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ARE THE NEW CRYPTO-CURRENCIES QUALIFIED TO BE INCLUDED IN THE STOCK OF HIGH QUALITY LIQUID ASSETS? A CASE STUDY OF BITCOIN CURRENCY

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Razali Haron

Abstract

As crypto-currencies hold dual nature of a medium of exchange (currency) and an investment asset, some questions may arise about the potentiality of including crypto-currencies as liquid investment asset in financial institutions particularly in the banking sector to enhance their liquidity risk management and improve their portfolio diversification investment strategy. The objective of this study therefore is to examine the characteristics of Bitcoin currency based on the requirements of High-Quality Liquid Assets (HQLA) standards of Basel III and compare its volatility structure with other traditional asset classes that are already recommended by Basle III as HQLA. The study utilizes both descriptive and quantitative analysis using the GARCH family models to examine the volatility structures of these assets. The findings show that Bitcoin currency holds the same characteristics of HQLA, however; the risk of legality and recognition is still under consideration by legal authorities around the world and this risk will be eradicated in the future as crypto-currencies derive their legality from their real intrinsic value, multi-economic usefulness and not by law as in the case of fiat money currency. Furthermore, the symmetric volatility structure analysis shows the continuing persistence of volatility and predictability behavior in return series of Bitcoin currency and other- traditional asset classes in the U.S. market. However, Bitcoin's stability has gradually improved over time. With regard to the asymmetric informative response, Bitcoin returns respond more to negative shock *but it has no statistical significance, thus suggesting the lack of leveraging effect in Bitcoin market but this effect was found to be statistically persistent in other traditional asset class markets. In addition, Bitcoin returns show very low correlation with other traditional asset classes. All these imply that Bitcoin is a potential candidate as a hedge and asset diversifier, which is recommended to be included in the HQLA. This study provides some support to recent theoretical work on crypto asset return behaviour and liquidity risk management. The findings provide appropriate information about Bitcoin asset behaviour compared to other traditional asset classes which will enable them to make the right investment decision with regard to hedging, diversification and liquidity risk management. The findings of this study may assist in evaluating the suitability of including crypto assets into HQLA to improve the liquidity requirement standards and ensure that banks have an adequate amount of HQLA specifically during times of financial turmoil.*

Keywords: Crypto-currencies, Bitcoin, High Quality Liquid Assets, Traditional Asset Classes

1.0 Introduction

Liquidity is defined as "an institution's ability to meet its obligations both expected and unexpected, without adversely affecting the daily operation or financial condition of the institution"[1]. The primary aim of liquidity risk management is to make sure that institutions are efficiently managing their liquidity to meet their obligations on due date without additional cost or loss incurred. Liquidity risk has two forms of interrelated risks, the funding liquidity risk and the asset liquidity risk[2]. Funding liquidity risk is attributed to circumstance where the institution cannot access the liquidity in the financial system or raise the funds through a loan. This may cause problems

[1] M.F. Akhtar, K. Ali and S. Sadaqat, "Liquidity Risk Management: A Comparative Study between Conventional and Islamic Banks of Pakistan", *Interdisciplinary Journal of Research in Business*, 1(1), (2011), 35-44.

[2] M. Kumar and G.C. Yadav, "Liquidity Risk Management in Bank: A Conceptual Framework", *AIMA Journal of Management & Research*, 7(2/4), (2013).

for the institution, such as inability to meet margin calls or capital withdrawal requests, meet collateral requirements or attain rollover of debt[3]. These issues may lead to assets liquidity risks, in which institutions may liquidate their assets to raise funds at less-sale prices causing significant loss for their stakeholders.

In addition, the 2007/2008 financial crisis has driven liquidity management to centre stage for banks and their regulators. This is because liquidity was the main issue in the 2007/2008 global banking crisis. Many banks were unable to secure sufficient liquidity to run their daily operations and resulting in several financial institutions going bankrupt, such as Lehman Brothers, while others including Fannie Mae, Freddie Mac, Royal Bank of Scotland, Bradford & Bingley, Fortis, and Hypo Real Estate had to seek additional funds from governments in order to survive. However, the majority of the affected banks opted for liquidation and were exposed to higher asset liquidity risks. In response to the negative consequences of the 2007/2008 global financial crisis the Bank of International Settlements (BIS) strived to improve the Basel II framework and introduced the Basel III by incorporating many developments including capital adequacy framework and liquidity risk management (LRM) for the purpose of developing a more resilient banking sector. These new developed principles offer guidelines on LRM and, monitoring including LCR and NSFR. The purpose of the LCR is to encourage temporary resilience of the banks' liquidity risk profile. Towards this end, it ensures that banks have sufficient stock of available HQLA for easy and immediate conversion in private markets into cash for the purpose of meeting their liquidity requirements for a 30-day period under the prescribed stress scenario[4]. These liquid assets comprise cash, certain types of sovereign debt, qualifying common equity shares and also various high quality public and corporate debt. The Basel Committee has established sets of characteristics for HQLA asset qualification; including basic characteristics such as "low risk; ease and certainty of valuation, low correlation with risky assets; listed on a developed and

[3] Ibid.

[4] Basel III, B. C. B. S. "The Liquidity Coverage Ratio and Liquidity Risk Monitoring Tools." *Bank for International Settlements* (2013).

recognized exchange" and market-specific features including "active and sizable market, and low volatility".

The financial market has witnessed the development of various traditional asset classes in the last century such as stocks, bonds, commodities, and foreign exchange assets. With the increased implementation of technology in financial markets, a new innovation of digital crypto-currency was introduced by Satoshi Nakamoto in 2008 as a medium of exchange. However, crypto-currencies can function well as an asset and can be stored securely and cheaply. For example, as a store of value, crypto-currencies are far simpler and secured than other financial assets and do not require on-going costs. Many investors, either institutions or individuals have already treated crypto-currencies as an investment asset rather than a currency[5,6]. Hence, the crypto-currencies market will continuously be highly speculative[7]. This is due to the fact that crypto- currencies hold the dual nature of an asset and as currency, which may be responsible for the higher volatility. In addition, many researchers have investigated the behaviors of the new crypto assets such as[8] who found that Bitcoin currency could be used as a hedging asset against stocks in the Financial Times Stock Exchange Index and the U.S. dollar for a limited period. The most recent study of Wong et al.[9], examined the possibility of crypto-currencies such as Bitcoin, Litecoin and Ripple being used as an investment instrument in terms of hedging or diversification. The study found that both Bitcoin and Litecoin currencies show the opportunity of a hedging asset being used while Ripple showed behaviors of a diversifier[10] found that Crypto Index

[5] F. Glaser., K. Zimmermann, M. Haferkorn, M. Weber and M. Siering, "Bitcoin-Asset or Currency? Revealing Users' Hidden Intentions", (2014).

[6] A.H. Dyhrberg, "Bitcoin, Gold and the Dollar – A GARCH Volatility Analysis." *Finance Research Letters,* 16, (2016), 85-92.

[7] P. Katsiampa, "Volatility Estimation for Bitcoin: A comparison of GARCH Models." *Economics Letters*, 158, (2017), 3-6.

[8] A.H. Dyhrberg, *Finance Research Letters,* 16, (2016), 85-92, op. cit.

[9] W.S. Wong, D. Saerback and D. Delgado Silva, "Crypto-Currency: A New Investment Opportunity? An Investigation of the Hedging Capability of Crypto-currencies and Their Influence on Stock, Bond and Gold Portfolios", (2018).

