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An Investigation of Diversification Benefits and Hedging Capabilities of Cryptocurrencies in Portfolio Management during COVID-19

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Abstract: The study aims to explore the hedging capabilities and diversification benefits of three cryptocurrencies, Ethereum, Ripple and Litecoin in a portfolio, constructed with traditional asset classes. The portfolio comprises traditional assets gold, Brent oil, USRE, S&P 500 and Pvt. Equity. The daily data has been taken from 31st Aug 2015 to 31st Aug 2021. The daily data has been obtained from Coin desk Market and St, Louis FRED database. Dynamic conditional correlation GARCH (DCC-GARCH) model has been applied to find the hedging capabilities and diversification benefits of cryptocurrencies in the portfolio pre-COVID-19 and during COVID-19. The empirical results reveal that Ethereum, Litecoin and Ripple provide diversification benefits. Moreover, hedging capabilities and diversification benefits of three cryptocurrencies, Ethereum, Ripple and Litecoin have been forecasted by employing the Vector Autoregression (VAR) model and found that the price of Ripple has been an increasing trend.

INTRODUCTION

The outbreak of Coronavirus flares up the value of certain assets like pharmaceutical and Information Technology (IT), on the other hand, influences the prices of some assets such as crude oil, currencies, Forex, etc..

The COVID-19 pandemic weakened the global financial framework in the first quarter of 2020[1]. Global stock markets and commodity markets face a slump and the prices of commodities and stocks dropped abruptly. Since, the start of the COVID-19 pandemic, the value of financial assets fell sharply, even turned to negative returns[2]. In any case, it draws a significant consideration from financial practitioners, media and researchers. Similar to the Global Financial Crisis (GFC), the financial markets faced an overall economic recession during the worldwide and financial crisis that began in 2007 with the sub-prime mortgages in the USA, the gold price has been recorded an extraordinary increment while different resources had misfortunes[3].

The recent COVID-19 pandemic, in research, has been connected to GFC, due to its unique nature. During the pandemic, the hedging capabilities of certain assets have been changed, yet gold is still viewed as a zero-beta asset and is often said to be uncorrelated with other assets[4]. Other assets such as bonds, futures of commodities, real estate, T-bills, currencies, etc. have

been used to construct a portfolio to diversify or hedge risk. Government securities are found to be the safest hedge against uncertainties[5]. The relationship between gold and the crude oil price has been investigated and found to be inversely correlated, because oil has the highest unpredictability while gold has the least instability[6]. The literature utilized various types of GARCH Models that have been applied to find volatility in the prices of assets which implies that positive and negative shocks effects that influence the price of assets in terms of magnitude[6]. The literature explores that the worldwide vulnerability encompassing the 2007 global financial crisis resulted from the development of the initial decentralized cryptographic money recorded onthe "Blockchain" innovation named Bitcoin and fortified its fame. The emergence of cryptocurrencies is considered to be a significant development after the Global Financial Crisis (GFC). These cryptocurrencies are decentralized and recorded on a digital ledger, "Blockchain" and uses cryptography to control, transfers and manage[7]. The pioneer of cryptocurrency Satoshi Nakamoto has introduced this currency in 2008. The Global Financial Crisis (GFC) is classified as a global recession which was revealed in the shape of an overall economic crisis that led to inflation, trade deficit, low economic growth, money devaluation and dwindling monetary reserves[7]. Soon after GFC, the investors faced tight policies of financial markets and less chance of investment, moreover, less diverse portfolio as many assets turned to negative returns[8]. So, the investors look for alternative assets, then existing, to prepare a diverse portfolio. In this context, Bitcoin, being the first cryptocurrency, gained much attention from the investors, later on, many other currencies rose to prominence. Bitcoin has also been argued as an asset with high transaction cost, less acceptability worldwide, especially in emerging economies and recognize as an asset in the world's formal financial system[9]. Fiat money, till now, is not considered a recognized medium of exchange. Even then, over time, many other cryptocurrencies were introduced such as Ripple, Lite coin, Ethereum, Binance Coin, Tether, Cardano (ADA),Dogecoinetc[10]. However, data extraction is difficult for many investors. Cryptocurrencies have been evolved gradually and were considered immature markets but over the last few years, it is reaching maturity and has been considered as an attractive asset for hedge[11]. This attribute of acting like a hedge increases the growth and development of cryptocurrencies, moreover, trading frequency and volume. Cryptocurrencies resemble the other assets used as a hedge in a portfolio, however, distinct features from traditional assets, in terms of liquidity, the existence of marginal arbitrage and trading platforms[12]. Due to these differences, cryptocurrencies, even not gained momentum but have been used as a hedge or a diversifier in a portfolio. The cryptocurrency market needs more time to become mature and gain acceptability in the financial mainstream. Although, Bitcoin, among all cryptocurrencies, has been much researched and used as a hedge in portfolios yet, other cryptocurrencies are also gaining the attention of investors[13]. Moreover, the acceptance of cryptocurrencies as a reliable medium of exchange is still disputable due to their anti-regulatory, anti-environment, exotic nature and sometime fraudulent 'feel[14]. Moreover, cryptocurrencies unable to prove be an asset with some intrinsic value and act as a hedge[13]. Cryptocurrency market is believed to be far from an efficient market as inexperienced young individual investors' trade in cryptocurrencies. These currencies are more for a speculator than an experienced investor. Subsequently, in absence of taxation and regulatory regulations and institutional investors, cryptocurrencies are not considered as safe investment. Cryptocurrencies, by nature, carry risk factors but have been considered as fiat money or only a digital currency[15]. However, some researchers consider cryptocurrencies as speculative assets[16]. Contrary to this, some considered that by adding cryptocurrencies, a portfolio is considered to diversify and these currencies have used a hedge or a diversifier, especially during the economic recession. The existing literature explores cryptocurrencies in context to other assets with high intrinsic value as gold and Brent oil[17]. Much of the literature while discussing the hedging attributes of an asset, discusses the newly evolve cryptocurrencies concerning other assets such as gold, Bonds, USD, real estate, etc.[5].

