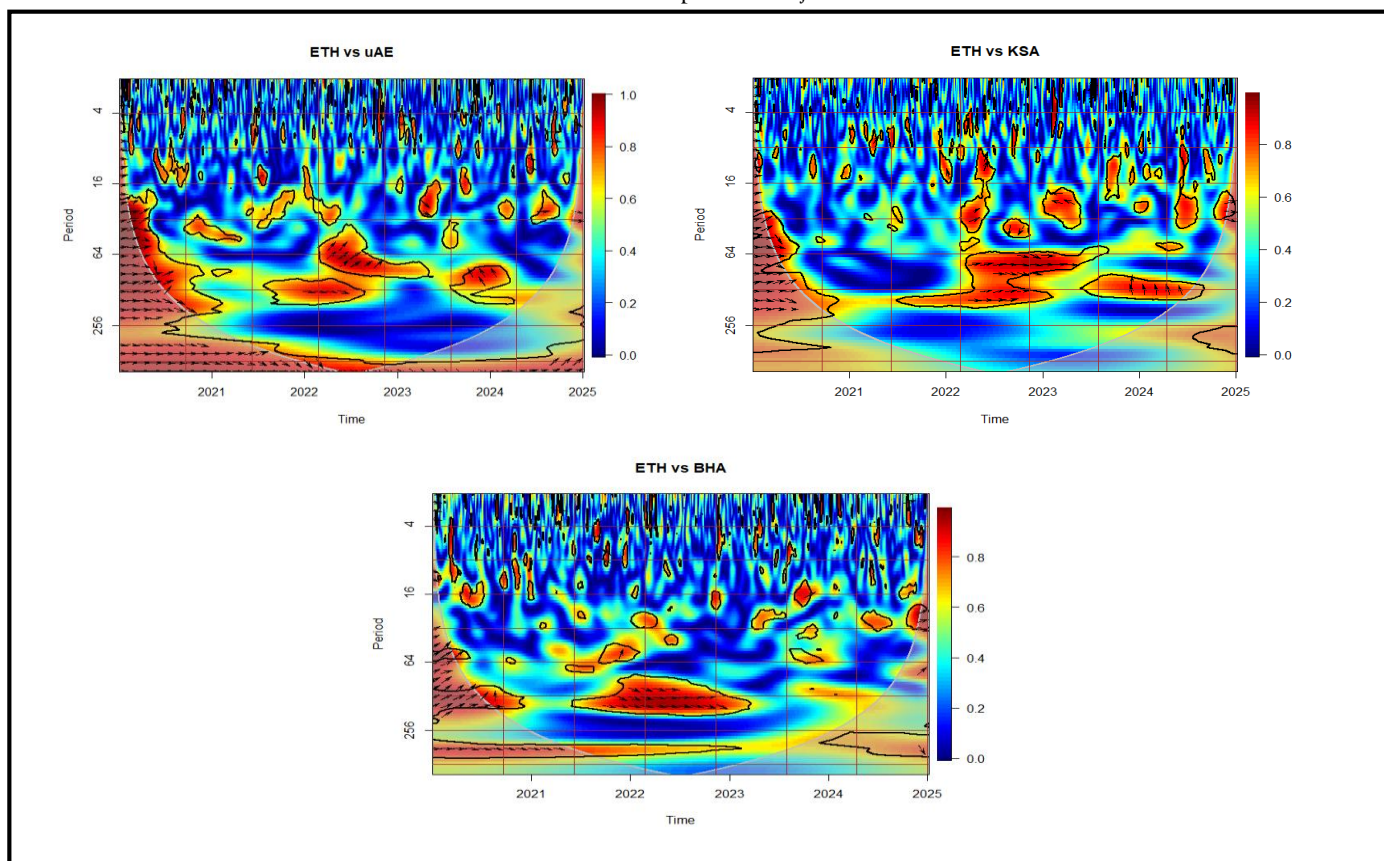


In picture 4 (BTC vs UAE) have positive correlation with one another just before 2021 till 2023 between period 4 to 16 arrows move diagonally upward and right side this suggesting that crypto currency control in the market. Comparable patterns are seen between 2023 to 2024 on period 64 while a negative connection between the variable diagonal arrows pointing left direction on upward and in between 2024 to 2025 on period 16 its shows the vector arrows move on the right side diagonally upward which indicting the cryptocurrency have great impact and both index are have positive correlation. . In picture 2 (BTC vs KSA) just before 2021 at the period 64 to 16 vectors arrows are positively correlated arrows going diagonally upward to the right side in between its indicating the crypto currency is leading in the market. At 20222 to 2025 in period 64 to 16 providing positive correlation it's indicate that cryptocurrency has still a great impact in the leading market diagonally upward to the right side in between its indicating the crypto currency is

leading in the market. At 2022 to 2025 in period 64 to 16 providing positive correlation it's indicate that cryptocurrency has still a great impact in the leading market. In picture 3 (BTC vs BH) even before 2021 to 2022 there existences an upward trend in between BTC and Bahrain stock index as demonstrated by vector arrows heading diagonally upward. This indicate that the cryptocurrency market is leading.in between 2022 to 2024 at the period 64 the vector arrows show slightly upward on right side as the some down ward on the right side which indicating the negative impact and slightly positive correlation reappears in between 2024 to 2025 roughly around period 64 to 16 with vector arrows moving diagonal upward to the right side that suggesting the crypto currency us driving in the market.