[10] D.K.C. Lee, L. Guo and Y. Wang, "Cryptocurrency: A New Investment Opportunity?" *Journal of Alternative Investments*, 20(3), (2018), 16.

and crypto-currencies could be good options to help diversify the portfolio risks as the correlations between crypto-currencies and traditional assets are consistently low and the average daily return of most crypto-currencies is higher than that of traditional investments. Baur et al.[11] investigated whether the Bitcoin currency plays the role of an exchange medium or speculatively as an investment asset. The results of analysis showed that Bitcoin's return properties differ significantly from asset classes such as currencies and therefore permits considerable diversification benefits in both stable and turbulent times. Furthermore, the result showed that the minority of users used Bitcoin as an exchange medium while the majority used it as an investment asset. Their study therefore suggests that currently, crypto-currencies are more appropriate for investment purposes rather than as a medium of exchange.

The new crypto-currencies hold dual nature as an exchange medium or an investment asset and many empirical studies have provided evidence that new cryptographic currencies have the potential to be a hedge or safe-haven asset against market risk, especially during a time of economic slowdown. Additionally, crypto-currencies returns basically have low association with all major conventional asset classes like stocks, bonds, gold and commodities, which offer large diversification benefits for market portfolio investment strategy. It is therefore a great opportunity for market participants, particularly bank' regulators to make in-depth research about the characteristics of these new innovative digital currencies and examine their capability to be included into the HQLA stock under Basel III standards to improve the LRM in the banking segment. This study therefore, aims to analyze the characteristics of the crypto-currencies based on the Basel III HQLA requirement standards to explore whether the crypto-currencies are suitable financial assets to eliminate liquidity risk in the banking sector compared with other traditional asset classes that have already been recommended by Basle III standards.

[11] D.G. Baur, K. Hong and A.D. Lee, "Bitcoin: Medium of Exchange or Speculative Assets?" *Journal of International Financial Markets, Institutions and Money* (2017).

2.0 Characteristics of Cryptocurrencies-related HQLA

In this section, the characteristics of the crypto assets, particularly Bitcoin currency will be examined based on the Basle III requirements' Liquidity Standards for HQLA assets. According to Basel III standards, "assets are considered to be HQLA if they can be easily and immediately converted into cash with little or no loss of value." There are two characteristic classes that determine the HQLA, (i) Fundamental characteristics, and (ii) Market-related characteristics.

2.1 Fundamental Characteristics

i. *Low risk: "Assets that are less risky tend to have higher liquidity. High credit standing of the issuer and a low degree of subordination increase an asset's liquidity. Low duration, low legal risk, low inflation risk and denomination in a convertible currency with low foreign exchange risk all enhance an asset's liquidity.""*

The assessment of crypto-currencies, particularly Bitcoin currency based on credit standing of the issuer shows that many rating agencies have started developing rating credit standing of crypto-currencies such as the U.S. independent rating agency, namely Weiss Ratings. The agency started publishing their crypto ratings on January 24, 2018. The list shows that an overall rating of Bitcoin currency is B- and none of the listed crypto-currencies has been rated an A or a B+. Furthermore, the crypto-currencies have low degree of subordination as they are decentralized currencies, which give them intrinsic value that is hard to deny.

In terms of legal risk, the situation is still under consideration and the attitude of legal authorities of all countries around the world is generally divided into three groups: approving, not deciding, and non-approving countries. In the meantime, the majority of the countries in the first and the second groups have accepted the crypto-currencies as legal alternative investment assets and a medium of exchange for payment purposes. These countries include Japan, Switzerland, Canada, New Zealand, Australia, Sweden, Bulgaria, Chile, Colombia, Czech Republic, Denmark, Estonia, Finland, Germany, Hong Kong, Indonesia, Malaysia, Italy, Kazakhstan, Lithuania, Luxembourg, Mexico, the Netherlands, Norway, Pakistan, Philippines, Poland, Portugal, Slovenia, South Africa, South Korea, Spain, Ukraine, United Kingdom, United States, Vietnam, Morocco, Nigeria, Namibia, Zimbabwe, Costa Rica, Jamaica, Bolivia, Brazil, Kyrgyzstan, Cyprus, Russia, United Arab Emirates, Saudi Arabia, Jordan, Lebanon, Turkey, Iran, India, China, Taiwan, Singapore, Thailand, Austria, Croatia, Romania, Slovakia, Belarus, Iceland, Ireland, France, Belgium, Macedonia, Malta, Greece, Bosnia and Herzegovina, Hungary, Argentina, Nicaragua and European Union. The third group includes Algeria, Bolivia, Ecuador, Bangladesh, Nepal, and Cambodia, which still have not recognized it as either currency or financial asset, but have started studying the possibility of establishing such regulation for crypto-currencies industry for tax purpose only[12]. Despite the number of countries that have started to recognize it as an exchange medium or as an investment asset, the regulation risks will continue to be a big challenge for both investors and monetary authorities. This is because a Bitcoin currency is globally decentralized in nature and is not subject to any Central Bank or supranational control[13].

Fundamentally, the legality of crypto-currencies is created by its intrinsic value. It is useful, enjoys wide acceptance (as an exchange medium and store of value), with low transaction cost (peer-to-peer network dealing), high level of security (using block-chain technology), is decentralized, offers ease-of-use, real time settlement, and it is completely anonymous and at the same time fully transparent as the history of all transactions that have ever taken place is stored. On the other hand, the current fiat money's intrinsic value is created only by government laws and regulations. Most importantly, crypto-currencies are not represented by debts or liability of any central banks in the world, like the traditional fiat money system. However, they are intangible assets created by

[12] Source: https://en.wikipedia.org/wiki/Legality_of_bitcoin_by_country_or_territory

[13] D.G. Baur, A.D, Lee and K. Hong, "Bitcoin: Currency or Investment?" (2015), op. cit.

powerful mining computers that need a lot of resources to work[14,15]. Thus, the legal risk of the crypto-currency system is considered as short-term risk and will be eliminated in the future when the crypto market is matured enough. The fact remains that crypto-currencies continue to be at the forefront of the modern day technological advancement and its possible future applications.

In terms of low inflation, crypto-currencies system is actually deflationary in nature. This is because crypto-currencies rely on an algorithm to limit the growth of the money supply[16]. The decentralized design of crypto-currencies is to protect against long-term inflation uncertainty as no central banks have the right to regulate and control the money supply in global economic circulation. Thus, for example, the value of Bitcoin currency will increase over time because there are only going to be a finite number of units (capped at 21 million units) in global economic circulation. Thus, crypto-currencies fulfil the HQLA requirement in terms of inflation effects.

In terms of a convertible currency, crypto-currency is considered as convertible currency to some degree because of its easy convertibility into different goods, services, and payment approaches employed by users[17]. Furthermore, many countries have started using it as a medium of exchange (like fiat money) such as Japan, Canada, Germany, Switzerland, Sweden, Bermuda, Venezuela and the Netherlands. The increased acceptance of cryptocurrency as a medium of exchange continues to surge daily and this gives positive impact to its intrinsic value and helps to realize a fair price for this new digital asset. For example, Bitcoins currency can be used at traditional business

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[14] G.P. Dwyer, "The Economics of Bitcoin and Similar Private Digital Currencies". *Journal of Financial Stability*, *17*, (2015), 81-91.

[15] Public-Privet analytic Report, 2017, [Onlinehttps://hackernoon.com.https://webcache.googleusercontent.com/search?q=cache:XzypAJnl8xsJ:https://www.dni.gov/files/PE/Documents/9---2017-AEP_Risks-and-Vulnerabilities-of-Virtual-Currency.pdf+&cd=1&hl=en&ct=clnk&gl=my. [Cited: July 21, 2018].

[16] T. Moore, "The Promise and Perils of Digital Currencies", *International Journal of Critical Infrastructure Protection*, 6(3-4), (2013), 147-149.

[17] D. He, K.F. Habermeier, R.B. Leckow, V. Haksar, Y. Almeida, M. Kashima and C.V. Yepes, "*Virtual Currencies and Beyond: Initial Considerations",* No.16/3, 2016. International Monetary Fund.

outlets, for online shopping, and various other online purchasing activities. Furthermore, the introduction of Bitcoin-to-cash payment cards and ATM networks also help to increase the usefulness and consumer recognition of Bitcoins currency. This will assist purchases and withdrawals at the market price of Bitcoins and contribute to increasing liquidity while protecting security.