Recent developments in introducing digital currencies after the global financial, cryptocurrencies have gained some solid ground in terms of a reliable medium of transaction. However, the empirical evidence shows that cryptocurrencies provide a hedge but not a safe haven[18]. Therefore, the behavior of cryptocurrencies against other assets may change during economic uncertainty. Cryptocurrencies have been discussed to be a hedge against downside risk in a portfolio with other assets such as crude oil, currencies, bonds, commodities, metals, etc.[19]. Utilizing digital money rather than paper cash implies staying away from bank intermediation, transaction and confirmation costs[20]. The prefix "crypto" shows the utilization of cryptography for security and confirmation purposes throughout making and ready cash. The cryptographic money exchanges are handled by Blockchain digital ledgers the innovation that supports a large number of the developments that are as of now altering the financial administration's area throughout the planet[7]. The most outstanding use of "Blockchain" is in

the turn of events and activity of cryptographic in forms of money, however, there is an opportunity for its application in different economies like tax assessment, global exchange, store network the executives, business tasks and administration[5]. The creators of cryptocurrencies show how associations and controllers can use "Blockchain" to further develop business and proficiency while reducing functional expenses. The stockpile of digital currency is restricted, i.e., cryptographic forms of money are mined and are made by decoding complex numerical undertakings are tackled by the influence of advance digital ledger[15]. After discovering the arrangement, the digger assembles a square and adds it to the chain for which they are compensated with a specific measure of digital money[21]. Furthermore, the other cryptocurrencies are also gaining market share over time and have been used in constructing a portfolio. Fora long, portfolio management is a matter of concern for investors and academicians. An extensive literature discusses portfolio management in different countries and diverse contexts[5]. Along with cryptocurrency investment, some other assets act as a hedge during an economic crisis[22].

The relationship between these assets has been examined and found mixed results. The empirical investigation shows that Lite coin, Monero, Dash and Ripple, S&P 500, government security and gold[23]. The outcomes indicated that the concentrated cryptographic forms of money are firmly connected. Be that as it may, the associations between digital forms of money and customary monetary assets are insignificant. It is also examined time-varying connections between the S&P 500 and other digital currencies[22]. They recommended that digital currencies are seen to be a support against the dangers of the S&P 500. Moreover, it is investigated the dynamic connection between Lite coin and Ethereum and major monetary commodities and protections[24]. They upheld the possibility that these two cryptocurrencies can be great for monetary broadening. The place of refuge role of the Lite coin, wares and gold against the worldwide and country stock market[25]. The findings showed that lite coin is confined from monetary assets and can be viewed as another virtual gold[12]. Previous studies focused predominantly on lite coin and Ethereum as opposed to gold and other financial assets while little consideration was paid to other digital currencies[26].

Considering that the information given by the crude oil fills in as a significant reference to financial analysts, it is imperative to inspect the connection between digital forms of money and crude oil[8]. However, the combination of assets in a portfolio, hedging capabilities and diversification of a portfolio, during COVID-19 is still inconclusive. The behavior of the assets differs in different economies. In this paper, we break down the connection between three digital currencies (Ripple, Lite coin, Ethereum), S&P500, Brent oil, gold, Pvt. Equity price and US real estate. In the first place, we gauge the hedging capabilities of selected digital currencies, S&P500, Pvt. Equity price and US real estate[26]. Second, we gauge the dynamic contingent relationships between digital currencies. At last, we examine the dynamic correlation between gold, selected cryptocurrencies and Brent oil[27]. This study contributes to the current literature in two ways. In the first place, it investigates the connections among cryptocurrencies and financial resources in contrast to gold, particularly during the COVID-19 episode. Second, it dissects the relationship between three digital forms of currencies and Brent oil, real estate and Pvt. Equity[10].

Nonetheless, negative impacts of crude oil prices have been found on cryptocurrency prices. While cryptocurrencies are is still perceived to be puzzling and not very surely known by numerous stakeholders[28]. The examination of cryptocurrency's capabilities as a hedge or a diversifier in a portfolio is still inconclusive. Moreover, the volatile behavior of cryptocurrencies' has been empirically examined by employing GARCH family models[29].

Yet, this study focuses on the role of cryptocurrencies as a hedge or a diversifier against other assets during the COVID-19 episode[30]. However, the current writing comes up short on a reasonable comprehension of Bitcoin's unpredictability. It also needs proof of connections between other cryptographic forms of money and conventional asset classes. Most of the investigations that concentrated on the relationships betwe encryptocurrencies and different resources have utilized multi-variate GARCH models like BEKK-GARCH, DCC-GARCH or ADCC-GARCH[31, 13, 12]. Several new digital forms of money showed up and the majority of them are created hide based on Blockchain. Prior investigations were keen on model selection unpredictability elements of cryptographic forms of money. Be that as it may, few examinations have investigated the unpredictability of transmission digital currencies[32].

It has turned into a fundamental theme in the investors and the academic community. Given the acknowledgment of cryptocurrencies as a contributing asset and their rising significance, displaying value instability becomes important to venture choices and hazard the board. Many investigations used the GARCH-family models as the foundation of demonstrating cryptocurrencies' instability[33].