Figure 5
ETH and GCC Stock Indices

upward direction suggesting that cryptocurrency is regulating the market. In picture 2 (ETH vs KSA) both variables have positive correction link around period 64 just before 2021.



In picture 1(ETH vs UAE) have a positive relationship in year 2021 to 2022 from time frame 64 to 16. This correlation is showing diagonally arrows pointing right direction on upward side. Demon string the cryptocurrency is infusing in the market. After the year 2022 on some point show negative correlation as the factor arrows moving downright side at the point on 64.in between 2022 to 2023 shows there factor arrows move positively diagonal right side which indicate the crypto currency have positive relation in the market leading. At the point 64 in 2024 factor arrows move diagonally left up side which indicting the negative impact between variables. Yet at period 16 in 2024 to 2025 diagonal arrows move right

A positive connection is seen at the 2022 to 2023 in period 64 there is a brief upward right that suggest cryptocurrency is booming the market and both index are growing in importance. A negative correlation is seen at point 64 to 16 in years 2022 to 2024 with decreasing tries and vectors arrows point upward slop on left side which is revealing a decrease in the crypto currency market. In picture 3 (ETH vs BH) have a positive relationship just before 2021 at the time frame 64. This correlation is shown by diagonal arrows pointing right side upward direction

demonstrating the crypto currency is influencing in the market. In between 2022 to 2023 at period 256 to 64 a negative connection that shows diagonal arrows pointing right downward direction suggestion that BH stock index is leading in the market which crypto currency is trailing behind a slightly positive impact shown in between 2023 to 2024 means positive correlation impact.

DISCUSSION & CONCLUSION

The present research explores the dynamic impact of newly emerging financial technologies cryptocurrencies (bitcoin, Ethereum), and (Fintech Index), as well as artificial intelligence (AI) assets in the stock markets of GCC countries (UAE, Saudi Arabia and Bahrain). With the aid of wavelet-based methods, particularly Continuous Morlet Wavelet Transform (CMWT), the study decomposed time-series by examining co-movements and volatility patterns at various time horizons and frequency levels. The findings illustrate that the interaction of these innovative technologies with the financial market indices of GCC is time dependent, multi-scaled and complicated. We found periods of high coherence during some economic and geopolitical events, and thereby concluded that digital assets, for example, Bitcoin and Ethereum, in addition to the FinTech and AI innovations, can have impact on the regional financial markets in both short and long time frame. More importantly, AI and FinTech assets seemed to have significant lead-lag relationship stock indexes, suggesting the increasing significance of these new assets as potential market mimickers in the GCC. The Study's conclusions also suggest that investors along with authorities in financial technology have no choice but to use direct interventions to stem the risks posed to stock markets and the price of bitcoin. Moreover the presence of both leading and lagging behaviors in the findings provides ample marketable intelligence for investors with regard to the optimal times to enter the market for portfolio diversification as well as risk mitigation. Such conclusions assist regulators in the GCC to facilitate the growth of financial technology as well as the economic development of the region by understanding the interrelation in the financial market.

Above all, the study has importance for investors, financial regulators, and policy makers. It highlights the importance of observing the dynamic inter-relationship between technology-based assets and regional economies. Wavelet analysis is applied, as a powerful method for the capture of the dynamic and non-linear natures of these associations. Serving as a foundation for these intricate co-movements, a deeper and clearer comprehension can be used by GCC stakeholders when considering investment strategies, policy frameworks and risk management in an era of growing digitalization in the financial domain.

Limitations and Future Research:

This research has several limitations despite the fact that it is presenting informative data regarding the dynamic effects of fintech, cryptocurrency and artificial intelligence on GCC stock market indices. The analysis is not likely to take into consideration long term structural shifts in financial markets since it is limited to the period from March 1 2020 through February 28 2025. Other powerful macroeconomics and geopolitical factors such as interest rates, inflation and volatility of oil prices are outside the scope of the attention to a handful of variables; cryptocurrencies, fintech, artificial intelligence and GCC stock Indexes. The Continuous Morlet Wavelet Transform (CMWT) is limited with regards to handling nonlinearities sudden interruptions or high volatility even if it is effective in exploring time frequency relationships.

For any future study, significant numbers of changes can be suggested. In place of time series data at longer intervals, scholars can use daily or hourly data to find high frequency relationships between cryptocurrencies and other financial assets. This framework can also be used for new markets in the fintech and cryptocurrencies

sector such as the GCC and south Asia by combining regional Fintech indices or stock benchmarks related to the sector. In addition unknown phenomena of conventional stock indices could be unveiled by combining DeFi indices with tokenized assets and AI enhanced fintech indicators. Lastly upcoming research could improve the treatment of temporal changes and structural breaks in the interplays between crypto and financial systems by employing other data analyzing methods

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