In terms of low foreign exchange risk, people can trade in crypto-currencies or acquire their preferred fiat currency (if available at the exchange), similar to forex dealings. For example, US exchange establishments are controlled by state legislation as money transmitters/money services businesses and to Know Your Customer regulations under the Bank Secrecy Act. Crypto-currency exchanges provide a range of varying services resembling those of retail banking and merchant payment processing services besides crypto-currency/fiat currency exchange. Crypto-currency rates of exchange are prone to significant fluctuation from day to day as we and one exchange to another, thus providing traders possible arbitrage prospects. Thus, an increase in volume of crypto-currency trading and its frequent use in the market exchange will help to enhance its future liquidity.

ii. Ease and certainty of valuation: implies that "an asset's liquidity increases should there be a greater likelihood of market participants agreeing on its valuation. Assets with more standardization, homogeneity and structural simplicity are likely to be more fungible, which promotes liquidity."

The most frequent question that bothers crypto investors is how the price is determined in the market, or in other words, how the crypto investors can evaluate their crypto assets in order to buy, sell or to hold their crypto assets. Over the last few years, several models have been developed and proposed by economists, researchers and financial analysts to value crypto assets. This includes three main methods: i) production cost, ii) currency value, and iii) network value, as well as the traditional valuation models of Capital Assets Price Model (CAPM) and Dividends Discounting Model (DDM) as presented in Table[1] below. Currently, each of these proposed models still suffers from such limitations and exhibits such difficulties in the real daily market evaluation practices by the crypto-investors. However, in the future, when the Crypto industry becomes more mature and crypto asset behaviours are clearly defined and recognized, then valuation models will be more predictive and informative in evaluating the crypto assets.

Table 1 Proposed Models for Evaluating Crypto Assets

Method	Equation	Notes
Cost of Production by Adam Hayes [18]		
\$P = E_{day} / BTC / day, where, **\$P** is expressed in USD per Bitcoin, **E_{day}** is the cost of mining per unit of mining power per day, and **BTC/day** is the expected number of coins to be mined per day on average per unit of mining power.		Variables that determine the Crypto Assets Value are: (i) computational capability, (ii) rate of coin production, and (iii) how difficult the mining algorithm is.
Valuing a Crypto Asset as a Currency		
INET & Crypto J-Curve Thesis built by Chris Burniske based on Equation of Exchange formula (Hume & Fisher).	**MV=PQ** where, **M** = size of the monetary base required for supporting a crypto economy of size PQ, at Velocity V, **V** = velocity of the asset, **P** = price of the digital resource being provisioned, and **Q** = quantity of the digital resource being provisioned.	Burniske[19] maintains that a crypto asset valuation mainly comprises solving for M, and thus the formula is rearranged as **M=PQ/V** Token price is further broken down into two components whose contributions change over time: "current utility value" (CUV), which denotes value driven by usefulness and usage today, and "discounted expected utility value" (DEUV), which denotes value driven by speculative investment.

[18] A. Hayes, "A Cost of Production Model for Bitcoin", 2015, op. cit.

[19] C. Burniske and J. Tatar, Crypto assets: The Innovative Investor's Guide to Bitcoin and Beyond (2017), McGraw Hill Professional.

Valuing a Crypto Asset as Network		
Daily Active Users (DAU) modelled by Tom Lee model built based on Robert Metcalfe's Law	**Value of bitcoin = Unique Addresses^2 * $ volume per account** where, unique addresses denote the number of unique bitcoin addresses taking part in the network per day $ volume per account denotes bitcoin transaction volume per day	Metcalfe suggested that the value of a network is in proportion to the square of the nodes, or users on the network multiplied by bitcoin transaction volume per day
Network Value-to-Transaction Ratio (NVT) approach proposed by Chris Burniske, Willy Woo, Coinmetrics team, Dmitriy Kalichkin	**NVT = network value / daily trx volume.** where, NVT is a valuation ratio that compares the network value (equals the market cap) to the network's daily on-chain transaction volume (trx).	In the same way as the popular equity P/E valuation ratio (either stock price / earnings per share, or market cap / total earnings), NVT may show if a network token is under or over-valued by indicating the market cap in relation to the network's transaction volume
Daily Active addresses / users (DAA)	**Value of bitcoin = Unique Addresses^2 * $ volume per account**. where, unique addresses denote the number of unique bitcoin addresses taking part in the network per day $ volume per account denotes bitcoin transaction volume per day	In the same way as daily active users (DAU) for software and apps, DAA can offer information about the number of users in a network, which can inform trends and complement other indicators such as NVT and on-chain transaction volume.
Traditional Models		

Luigi D'Onorio DeMeo and Christopher Young model built on Hayes' approach and Adam Hayes approach.	**$PV = (X_{day} / EC_{day}) / (1 + r)^n$** where, \$PV = Present value of a Crypto Asset, X_{day} = Cost of mining per unit of mining power per day, EC_{day} = Expected coins received per unit of mining power per day, r = discount rate, n = number of periods	It was established based on Marginal Cost of Production model by projecting major assumptions such as energy efficiency, cost of electricity, difficulty and then discounting the value to the present.
CAPM model Sharpe (1964)[20]	$R_j = R_f + B_j (R_M - R_f)$ *Where:* Rj refers to expected rate of return on crypto asset 'j'; Rf is risk free rate; Bj indicates for Beta coefficient, Rm is the market return; and (RM–Rf) is the market risk premium.	As historic return data for the crypto industry still have a short period, the CAPM model is currently not appropriate to effectively evaluate the crypto assets, but in the future when the crypto asset market is matured enough and has a long data period to study the relationships of token prices and various drivers, the model will be more effective.
Discounted Cash Flow Analysis (DCF	In general, DCF method is inappropriate because token investments are not the generators of cash flows or denote equity claims on cash flows such as Equity or bond assets.	

Sources: https://blockchainatberkeley.blog/@ABLannquist.
https://www.aeaweb.org/conference/2018/preliminary/paper/tsFKfa85.
https://www.businessinsider.my/bitcoin-price-movement-explained-by-one-equation-fundstrat-tom-lee-metcalf-law-network-effect-2017-10./?r=US&IR=T.

iii. Low correlation with risky assets: means that "stock of HQLA assets should not be subject to highly-correlated risk."

Accordingly, the Bitcoin currency price trend exhibits positive association with other traditional asset classes of equity, bonds, and fiat money (dollar index) that are recommended by Basel III as High liquid assets.

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[20] W.F. Sharpe, "Capital Asset Pricing Theory of Market Equilibrium under Conditions if Risk", *Journal of Finance,* 19, (1964), 425–442.

Figure 1: Price movement of BIT, Stock indices, 3-month TBR, and Dollar index in U.S. over the period of 2013-2017.

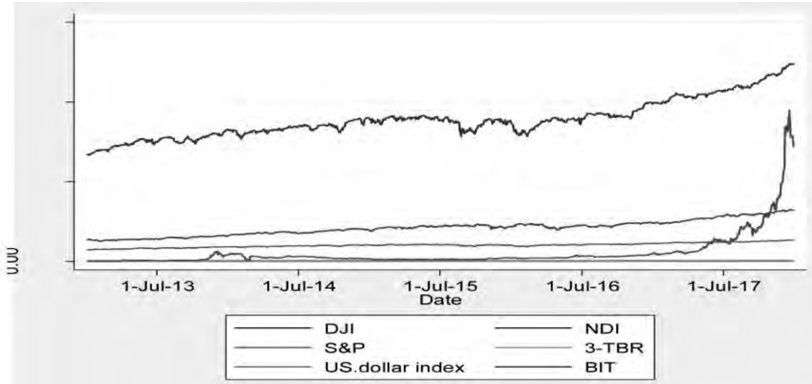


Table 2 confirms that the correlation between the Bitcoin currency's return (volatility) and all HQLA recommended assets' returns are very low in the United States market. The low correlation between Bitcoin currency and other traditional asset classes and the fact that all these assets are traded in an organized U.S. exchange market with low transaction costs make them potentially attractive portfolio components to reduce market risk and increase their liquidity. This outcome is in line with the earlier research of [21,22], who found that the correlations between Bitcoin currency and other Traditional asset classes were very low.