Literature review: A few mind-blowing developments have been observed to be happened ever, from shares to valuable metals, plastic money, paper money and Visa cards and presently the development of digital money[14]. The origin of digital forms of money was to determine vulnerabilities and doubt because of prophetic variances in monetary frameworks. The advancement of cryptographic forms of money has become progressively famous among market analysts, financial analysts and financial experts[34]. In this comprehensive discussion, the outcomes have been presented digital money strategy hazard. An extensive literature is available that explored the role of cryptocurrencyin different economies. Cryptocurrencies act as diversifiers or a hedge against extreme price loss of other assets such as Petro (resource upheld) an oil and mineral assets supported (state-possessed) digital currency in Venezuela is obvious proof for development to keep on tracking down its progressive course. The declaration of KODAK Coin by Eastman Kodak USA tech organization in 2018 strongly plunged the offer cost of Kodak from $3 US dollar to $12 US dollar inside seven days[35]. Besides, the costs and instability of Kodak, Bitcoin and DJIA are discovered profoundly associated utilizing dynamic restrictive connection summed up auto-regressive contingent heteroscedasticity-DCC-GARCH Model[25]. In this way having digital currency with a stable buying force can be valuable for speculative reasons in political-financial disturbance[9].

Cryptocurrency can be described as advanced coins which are straightforwardly open to everyone directly independent from currency-related regulatory subject matter experts, sovereign governments and obliged by the complex common course of action of cryptography electronically reliant upon Blockchain development[36, 11, 37]. A common electronic structure was introduced by Nakamoto who formed the absolute previously modernized cash called Bitcoin in 2008[38]. Unquestionably, the inevitable destiny of present-day cash may rely upon the advancement of Blockchain in light of enormous advantages. Peculiarly, the prospect of most monetary patrons has changed from Bitcoin to other emerging advanced monetary standards, achieving the strength of Bitcoin dropping. In 2014, Bitcoin held 88% of the deal in the outright market in any case 63% at this point. In computerized monetary standards, Bitcoin is considered as a safe space against the economic recession and well off recorded as a hard copy with a strong observational and speculative establishment[39]. Bitcoin strength as a safe space will be decreased later on. In addition, the Bitcoin shocks are suffering yet are not winning concerning various financial structures, even the greatest in the advanced currency market. Likewise, this shows the inadequacy of the exploratory assessment on the risk the board occupation of other cryptographic types of cash[12]. With the popularity of Bitcoin, other digital currencies gradually gained attention to become diversifier or a hedge in a portfolio. The literature explored that other digital currencies such as Ripple, Lite coin, Binance Coin, Ethereum, Tether, Cardano (ADA), Dogecoin, etc. Ripple, Litecoin, Binance Coin and Ethereum have been used to hedge the downside risk[13].

A variety of measures are available to test the risk, associated with a portfolio which has been applied by analysts during the last two decades, the most settled measure is the standard deviation between asset value and returns on the said assets[40]. There found mixed results regarding the relationship between the assets. Crude oil was found to be negatively associated with S&P500 for transparency offsetting during the long run[10]. Regardless, the latest debate, two different searches have been explored, internet-based search and paper-based records. Cryptocurrenciesare found to be searched via the internet. Later on, it was explored that these currencies face, political risk, feeling piece vulnerability of vulnerability related to money[41].

Therefore, these records have few limitations such as being hard to rehash in many countries, stunning in nature and not suitable for long-term investment[42]. Additionally, the Global Economic Uncertainty Index accessed with comparable points of developed countries with the respective GDP growth. The research explored that the Economic Policy Uncertainty Index supports the idea of global monetary approach vulnerability[43]. With the increase in monetary policies vulnerability, the models can be some help for investors to update their portfolio, adding advanced monetary standards to avoid conceivable hardship. Something different, the uncertain money-related game plans can keep adventure stream. A study has contemplated Ethereum while utilizing the D-Vine Pair-Copula strategy to set up the reason of supporting readiness for other progressed money-related structures. Ethereum was found even more astoundingly compared with US EPU stood out from Ripple and Bitcoin[13]. Thusly, the wellness of Ethereum as a hedge against EPU of the USA has recently been inspected. However, the latest research examines the role of cryptocurrencies as a diversifier or a hedge during COVID-19[44]. Much of the research explores that Bitcoin acts as a diversifier in a portfolio. Most recent evidence has considered a couple of computerized types of cash for supporting public EPUs and Bitcoin has been proficient. While assessing future ecocentrism of computerized monetary standards like Bitcoin, Litecoin and Ripple using backslide construction, discussed Chinese EPU as

more sensitive toward expecting the shakiness of Bitcoin and Litecoin while other EPU index, like the United States of America, Korea and Japan couldn't predict their future EPU[43, 45, 46]. Finally, computerized types of cash (Bitcoin and Litecoin) can be used to help public EPU. Another late investigation applied the farsighted backslide model to check out whether the EPU predicts the month-to-month return of cryptographic types of cash[27].

The adroit group kept a similar model instructive assortment, besides the extension of Ethereum whose data detachment issue restricted the time-frame to three years and four months[44]. While closing the conversation fought, the single Chinese EPU record can expect the benefits. As such, the significant information that monetary methodology vulnerability records contain redesigns the power in anticipating both return and shakiness in advanced monetary forms like Bitcoin[10]. Alternately, the flightiness of computerized types of cash isn't driven by money-related and monetary parts of a single economy yet by the overall business cycle and REAI (Real Economic Activities Index). Regardless, the middle concern is to explore peril the important plans in cryptographic types of cash yet these assessments ought to be referred to as they offer ideas to risk easing[14]. The uncertainties that affect the money-related plan vulnerability of the US toward Bitcoin were seen to be minor which is unimportant. The usage of the Multivariate Quantile Model and Granger Causality supported the introduction of Bitcoin as a diversifier or safe space against unexpected EPU incredible shocks[47].