[21] E. Bouri, P. Molnár, G. Azzi, D. Roubaud and L.I. Hagfors, "On the Hedge and Safe Haven Properties of Bitcoin: Is It Really More than a Diversifier?" *Finance Research Letters*, 20, (2017), 192-198.

[22] A.H. Dyhrberg, Finance Research Letters, 16, (2016), 85-92, op. cit.

Table 2 Correlation Matrix Results between Return of BIT and the Traditional Asset Classes in U.S.

	BIT	DJI	S&P	NDI	3-TBR	U.S. Dollar
BIT	1					
DJI	0.0224	1				
S&P	0.0258	0.963***	1			
NDI	0.0184	0.0294	0.0243	1		
TBR	0.0086	0.047	0.0343	0.0396	1	
U.S. Dollar	0.0123	-0.0003	0.0068	-0.0507	-0.0092	1

Note: ***and, ** denotes significant at 1% and 5% significance level.

iv) Listed on a developed and recognized exchange: "implies that being listed enhances an asset's transparency."

Based on statistical information of the global crypto-currency market there are a number of firms which have been launched and listed on public exchanges worldwide. As of 5 July 2018 there were 1981 crypto listed companies in 79 global public exchanges. A unique feature of crypto-currencies with respect to liquidity is that coin holders can easily sell their coins on the public exchange such as Binance, Bitfinex, Huobi, HitBTC, Coinbase GDAX, Quoine, Bitstamp, Bithumb, Bittrex Gemini, Coinone , Gate.io, Poloniex BitFlyer , and Livecoin at the market price with very low cost.

2.2 Market-related Characteristics

v) Active and sizable market: According to this standard "the asset should have active outright sale or repo markets at all times."

In terms of active and sizable market standard, the global crypto-currency market has witnessed rapid and extensive growth in terms of number of firms and market capitalization. As of 5 July, 2018, a total of 1981 crypto-currencies were launched and traded in global financial markets, with total market capitalization of USD 273. 287 Billion. According to the CEO of Kraken, Jesse Powell, the entire crypto-currency market is expected to cross a valuation of

USD 1 trillion at the end of 2018. The market still remains subject to unpredictable and extreme growth in terms of market participants, crypto companies, mining and market capitalization. The market is actually led by Bitcoin currency as it was the first digital money introduced to the public using block-chain technology. In line with this development, the Bitcoin market capitalization increased from approximately USD 0.04 billion in the first quarter of 2012 to reach around USD114.637 billion at the beginning of the third quarter of 2018, with total of 17.131million coins in global economic circulation. This indicates that between 2012 and 2018 the Bitcoin market grew approximately by 286,490% or about 40,927% per annum. This therefore indicates the robust market infrastructure has already taken place in crypto-currencies industry and that will lead to increase availability of liquidity for market players. Furthermore, the increasing acceptance of the crypto-currencies as medium of exchange by many popular organizations and market players will influence the faith of the public in this new disruptive technology resulting in high liquidity in the market.

vi). Low volatility: is defined as "Assets whose prices remain relatively stable and are less prone to sharp price declines over time will have a lower probability of triggering forced sales to meet liquidity requirements." There should be historical evidence of relative stability of market terms (egg prices and haircuts) and volumes during stressed periods.

The high volatility of crypto-currencies may lead to a great decrease in its usefulness as a currency. However, it may increase its usefulness as an investment asset. This is due to the fact that volatility represents the main resource for investors' return. Many economists and financial analysts have claimed that the new crypto-currencies are very volatile but the stability of new crypto assets is gradually improving within the time. The Bank for International Settlements voices a valid concern about the price volatility of crypto-currency markets. However, this is almost entirely due to their illiquidity. As they mature, they will gain more liquidity over time. The rest of this study therefore aims to examine the volatility structure of crypto-currencies market, particularly Bitcoin currency, comparing it with the traditional asset classes recommended by Basel III requirement liquidity standards.

3.0 Data and Methodology

The daily data of all closing prices indices of Bitcoin currency and U.S. traditional asset classes, namely, stocks, bonds and dollar index (fiat money) are studied for a logarithmic daily return volatility to analyze their volatility structure. The day to day data have been adjusted to a 5-day week basis series (weekday holidays are excluded). The data consist of 2,723 daily observations of the Bitcoin index over the period 18 July 2010 to 31 December 2017, and then expand further to cover 2018 (total 3,088 observations) in order to capture market sharp decline impacts, and 3,050 daily observations of the Dow Jones Index (DJI), Nasdaq Composite Index (NDI), and the Standard & Poor's 500 Index (S&P) as well as the 3-month TBR from 3 January 2005 to 29 December 2017. The data also consist of 2,822 observations for U.S. Dollar Index covering the period of 1 February 2007 to 31 December 2017. Dollar index refers to the measurement value of the USD related to a basket of foreign currencies such as Euro (EUR), Japanese yen (JPY) Pound sterling (GBP), Canadian dollar (CAD), Swedish, krona (SEK), Swiss franc (CHF) in the fiat money system. All variables data are denominated in U.S. dollar and sourced from *https://www.investing.com/*. The estimation of the return is as expressed below:

$$r_t = \text{Log}\left[\frac{p_t}{P_{\ t-1}}\right] * 100$$

where:

r_t is the logarithmic daily return on each index for time t,

P_t is the closing price at time t, and

P_{t-1} is the corresponding price in the period at time $_{t-1}$.

3.1 Methodology

Different conditional heteroskedastic models such as GARCH (1,1)[23],

[23] T. Bollerslev, "Generalized Autoregressive Conditional Heteroskedasticity", *Journal of Econometrics,* 31 (3), (1986), 307–327.

EGARCH (1,1)[24] APGARCH (1,1)[25] and TGARCH (1,1)[26] are utilized to estimate the returns volatility structure of Bitcoin currency compared to the U.S. traditional asset classes. The assets returns are preliminarily tested using diverse descriptive statistics such as mean, standard deviations, minimum, maximum, skewedness, and kurtosis in order to clarify the fundamental features of the data and offer the history of the background for the variable behavior. Furthermore, diagnostic tests were conducted on the Ordinary Least Square (OLS) regression specification to check the normality, stationarity and autoregressive conditional heteroscedasticity (ARCH) effect of the data using Jarque-Bera test[27], Augmented Dickey Fuller (1979) (ADF)[28] and the Phillips-Perron (PP)[29] for unit root tests and the Lagrange Multiplier (LM) test respectively. These tests were also applied to confirm whether the statistical features of data were a best fit for the GARCH models used. Following the study by Bollerslev[30] the utilized GARCH models were tested to select the optimal model based on the highest value of Maximum likelihood (ML) ration, and lowest value of the Akaike information criterion (AIC)[31] and the Schwarz Information Criterion (SIC).[32] The

[24] D. B. Nelson, "Conditional Heteroscedasticity in Asset Returns: A New Approach", *Econometrica* 59 (2), (1991), 347–70.

[25] Z. Ding, R. F. Engle and C. W. J. Granger, "Long Memory Properties of Stock Market Returns and a New Model", *Journal of Empirical Finance* 1 (1), (1993), 83–106.

[26] J.M. Zakoian, "Threshold heteroskedastic models", *Journal of Economic Dynamics and Control*, 18, (1994), 931–955.

[27] G.M. Jarque and A.K. Bera, "Efficient Test for Normality, Homoscedasticity, and Serial Independence of Regression Residuals", *Economics Letters* (6), (1980), 255-259.

[28] D.A. Dickey and W.A. Fuller, "Distribution of the Estimators for Autoregressive Time Series with a Unit Root", *Journal of the American Statistical Association*, 74(366a), (1979), 427-431.

[29] P. C. B. Phillips and P. Perron, "Testing for a Unit Root in Time Series Regression." *Biometrika, 75*, (1988), 335-346.

[30] T. Bollerslev, "Generalized Autoregressive Conditional Heteroskedasticity", *Journal of Econometrics* 31 (3), (1986), 307–327.

[31] H. Akaike, "A New Look at the Statistical Model Identification", *IEEE Transactions on Automatic Control*, *19*(6), (1974), 716-723.

[32] G. Schwarz, "Estimating the Dimension of a Model", *The Annals of Statistics*, 6(2), (1978), 461-464.

parameters were estimated using quasi-maximum likelihood method proposed by Bollerslev-Wooldridge[33], under the assumption of Gaussian normal error distribution. Finally, the study carried out the diagnostic test for all GARCH models to ensure that the residuals were free from ARCH effect and the variance equations of the models were adequate and well-specified. The variance equations under different models specification of symmetric and asymmetric effect are summarized in Table 3 below.

3.1.1 News Impact Curve

The asymmetric effect is further validated with the graph of news impact curve (NIC) in relation to *r* today's returns and tomorrow's volatility. In other words, the NIC examines the relationship between the current news and future volatility for asset returns. Engle and Ng[34] described it as *"The news impact curve is the functional relationship between conditional variance at time t and the shock term (error term) at time t $_1$, holding constant the information dated t_2 and earlier, and with all lagged conditional variance evaluated at the level of the unconditional variance."* Following[35], the NIC mathematically presented by following formula.

$$\mathrm{E}(\sigma_{t+1}^2 | \epsilon_t)$$

where: expected conditional variance E of the next period conditional on the current shock, "ϵ_t

[33] T. Bollerslev and J. Wooldridge, "Quasi-maximum Likelihood Estimation Inference in Dynamic Models with Time-Varying Covariance", *Econometric Theory*, 11, (1992), 143–72.
[34] R.F. Engle and V.K. Ng, *The Journal of Finance*, 48(5), (1993), 1749-1778. op. cit.
[35] C. Bauer, "A Better Asymmetric Model of Changing Volatility in Stock and Exchange Rate Returns: Trend-GARCH", *The European Journal of Finance*, 13(1), (2007), 65-87.

Table 3: Symmetric and Asymmetric GARCH Models

	Symmetric Volatility	Asymmetric Volatility		
	GARCH (1,1)	E-GARCH (1,1)	AP-GARCH (1,1)	T-GARCH (1,1)
Mean Equation	$r_t = \mu + \varepsilon_t$	$r_t = \mu + \varepsilon_t$	$r_t = \mu + \varepsilon_t$	$r_t = \mu + \varepsilon_t$
	where: r_t is the return of each currency form at time t, μ is the average return, and ε_t is the random innovations with zero mean and constant variance.			
Variance Equestrian	$\sigma_t^2 = \omega + \alpha\, \varepsilon_{t-1}^2 + \beta \sigma_{t-1}^2$ where: σ_t^2 is the conditional variance at time t, ω is the intercept (constant), while α refers to ARCH effect and β indicates GARCH effect. α and β determine the short-run dynamics of the volatility time series, while ε_{t-1}^2 refers to ARCH term that measures the impact of recent news on volatility. To ensure that σ_t^2 is positive for all t. Bollerslev [36] enforced these restrictions of $\omega>0$, $\alpha_i \geq 0$, for i=1, 2,…, q, and $\beta_i \geq 0$ (for j=1,2,…,p).	$\ln(\sigma_t^2) = \omega + \beta_1 \ln(\sigma_{t-1}^2) +$ $\alpha_1 \left\{\left\lvert\frac{\varepsilon_{t-1}}{\sigma_{t-1}}\right\rvert - \sqrt{\frac{\pi}{2}}\right\} - \gamma \frac{\varepsilon_{t-1}}{\sigma_{t-1}}.$ The $\ln(\sigma_t^2)$ is stated for the log of the conditional variance, ω is the intercept (constant), γ is referred to the asymmetry or leverage effect parameter and α refers to ARCH effect and β indicates GARCH effect, While, the ε_{t-1}indicates Lagged error term.	$\sigma_t^\delta = \omega + \alpha k\, (\varepsilon_{t-1})^\delta\, \varepsilon_{t-1}^2 + \beta_1 \sigma_{t-1}^\delta$ $k\,(\varepsilon_{t-1}) = \lvert\varepsilon_{t-1}\rvert - \gamma \varepsilon_{t-1}$ where: σ_t^δ is the conditional variance at time t, ω is the intercept (constant), α refers to ARCH effect and β indicates \ GARCH effect. δ plays the role of a Box-Cox transformation of the conditional standard deviation, γ refers to the asymmetry or leverage effect parameter and ε_{t-1} Lagged error term. Finally, $\lvert\boldsymbol{\varepsilon_{t-1}}\rvert$refers to the absolute value of the standardized residuals.	$\sigma_t^2 = \omega + \alpha_1\, \varepsilon_{t-1}^2 + \gamma\, d_{t-1} \varepsilon_{t-1}^2 + \beta_1 \sigma_{t-1}^2$ where” σ_t^2 is the conditional variance at time t, ω is the intercept (constant), γ refers to the asymmetry or leverage effect parameter, α refers to ARCH effect and β indicates GARCH effect, while ε_{t-1}^2 refers to the ARCH term that measures the impact of recent news on volatility. In the above model, the conditional variance is affected differently by both good news ($\varepsilon t-1 > 0$) and bad news ($\varepsilon t-1 < 0$). The good news has an effect on α_i, while bad news has an effect on $\alpha_i+\gamma_i$. Thus, if γ is significant and positive, negative shocks have a larger effect on σ_t^2 than the positive shocks.

[36] T. Bollerslev, *Journal of Econometrics,* 31 (3), (1986), 307–327.

4.0 Results and Discussion

4.1 Descriptive Statistic

Table 3 below provides a summary of the basic statistics relating to the Bitcoin currency and traditional assets classes in the U.S. financial market. Mean return of Bitcoin Token is higher than the mean returns of traditional assets classes in the U.S. market. The return series show a sizable gap between the minimum return and maximum return in the U.S. market particularly for Crypto and TBR asset. The standard deviation in returns indicates that Bitcoin currency market return is risker as compared to stock and U.S. dollar markets returns, while it is less risker related to bond market returns.

Table (3), Descriptive Statistics for Bitcoin Currency, and U.S. Traditional Assets Classes

Variable	Mean	Std. Dev.	Min	Max	Skewness	Kurtosis	Obs
BIT	0.434	7.5624	-84.88	147.418	2.683	67.870	2723
DJI	0.027	1.116	-8.201	10.508	-0.268	13.103	3050
NDI	0.045	1.329	-11.114	11.849	-0.335	10.667	3050
S&P	0.026	1.211	-9.469	10.957	-0.492	13.673	3050
3-TBR	0.031	23.11	-333.221	203.688	-0.567	31.121	3219
US. Dollar	0.002	0.517	-2.739	2.368	-0.021	5.0370	2822

Table 3 also shows the shape of the data distribution of the assets under study. The returns of Bitcoin currency are positively skewed over the sample period of the study, or in other words, series have long right tails. This characteristic differs from the features perceived in general in stocks, bonds, and U.S. dollar market, which is a negative skewness. According to Skewness test all the variables data are almost normally distributed except the Bitcoin currency which exhibits heavy-tailedness and falls outside the range of -1 to +1[37]. The kurtosis statistic indicates that the returns series are