While examining the properties of Bitcoin used GARCH and Quantile Model with contributing factors, finding that it doesn't exhibit to help the financial methodology risk of the USA in normal conditions[3]. Also, in uncertain financial circumstances, whether or not consecutive or bullish and negative examples, the ability to be as hedger or safe haven is weak but can be used for development or supporting reason. Another late concentrate chronicled the appraisal of Quantile backslide and Ordinary Least Square techniques to portray the lead among Bitcoin returns and EPU (UK, USA, Japan, China and Hong Kong), Global EPU, money related approach vulnerability (MPU), VIX2 and SPX3 and Bitcoin returns[48-50]. Results attested that Bitcoin can continue as a hedge or diversifier against market vulnerability, particularly returns of Bitcoin are more open to money-related methodology vulnerability of China, Japan and United States[31, 43, 11]. Exhaustive, the relationship between Bitcoin returns and the vulnerability and uncertainty of significant market capitalization is negative.The empirical evidence intends to focus on the inconspicuous miracles of other advanced types of cash to ensure whether the losing transcendence of Bitcoin in the computerized money market opens the limits of other most elevated cryptographic types of currencies Bitcoin, XRP, Ethereum and Litecoin. It is documented that the social aspect of Bitcoin monetary supporters and Bitcoin value crash risk with financial methodology vulnerability[25,24]. Particularly, the relationship of Bitcoin value crash during financial uncertainty showed a strong negative association with other assets. While pondering this, Bitcoin can be considered as a hedge against monetary policy vulnerability because of its positive or negative associations[1, 51, 12].

A couple of empirical studies have shown transient ecocentrism and return of cryptographic types of cash, in any case, explored the somewhat involved acquaintance of cryptographic currency market with proposed flightiness using GARCH-MIDAS Model[12, 52, 46]. They found a strong antagonistic outcome of NVIX on the vulnerability or flimsiness of the cryptographic currency market. Inquisitively, they documented that change in human insight has a significantly more grounded impact on cryptographic types of cash than that of financial essentials. The effect of information lopsidedness on premium in cryptographic currency market using the probability of taught trading and Vector Error Correction model. They found that the investors rely upon assessment rather than information about cryptographic types of cash. It is investigated that the incredible impact of worldwide and financial uncertainty on the association instances of a couple of currency-related stocks and other assets with cryptocurrencies using DCC-GJR-GARCH[53].

Moreover, they checked the impact of these parts on Bitcoin peril premium and flightiness[1, 54, 55, 47]. Results attested that EPU and GPU hold a strong impact during horrendous money-related and financial periods. Another study examined the non-directional relationship between financial uncertainty-bearish and bullish market trend (market assessment) and portfolio management. They used non-parametric quantile and Granger Causality test and found that EPU document firmly connected with a couple of computerized types of cash in purchaser market and the shockingly greater number of money related principles compared to bear market[56]. Additionally, the impact of political and financial uncertainty on the cryptocurrency market using OLS Model[5].

The monthly data of cryptographic types of cash has strong support against GPU and weak against EPU during the bullish market condition. During the financial course of action, weakness is an especially basic factor to choose the benefits of cryptographic types of cash. Another study

used EWMA Models and GAS Model and noticed Bitcoin be a supporting instrument against US EPU[53]. Furthermore, it is investigated the effect of monetary strategy vulnerability on the best four digital forms of money utilizing the Granger Causality test and found that Bitcoin, Ripple and Ethereum[57-60, 19, 61].

A study explores the relationship by employing Quantile cross-validation regression to assess the connectedness among cryptographic forms of money and financial arrangement vulnerability during COVID-19[62, 47]. The research found that Bitcoin and XRP are the most fitting support against high-EPU. Actually, on account of low or moderate EPU, digital currencies are not a significant hedge. Similarly, new exploration has broken down a connection among computerized and EPU and investigated supporting place of refuge and diversifier properties utilizing the ARCH Model[13]. They found that Litecoin and Ethereum are diversifiers for Bitcoin[25, 24] and Bitcoin is a place of a hedge or a diversifier for EPU[46]. Similarly, the connectedness among EPU, valuable metals and Bitcoin utilizing a non-parametric quantile approach[63]. They tracked down that both valuable metals and Bitcoin don't go about as a safe haven. In addition to this, the EPU and Bitcoin return during COVID-19 utilizing the Predictive Model (OLS-GQS summed up quantile relapse). The researchers reasoned that Bitcoin is a hedge for EPU hazards during the COVID-19 pandemic. Likewise, cryptographic money and strategy vulnerability relationship and prescient capacity of EPU for digital currency return utilizing time-varying VAR[42]. They found that EPU predicts cryptographic money vulnerability and is consequently appropriate support. One more ongoing paper revealed the effect of EPU on the digital currency market utilizing basic OLS relapse on monthly data[64]. The outcomes recommended solid and feeble hedge and place of refuge EPU and economic uncertainties. One more intriguing piece of examination has as of late been considering the COVID-19 pandemic and place of a hedge of crypto-resources for EPU[46]. They found that digital forms of money are the place of hedge non-financial uncertain intermediaries but these currencies are not a hedge for monetary intermediaries during COVID-19[13]. In a comparable unbiased, a review researched the connection between Bitcoin and EPU utilizing the OLS regression model through everyday information[55]. They reasoned that cryptocurrency goes about as a place of hedge during COVID-19. An ongoing investigation found that when the cost of cryptocurrency floods it causes a decrease in the cost of gold, along these lines an obvious indicator of sabotaging the recorded supporting inclination of the gold[31]. Notwithstanding, a similar example has been found for gold against cryptocurrency, thusly, both can be utilized as an option not in a rivalry against the worldwide EPU in the negative and bullish market trend while the two of them relieve the danger of winning in the monetary framework. Characteristics of being used as a place of hedge and critically, store of significant worth, frequently include cryptocurrency as indistinguishable from gold. The solid mechanism of trade and the store of significant worth regularly put digital forms of money in the middle of Gold and US Dollars for a hedge, portfolio broadening and ideal decision hazard loath financial backers in the market found right off the bat[35]. Cryptocurrency can't generally be viewed as a hedge against Global EPU on the grounds that the costs and instability of cryptocurrencies are additionally controlled by outside (EPU and GEPU) and cryptocurrency explicit elements (digital assaults and theoretical air pockets). Aside from the related danger, financial backers should consider digital currencies like cryptocurrency for appealing advantages[56].