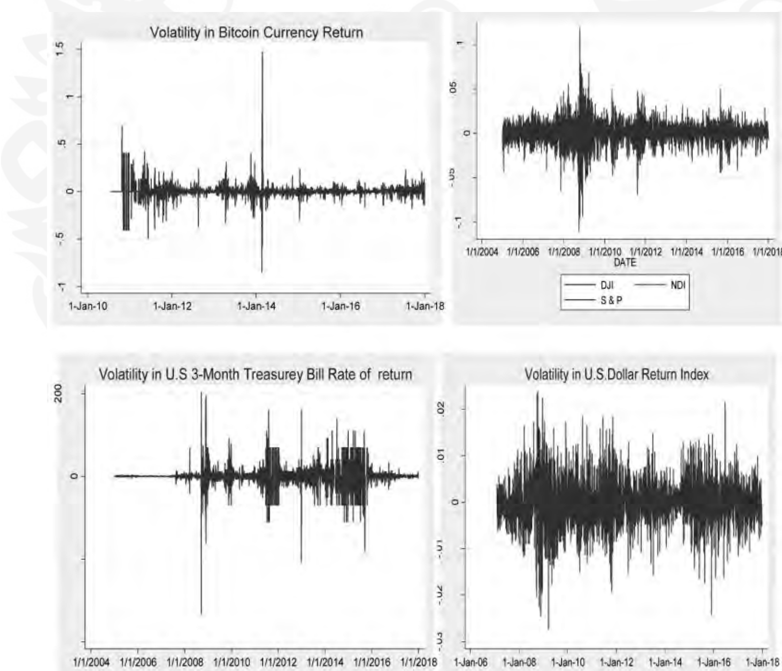
[37] J. Hair, JF, Black, W.C. Babin, B.J. Anderson, R.E. Tatham, *Multivariate Data Analysis* (2006), Upper Saddle River, NJ: Pearson-Prentice Hall.

consistently leptokurtic since all variables values exceed a range of +3, as recommended by Stock and Watson.[38] This may indicate a volatility clustering persistence in global Bitcoin and the U.S. financial markets.

4.2 Volatility Clustering

Figure 2 shows the movements of daily market returns of Bitcoin currency, and traditional assets classes in the U.S. market. Accordingly, all figures are exhibiting volatility clustering persistence in their daily markets returns, this due to the fact that their daily market return series volatility changes with time, or in other worlds, it is time-varying.

Figure 2: The Markets Volatility of Bitcoin Currency, and U.S. Traditional Assets Classes



[38] J.H. Stock and M.W. Watson, *Introduction to Econometrics* (2006), Addison Wesley.

Furthermore, the study applied residual diagnostic tests for all models, the Jarque-Bera test result displayed in Table 4 confirms that the data of the variables are non-normal distributed as the hypothesis of normal distribution is rejected at a very significant level. Table 4 exhibits the existence of unit root in the returns series tested employing ADF and PP tests since null hypothesis of non-persistence of unit root is rejected at 1% significance level. This therefore led to a conclusion that the time series data of the current study are stationary. In addition, the ARCH-LM test is employed to investigate the persistence of ARCH impact on the residuals of the return series. Table 4 shows that the null hypothesis of 'no ARCH effect' is rejected at 1% significance level, which confirms the existence of ARCH effects in the all models' residuals and therefore the results warrant that the best models fit for this time series returns behaviour is the GARCH family models.

Table (4) Normality, Heteroscedasticity and Unit Root Test Results

Variables	Normality Test	Unit Root Test Results		ARCH-LM Test Statistics
	Jarque-Bera	ADF-Test	PP Test	
Bitcoin Return Index	622393.8***	-26.340***	-52.363***	8.17077***
DJI Return Index	13008.99***	-42.911***	-61.008***	175.0929***
NDI Return Index	7528.846***	-42.245***	58.388***	216.8786***
S&P Return Index	14600.49***	-43.128***	-61.038***	169.5143***
U.S. 3-Month Treasury Rate of Return	106239.0***	-26.454***	-103.335***	219.638***
U.S. Dollar Return Index	488.1145***	-53.266***	-53.266***	13.60204***

Note: ***and, ** denotes significant at 1% and 5% significance level.

4.3 Estimation of Symmetric Volatility Persistence

This part of the paper describes the outcomes derived from fitting symmetric and asymmetric GARCH family models to the return series of Bitcoin currency and the U.S. traditional assets. Tables 5, 6, 7, and 8 report the estimated coefficients obtained by GARCH (1, 1), EGARCH (1, 1), APGARCH (1, 1) and TGARCH (1, 1) models. In the GARCH model the dynamics of the volatility of the return series are explained by the size of α (the ARCH term) and β (the GARCH term) parameters. Large coefficient estimation of α parameter suggests that volatility responds very strongly to market activities and the large coefficient estimation of β parameter indicates that the shocks to conditional variance require a significant length of time to die out or in other words, volatility persists[39]. The estimated coefficient of α and β parameters in Tables 5, 6, 7, and 8 have statistical significance at 1% and 5% levels in all GARCH specifications for the Bitcoin currency, and the U.S. stock indices (DJI, NDI, and S&P), 3-month treasury bill, and the U.S. dollar index, indicate that the day-to-day return exhibits time-varying volatility very persistently. Moreover, if the sum of α and β parameters is near to 1 (unity) unexpected shock in the market at time *t* will exist for several future periods and this suggests that assets return or volatility can be predicted for the near future[40]. Accordingly, the GARCH model for all cases (Tables 5, 6, 7, and 8) indicates that the estimated coefficient of β parameter is more than the estimated coefficient of α parameter and the sum of (α + β) is close to 1 and in such case above unity indicates a long period of volatility and predictability behavior to persist in return series of Bitcoin and the U.S. traditional assets.

4.4 Asymmetric and Leverage Effects Results

The symmetric ARCH or GARCH models discussed above successfully addressed the volatility clustering and leptokurtosis

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[39] M. Karmakar, "Asymmetric Volatility and Risk-Return Relationship in the Indian Stock Market", *South Asia Economic Journal*, Vol. 8, (2007), 99-116.

[40] S. Jegajeevan, "Return Volatility and Asymmetric News Effect in Sri Lankan Stock Market", *Staff Studies*, 40 (1), (2012).

distribution issue, but, they did not succeed in addressing the asymmetric "leverage effect" responses in the returns series. Statistically speaking, the asymmetric or leverage effects can be examined through many nonlinear asymmetric GARCH models such as EGARCH (1, 1), APGARCH (1, 1), and TGARCH (1, 1). The results of the EGARCH (1, 1) and APGARCH (1, 1) and TGARCH (1, 1) specifications are presented in Table 5, 6, 7 and 8. The γ parameter in all GARCH models refers to the estimated coefficient of asymmetric or leverage effects. In particular, the result in Table 5 indicates that there is no leverage effect exists in Bitcoin market as the estimated coefficient of γ parameters which are *-0.03774,* 0.0184, and 0.02635 for EGARCH, APGARCH, and TGARCH model respectively are statistically insignificant. This suggests that bitcoin currency is an appropriate asset to hedge against market risk. It also shows that the Bitcoin currency has a unique feature of a safe haven asset as the result shows insignificant effect of bad news on its return volatility. This means in times of financial turmoil the values of bitcoin currency will remain stable and positive. This finding is similar to former research of [41] and [42] who found that Bitcoin can potentially be used as a hedge asset. Moreover, [43] found that the digital currencies of Bitcoin, Ripple and Litecoin are unaffected by external market shocks, rendering them beneficial as a diversification and safe haven asset in short-term investment as they extend a portfolio's return and reduce its risk compared to traditional asset classes. Based on the selection conditions, the AP GARCH (1,1) model is considered the best fit model to explain the asymmetric effect in Bitcoin market.

[41] E. Bouri, P. Molnár, G. Azzi, D. Roubaud and L.I. Hagfors, *Finance Research Letters*, 20, (2017), 192-198, op. cit.

[42] A.H. Dyhrberg, *Finance Research Letters,* 16, (2016), 85-92, op. cit.

[43] S. Corbet, A. Meegan, C. Larkin, B. Lucey and L. Yarovaya, "Exploring the Dynamic Relationships between Crypto-Currencies and Other Financial Assets", *Economics Letters*, 165, (2018), 28-34.

Table (5): Estimated Result of GARCH (1, 1), EGARCH (1, 1), APGARCH (1, 1), and T-GARCH (1, 1) Models for Bitcoin Market Return Index during (2010-2017).

BITCOIN CURRENCY IN USD

Symmetric Information		Asymmetric Information		
Coefficient	GARCH (1,1)	E-GARCH (1,1)	AP-GARCH (1,1)	T-GARCH (1,1)
Mean				
μ (constant)	0.3880***	1.0821*	0.30135***	0.35490***
Variance				
ω (constant)	1.74764	0.007167	16.822	1.74599
α (Arch effect)	0.16131***	0.32293***	0.1466	0.14748***
β (Garch effect)	0.80828***	0.9384***	0.7129***	0.80874***
γ (Leverage effect)		*-0.03774*	0.0184	0.02635
$\alpha + \beta$	0.96959	1.26133	0.8595	0.95622
Log likelihood	-8262.442	-8363.917	-8234.3449	-8261.580
Akaike Info. Criterion (AIC)	6.07156	6.14683	6.05240	6.0716
Schwarz Info. Criterion (SIC)	6.0802	6.157687	6.06542	6.08252
ARCH-LM test statistics Prob. Chi-square	1.00288 0.99747	9.39607 0.99226	0.00249 0.9601	5.6116 0.99811

Note: ***and, ** denotes significant at 1% and 5% significance level.

Table 6 presents the estimated result of EGARCH (1, 1), APGARCH (1, 1) and T-GARCH (1, 1) model for U.S. stock market returns. The overall findings reveal higher leverage effects exist in the U.S. stock market. This is confirmed by the negative and statistically significant values of γ asymmetric coefficients in Table 6 for DJI, NDI, and S&P stock market indices at 1% level significant. This provides an evidence of asymmetric volatility persistence in daily U.S. stock market returns and indicates that adverse news (negative shock) has a tendency to increase stock market volatility more than positive news (positive shock) and diminishes market stability especially during financial crisis. This is due to the fact that when volatility is involved in the pricing mechanism, its rise causes the required return on equity to increase and then decrease the prices of the shares.[44,45,46] This therefore implies that stock markets shares in the U.S. markets are not capable for hedging market risk in times of financial turmoil compared to crypto assets.

Similarly, for the Treasury bill market the overall finding indicates the persistence of leverage effect on the U.S. bond market. Table 7 shows that the estimated coefficients (γ) of -0.064975 for EGARCH model is statistically negative and is significant at 1% confidence level, while it is statistically insignificant for APGARCH (1,1) and TGARCH (1,1) models. Based on EGARCH (1, 1) model estimation the result indicates that volatility of bond market return tends to rise in response to negative shock and fall in response to positive chock in United States market. On the other hand, the fiat money (dollar index) shows difference behaviour compared to Bitcoin, stock and bond assets in U.S. market. As presented in Table 8 the projected coefficients (γ) of USD return index is positive and statistically significant at 1% confidence level. This suggests that asymmetric information effect is persistence in the U.S. forex market. However, the volatility of the U.S. dollar return index responses more and significantly to good economic news than bad economic news. A possible explanation for this result is that investors usually prefer to trade dollars during economic boom causing high volatility in dollar index while during economic slowdown period investors always prefer to hold the dollar to face any expected liquidity risks as consequences reduction in dollar index volatility. Finally, ARCH-LM test was applied for all GARCH specifications to check for the ARCH effect in residuals and from the results shown in Table 5, 6, 7 and 8, it is inferred that the P-values are more than 0.05, confirming

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[44] J. Kurka, "Do Crypto-currencies and Traditional Asset Classes Influence Each Other?", No. 29/2017), IES Working Paper.

[45] R.S. Pindyck, "Risk, Inflation, and the Stock Market", *American Economic Review*, (1983), 334-351.

[46] K.R. French, G.W. Schwert and R.F. Stambaugh, "Expected Stock Returns and Volatility", *Journal of Financial Economics*, 19(1), (1987), 3-29.

that the null hypothesis of “no arch effect” is accepted. This suggests no additional ARCH effect left and the variance equations are well determined for all GARCH models.

Table (6): Estimated Result of GARCH (1, 1), EGARCH (1, 1), APGARCH (1, 1), and T-GARCH (1, 1) Models for U.S. Stock Market Indices during (2005-2017).

	Symmetric Information		Asymmetric Information		
	Coefficient	GARCH (1,1)	E-GARCH (1,1)	APGARCH (1,1)	T-GARCH (1,1)
U.S. DJI STOCK INDEX	Mean				
	μ (constant)	0.066534***	0.033335***	0.029092**	0.031764**
	Variance				
	ω (constant)	0.021510***	-0.111199***	0.028086***	0.020712***
	α (Arch effect)	0.119630***	0.132823***	0.089454***	-0.022298**
	β (Garch effect)	0.858563***	0.972604***	0.901066***	0.891776***
	γ (Leverage effect)		-0.152519***	1.00000***	0.209142***
	$\alpha+\beta$	0.978193	1.105427	0.99052	0.869478
	Log likelihood	-3842.145	-3770.817	-3757.011	-3773.393
	Akaike Info. Criterion (AIC)	2.52041	2.474323	2.465276	2.476011
	Schwarz Info. Criterion (SIC)	2.528304	2.484191	2.475144	2.48588
	ARCH-LM test statistics	2.753031	2.655126	4.383966	3.573354
	Prob. Chi-square	0.0971	0.1033	0.1117	0.0588
U.S. NDI STOCK INDEX	Mean				
	μ (constant)	0.085318***	0.037430**	0.03238*	0.04524**
	Variance				
	ω (constant)	0.032959***	-0.099947***	0.04431***	0.043419***
	α (Arch effect)	0.096461***	0.140201***	0.08327***	-0.013034
	β (Garch	0.881461***	0.96479***	0.89341***	0.878574***

	effect)				
	γ (Leverage effect)		-0.1491***	0.99998***	0.204721***
	$\alpha+\beta$	0.977922	1.104991	0.976687	0.86544
	Log likelihood	-4624.988	-4567.732	-4554.96	-4570.382
	Akaike Info. Criterion (AIC)	3.033413	2.996548	2.988833	3.007361
	Schwarz Info. Criterion (SIC)	3.041307	3.006416	3.000675	3.001039
	ARCH-LM test statistics	0.208065	2.253482	1.645562	1.893094
	Prob. Chi-square	0.6483	0.1051	0.1444	0.0922
U.S. S&P STOCK INDEX	Mean				
	μ (constant)	0.060350***	0.020905	0.017006	0.022522
	Variance				
	ω (constant)	0.020578***	-0.101037***	0.027554***	0.022533***
	α (Arch effect)	0.111507***	0.126573***	0.091342***	-0.024469
	β (Garch effect)	0.870123***	0.975817***	0.903495***	0.892252***
	γ (Leverage effect)		-0.160818***	0.999999***	0.216286***
	$\alpha+\beta$	0.98163	1.10239	0.994837	0.867783
	Log likelihood	-4025.848	-3952.757	-3943.07	-3957.779
	Akaike Info. Criterion (AIC)	2.640792	2.59355	2.587202	2.596841
	Schwarz Info. Criterion (SIC)	2.648686	2.603418	2.59707	2.606709
	ARCH-LM test statistics	2.656594	2.213426	2.98747	2.544564
	Prob. Chi-square	0.1032	0.1095	0.0506	0.0787

Note: ***and, ** denotes significant at 1% and 5% significance level.