The uncertain global financial strategy impacts the value of cryptocurrency somewhat, in this way frail impact on support could lead financial backers to limit their supporting results. The findings of DCC-MIDAS-GARCH approve cryptocurrencies as a hedge under a specific period and Global EPU impact emphatically on the relationship of cryptocurrencies with other assets, be that as it may, adversely on Bitcoin-Bonds[52]. Prior, mechanical loads of various developing business sectors observed to be adversely connected with GEPU thus can be added for the enhancement in cross-industry portfolios closed utilizing DCC-GARCH and Rolling Window system[29]. Also, cryptocurrency has been found as a hedge or diversifier against the Global Financial Stress Index for quite a long time during the European Debt and Cypriot Banking Crisis utilizing Copula-based displaying[21].

The foundation of crude oil, gold and US dollar related to the supporting prospects are clear in the composition. Cryptocurrencie's position in a portfolio, especially during uncertain financial conditions, is to be a hedge or a diversifier[8]. Moreover, this debate opens copious opportunities for academicians to research the risk-reducing properties of digital currencies. The investigation moves around the examination of the standard limit of gold and cryptocurrencies as diversifiers or a hedge during the higher overall financial crisis or higher GEPU[26]. Nevertheless, our assessment hopes to focus on the inconspicuous marvels of other advanced types of cash to ensure whether the losing strength of Bitcoin in the advanced currency market opens the limits of other most noteworthy computerized types of cash like Bitcoin, Ethereum, XRP and Litecoin[65]. Moreover, the

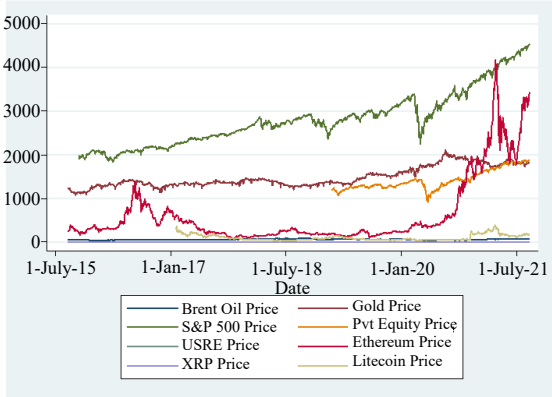

Fig. 1: The price data distribution during the sample period

hedging capabilities of cryptocurrencies Ethereum, XRP and Litecoin against in a portfolio with other assets, Brent oil, gold, S&P500, Pvt. Equity and US real estate[66]. Figure 1 shows the price data distribution during the sample period. The prices of Ethereum show a significant increase in price over time.

MATERIALS AND METHODS

This study comprises the daily dataset of eight assets including, gold, Pvt. equity, Brent oil, USRE, SP500, cryptocurrencies (Ethereum, XRP, Litecoin) for the period from 31-Aug-15 to 31-Aug-2021. The data has been obtained from Coin desk Market and St, Louis FRED database. To prepare a portfolio, the cryptocurrencies have been selected based on the market that is more than 1 billion. Moreover, they split into two widows based on the COVID-19 pandemic. The analysis has been conducted based on a whole period and since 01-Jan-2020, "Covid" has been taken into consideration.

From Table 1 shed light on descriptive statistics of the full sample period and COVID-19 window. During the full sample period, SP500 Price and Ethereum Price scored the highest volatility. On the other hand, the data is positively skewed other than Brent Oil Price, the data lies on the lowest side of the curve, while much of the data during the COVID-19 period is negatively skewed. The data of USRE Price and Ethereum Price have peak values (leptokurtic) and might face the thin tail risk. However, during the COVID-19 period, the distribution is platykurtic.

From Table 2 reveals the results of the Augmented Dicky Fuller Test for stationarity. The data is found to be stationary at a level of 5% significance. However, the data of USRE Price is stationary at 1st difference. During COVID-19, the data is found to be stationary at the level. From Table 3, shed light on the results of the correlation between the eight asset classes. According to the research question. While examining a portfolio, the correlation is considered to be a key concern to the investors. It has been explored that gold is positive, 48, 7 and 22% correlated with SP500Price, Pvt. equity price and Litecoin price, respectively in the portfolio during the COVID-19 period. Gold, in this scenario, plays the role of a safe haven to the investors. On the other hand, USRE Price is negatively correlated with gold during the full sample and also negatively correlated with other assets during the COVID-19 period. The three cryptocurrencies, Ethereum, XRP and Lite coin are positively correlated with other assets, however, XRP and Lite coin is negatively correlated with USRE Price during the COVID period, while the lite coin is also negatively correlated during the whole sample period.

Three of the cryptocurrencies are positively correlated to all other assets during the full sample period. Concerning MPT, the assets are utilized as a safe haven while negatively correlated with other asset classes. The existing literature supports gold as the safe haven against many assets, especially during an economic recession or financial turbulence, since, the 1960's it has been explored that gold is considered to be the safest asset for investors to invest in. This study also reveals consistent results. However, during COVID-19, the investments are found to be switched in other asset classes such as towards USRE, as the asset is negatively correlated.

Dynamic conditional correlation model: In this study, the DCC-GARCH Model proposed by Engle has been employed to address the research question. This model is applied to find out the conditional correlation between the assets over time, it also allows to detect of investor behavior over time in the reaction of market news and change in economic condition. Besides, the estimation strategy for dynamic conditional correlation is reasonable to investigate correlated impacts as a result of grouping conduct in creating financial sectors during the crisis. Furthermore, utilizing DCC-GARCH Model can be favorable to gauge connection coefficients of the normalized residuals, thus, represent heteroscedasticity straightforwardly. Attributable to the procedural change of instability, the time-differing DCC doesn't have any predisposition from unpredictability:

$$P_t = L+\tau rt\text{-}1+\varepsilon_t \quad (1)$$

where, ε_t stands for $H^{1/2}$ t η_t:

Table 1: Descriptive statistics

Variables	Obs.	Mean	SD	Min	Max	Skew.	Kurt.
Brent Oil Price	1550	56.457	12.806	19.33	86.29	-0.197	2.478
Gold Price	1550	1470.642	230.347	1070.8	2103.2	0.788	2.442
SP500 Price	1550	2806.425	628.994	1829.08	4528.79	0.822	3.132
Pvt. Equity Price	1550	1415.562	222.863	911.91	1877.02	0.627	2.393
USRE Price	1550	0.034	0.055	0	0.27	2.048	6.394
Ethereum Price	1550	487.076	717.688	6.7	4167.78	2.48	8.872
XRP Price	1550	0.324	0.356	0.004	2.78	2.347	11.2
Litecoin Price	1550	97.878	66.455	23.08	387.96	1.393	4.662
COVID-19 window							
Brent Oil Price	430	52.7030	14.6660	19.3300	77.1600	-0.0080	1.2540
Gold Price	430	1808.3700	110.9090	1494.6000	2103.2000	0.3540	2.3540
SP500 Price	430	3570.4990	525.2430	2237.4000	4528.7900	1.2750	1.0870
Pvt. Equity Price	430	1505.4630	228.6610	911.9100	1877.0200	-0.0076	1.2750
USRE Price	430	0.0020	0.0040	0.0000	0.0200	0.1860	1.8720
Ethereum Price	430	1428.9390	1036.1240	225.0900	4167.7800	-1.2640	2.1876
XRP Price	430	0.5740	0.3880	0.1750	1.8360	-0.1865	1.2650
Litecoin Price	430	115.8470	81.6880	29.7900	387.9600	-1.2760	1.1410

Table 2: ADF unit root test

	Full sample		COVID period
Variables	ADF-Level	1st Diff.	ADF-Level
Brent Oil Price	-2.860		-0.0018
Gold Price	-0.871		0.008
SP500Price	-0.569		-0.026
Pvt.Equity Price	-0.571		0.006
USRE Price	0.351	0.0253	0.025
Ethereum Price	-1.489		-0.724
XRP Price	-0.161		-0.243
Litecoin Price	-1.679		0.075

ADF = Augmented Dickey-Fuller significant at 5%*** level

Table 3: Correlation matrix

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) Brent Oil Price	1.000							
(2) Gold Price	-0.440	1.000						
(3) SP500Price	0.369	0.581	1.000					
(4) Pvt. EquityPrice	0.371	0.509	0.930	1.000				
(5) USREPrice	0.332	-0.671	-0.434	-0.395	1.000			
(6) EthereumPrice	0.269	0.526	0.902	0.890	-0.358	1.000		
(7) XRPPrice	0.280	0.405	0.764	0.762	-0.269	0.893	1.000	
(8) LitecoinPrice	0.425	0.167	0.647	0.651	-0.010	0.807	0.830	1.000
Correlation matrix-COVID-19 window								
(1) Brent Oil Price	1.000							
(2) Gold Price	-0.254	1.000						
(3) SP500 Price	0.433	0.483	1.000					
(4) Pvt. Equity Price	0.239	0.072	0.826	1.000				
(5) USRE Price	0.1.27	-0.762	-0.537	-0.182	1.000			
(6) Ethereum Price	0.492	-0.635	0.825	0.926	-0.282	1.000		
(7) XRP Price	0.320	-0.371	0.653	0.826	-0.352	0.725	1.000	
(8) Litecoin Price	0.563	0.218	0.725	0.562	-0.345	0.898	0.725	1.000

Correlation matrix for whole sample and "COVID-19" period

Where:

P_t = The price indexes
L = The fixed-parameter
τ = The coefficient matrix of the own-lag cross mean transmission values
ε_t = The error term
η_t = The iid stand for innovation matrix

While, conditional volatility matrix= $H^{1/2}$ t. The covariance matrix:

$$H_t = D_t R_t D_t \quad (2)$$

Where, diagonal matrix is: $D_t = \text{diag}(\sqrt{h_t^x}, \sqrt{h_t^y}, ...,)$ is the dynamic standard deviations of the assets in the portfolio. the dynamic conditional correlations between the assets have been found by employing the regression equation:

$$\rho xy_t = \alpha 0 + \delta 1 COVID_t + \delta 2 GFC_t + \varepsilon_t \quad (3)$$

where, ρxy_t, stands for conditional. The COVID period starts from 1st January 2020 till 21st August 2021 while the prior period is considered to be GFC period.

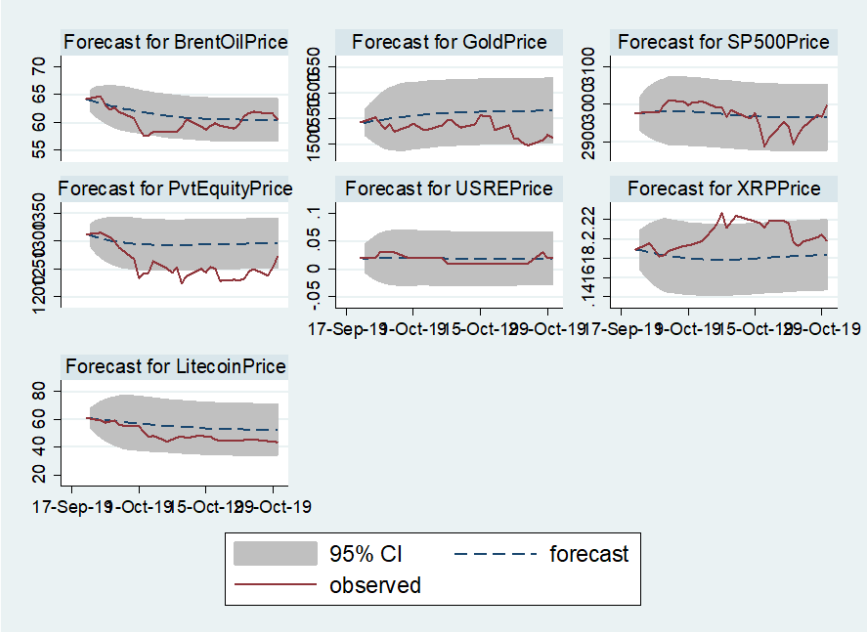

Fig. 2: Forecasting

Considering the advantages of portfolio management, broadening, supporting abilities and portrayal of cryptocurrencies as an important asset class, time-varying volatilities and dynamic relationships are imperative to decide. In this study, two unique connection GARCH models were utilized. DCC-GARCH displaying procedures with Gaussian and t-conveyance were utilized to assess essentials of extreme probability.

The consequences of the high probability of unpredictability parameters (lamda 1 and 2) and relationship parameters (lag) of t-distribution DCC with Gaussian DCC are displayed in Table 4 reveals these parameters which are profoundly critical in the two models. The amount of unpredictability parameters for every asset class series is under 1. It demonstrates that contingent volatilities are mean returning with consistent rot of volatilities. At the same time, the amount of connection between the parameters is likewise under 1 for all asset class series. It additionally shows that restrictive relationship is means returning entire volatility will gradually return to ordinary. Table 4, reveals that gold, XRP and Pvt. Equity prices are negatively correlated. The portfolio is diversified, during the financial crisis, the investment in gold, Litecoin, XPR and Pvt. Equity would act as a hedge for other assets in the portfolio.

Forecasting with VAR (Vector Aut-oregression) model: VAR captures the interdependency among the variables. VAR process is well established in testing interdependency and forecasting the multi-variate time series data. The model has been employed to analyze the interdependence of selected eight assets in a portfolio and the predicted behavior of these assets. Moreover, a causal relationship should exist between these assets. To test this relationship. The cause and effect relationship has been applied. All assets have been treated as endogenous, there are no exogenous assets exist in Table 5.

Before applying the VAR model, the lag selection criteria has been selected maximum at four lags and found that the results of AIC and SBIC refers first lag as lag selection criteria.

Forecasting techniques: After identification of the lag length criteria for the best model, as we have applied ADF test for stationarity, to construct a best-fitted model for forecasting.

Figure 2, shows the forecasted results by employing VAR model. Before COVID-19, the assets Brent oil, Gold, Pvt. Equity perfumed lower than the forecasted values. The rapid downfall in the world oil market created a slum in the overall market as many industries are associated with the oil sector. Yet, the graph shows that during the period of the downfall of Brent oil price, gold plays a role of a hedge with relatively high prices. Therefore, the price of Pvt. Equity falls sharply. SP 500 price is found to be greater than the furcated price at the beginning of the year but later on, fell sharply. The price of USRE was well predicted while XRP outperforms and more than the forecasted price yet there is not much difference in Lite coin observed and forecasted price.

Table 4: Dynamic conditional correlation MGARCH Model

Assets	Co-eff.	p-values	Variables	Co-eff.	p-values
LD. Brent Oil Price	0.026	0.000	Pvt. Equity Price	-0.02	0.000
Lite coin Price	-0.108	0.000	XRP Price	-0.087	0.000
Ethereum Price	0.115	0.000	L. USRE Price	0.02	0.000
SP500Price	0.086	0.000	Gold~i	-0.091	0.000
Constant	0.079		Constant	0.089	
Constant	0.11		Constant	0.098	
lambda1	0.241	0.007	lambda1	0.227	0.000
lambda2	0.758	0.007	lambda2	0.744	0.000

*** p<0.01; ** p<0.05; * p<.1; This table reports the estimates as: $\hat{\rho}xy_t = \alpha 0+\delta 1 Covid_t+\varepsilon_t$. ***, ** and * indicate statistically significant at 1, 5 and 10% levels, respectively

Table 5: Lag selection criteria

lag	LL	LR	Df.	p-values	FPE	AIC	HQIC	SBIC
1	-2183.570	3810.500	64	0.000	489778*	35.8028*	36.4612*	37.4235*
2	-2136.240	94.661	64	0.008	645381	36.067	37.311	39.129
3	-2080.540	111.410	64	0.000	758195	36.199	38.028	40.701
4	-2018.630	123.82*	64	0.000	830003	36.232	38.647	42.175

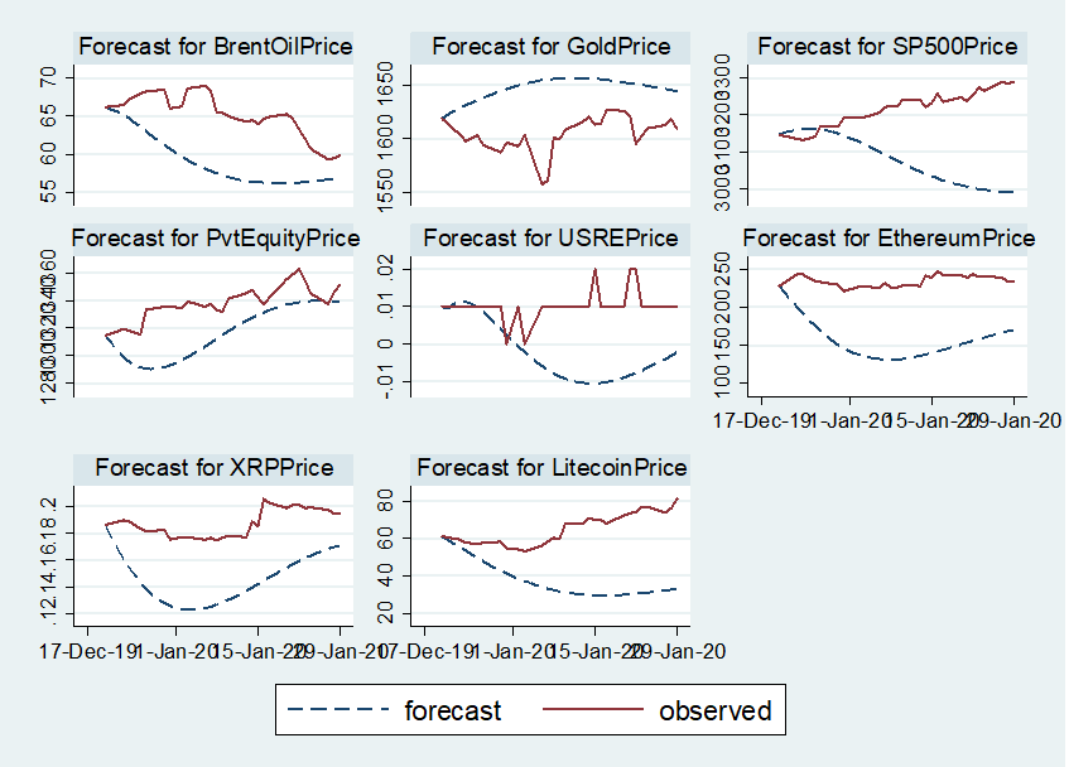

Fig. 3: VAR forecasting

Figure 3, reveals that the forecasting within the sample, of Brent oil, gold, S&P 500, Pvt. Equity price, USRE, Ethereum, XRP and Lite coin perform above the forecasted price during the COVID period while the gold prices perform less than the forecasted price.

Figure 4, reveals that the forecasting, within the sample, of Brent oil, S&P 500, gold, Pvt. Equity price, USRE, Ethereum, XRP and Lite coin perform above the forecasted prices. This study employed VAR model for 24 steps ahead to forecast the hedging capabilities of cryptocurrencies in the portfolio[67]. The graphs show that the price of Brent oil, S&P 500, Pvt. equity and ripple depict a rising trend in the future with reducing the price of gold and Litecoin. However, the price of Ethereum has been forecasted to almost follow the same trend with a little fluctuation.

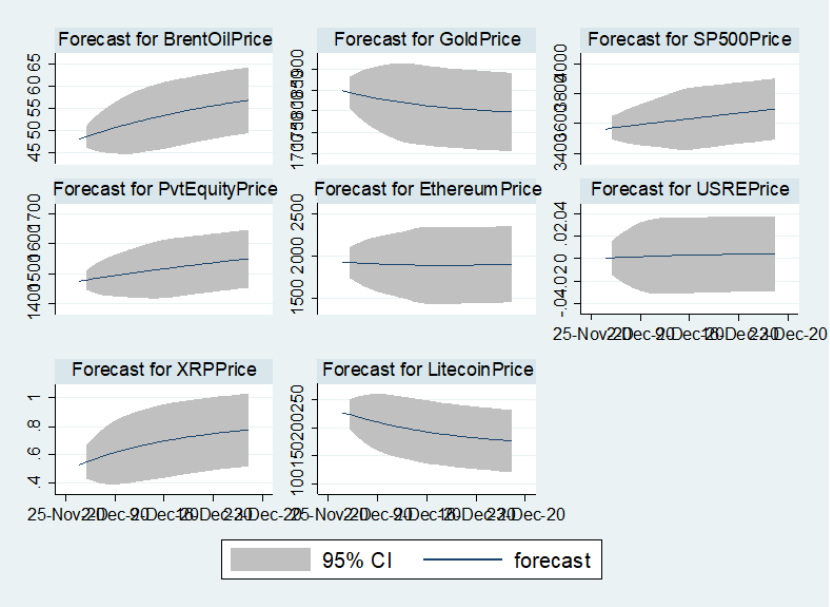

Fig. 4: Parameters of forecasting

RESULTS AND DISCUSSION

Investors and academicians seek to find a combination of assets to construct a well-diversified portfolio[68]. After the global financial crisis, a digital currency was introduced and gained much attention over time. These currencies are traded internationally through a digital ledger "Blockchain". Extensive research considers the cryptocurrencies, a hedger or a diversifier, in a portfolio with other traditional assets[68]. This study finds that, whether constructing a global portfolio with different traditional asset classes and enjoying diversification, may benefit from investments in cryptocurrencies. The optimal portfolio including cryptocurrencies may outperform a naïve yet optimal portfolio without cryptocurrencies, having a minimum variance of the portfolio with risk-adjusted returns. This study contributes to the existing literature by examining the marginal effect of adding cryptocurrencies in a portfolio with other traditional assets pre-COVID and during the COVID period[69]. As the prices of certain assets showed a volatile behavior during COVID-19 and the investors seek for the assets to act as a hedge and diversifier in the portfolio[70]. While considering US real estate prices, it is found that during COVID-19, US real estate acts as a hedge, due to a negative time-varying correlation with the other assets in the portfolio. Investors tend to invest in US real estate, after withdrawing funds from financial markets[71]. Therefore, in the future, other cryptocurrencies can be added to a portfolio with traditional assets to find the hedging capabilities of cryptocurrencies against the said assets[38, 4, 72].

CONCLUSION

Since, the outbreak of COVID-19, the hedging capabilities of certain assets have become suspicious. Using the data set of three liquid cryptocurrencies (ETH, XRP, LTC) and other assets gold, Brent oil, USRE, S&P 500 and Pvt. Equity to construct a well-diversified portfolio including traditional assets with hedging capabilities of cryptocurrencies. This study caters to the pre-COVID-19 and COVID-19 period and found thatcryptocurrencies', especially during the COVID-19 period, have potential diversification benefits while the selected cryptocurrencies show a positive correlation during the pre-COVID-19 period, while during COVID-19, the correlation between the assets understudy, has been reduced but do not turn to negative. However, the results affirm the cryptocurrencies, rather than being a hedge, contribute to a portfolio as a diversifier[73, 12, 74]. There found a piece of evidence that cryptocurrencies diversify the portfolio risk than become a safe haven. This study employs the DCC-GARCH model for volatility clustering and the results are consistent with the existing research.

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