Table (7): Estimated Result of GARCH (1, 1), EGARCH (1, 1), APGARCH (1, 1), and T-GARCH (1, 1) Models for U.S. 3-Month Treasury Bill Rate of Return Index during (2005-2017).

	Symmetric Information		Asymmetric Information		
	Coefficient	GARCH (1,1)	E-GARCH (1,1)	APGARCH (1,1)	T-GARCH (1,1)
U.S. 3-MONTH TREASURY BOND	Mean				
	μ (constant)	0.000216	-0.000672**	-6.27E-05	-2.82E-05
	Variance				
	ω (constant)	0.00000517***	-0.412895***	2.35E-05	0.000005***
	α (Arch effect)	0.232475***	0.342445***	0.225988***	0.18463***
	β (Garch effect)	0.798204***	0.97733***	0.814779***	0.804259***
	γ (Leverage effect)		-0.064975**	0.112101	0.085641
	$\alpha + \beta$	1.030679	1.319775	1.040767	0.988889
	Log likelihood	8255.552	8250.936	8263.586	8261.634
	Akaike Info. Criterion (AIC)	-5.071636	-5.068184	-5.075345	-5.07476
	Schwarz Info. Criterion (SIC)	-5.064153	-5.05883	-5.06412	-5.065406
	ARCH-LM test statistics	3.824578	1.326752	1.906938	3.03116
	Prob. Chi-square	0.0506	0.064	0.0899	0.0817

Note: ***and, ** denotes significant at 1% and 5% significance level.

Table (8): Estimated Result of GARCH (1, 1), EGARCH (1, 1), APGARCH (1, 1), and T-GARCH (1, 1) Models for U.S. Dollar Return Index during (2007-2017).

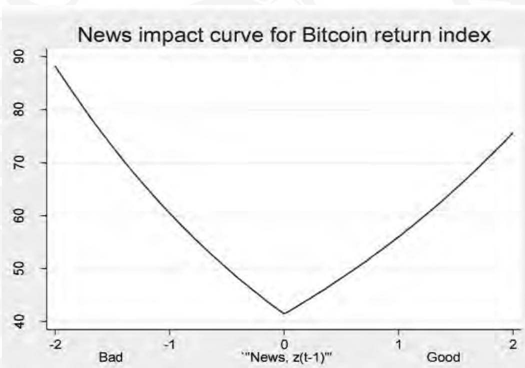
	Symmetric Information		**Asymmetric Information**		
	Coefficient	GARCH (1,1)	E-GARCH (1,1)	AP-GARCH(1,1)	T-GARCH (1,1)
U.S. DOLLAR INDEX	Mean				
	μ (constant)	-0.00088	.003215	0.00215	0.00171
	Variance				
	ω (constant)	.000832***	-0.05786***	0.00108**	0.00068***
	α (Arch effect)	0.03172***	0.06684***	0.03122***	0.03722***
	β (Garch effect)	0.9655***	0.9951***	0.9696***	0.9695***
	γ (Leverage effect)		0.01854**	-0.20143	-0.0183*
	$\alpha + \beta$	.99722	1.06194	1.00082	1.0067
	Log likelihood	-1923.218	-1920.158	-1919.205	-1919.603
	Akaike Info. Criterion (AIC)	1.36585	1.36439	1.364426	1.36399
	Schwarz Info. Criterion (SIC)	1.37428	1.37493	1.37706	1.37453
	ARCH-LM test statistics Prob. Chi-square	2.179375 0.13998	1.30186 0.2539	1.931919 0.16465	2.30798 0.12882

Note: *** and ** denotes significant at 1% and 5% significance level.

4.5 News Impact Curve Analysis Results

The GARCH specifications in the previous section showed different models having different signs for asymmetric response of good and bad news to each asset's volatility or return. The study therefore graphically illustrates their responses using News Impact Curve analysis, which describes the various levels of the impact of bad and good news[47]. In theory, bad economic news increases future volatility while good economic news reduces future volatility.[48] Figure 3 illustrates NIC for Bitcoin currency over the period of July 2010 to 2017. The negative side of the curve shows greater steepness than the positive side, thus indicating that negative news (shock) has slightly greater effect on the conditional variance compared to positive news (shock).

Figure 3: News Impact Curve for Bitcoin during (2010-2017)



In addition, Figure 4 shows how the news and future volatility of U.S. stock market returns of DJI, NDI, and S&P index are related. The findings indicate the impact of leveraging in the U.S. stock market, which means that future conditional variance of stocks' returns, responds more to bad shocks than good shocks. Similarly, the conditional variance of the U.S. Treasury bill returns seems to

[47] R.F. Engle and V.K. Ng, "Measuring and Testing the Impact of News on Volatility", *The Journal of Finance*, 48(5), (1993), 1749-1778.

[48] F. Black, "Studies of stock price volatility changes", (1976), op. cit.

have completely responded to the bad news rather than good news and the news impact curves validate this result as shown in Figure 5.

Figure 4: News Impact Curve for DJI, NDI, and S&P stock Indices during (2005-2017)

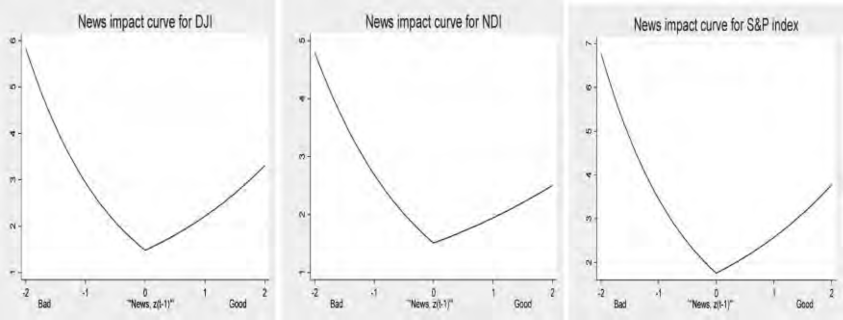
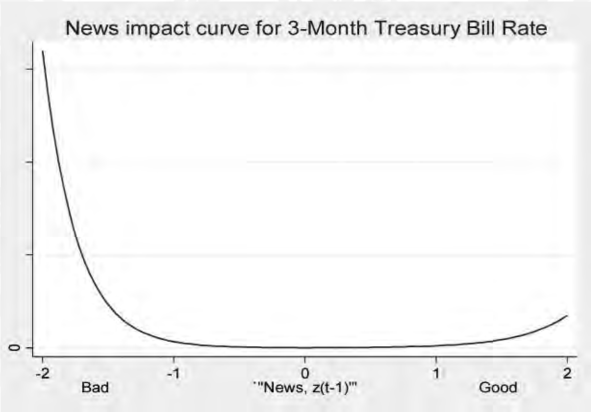
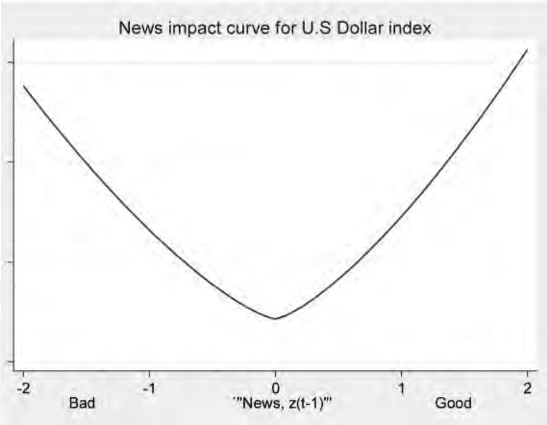


Figure 5 : News Impact Curve for TBR during (2005-2017)



Finally, Figure 6 depicts the relationship between the news and future volatility of the USD index returns which implies that positive shocks or good news more greatly affects the conditional variance compared to the negative shocks or bad news. This implies that a certain amount of good economic news is required to induce market activity.

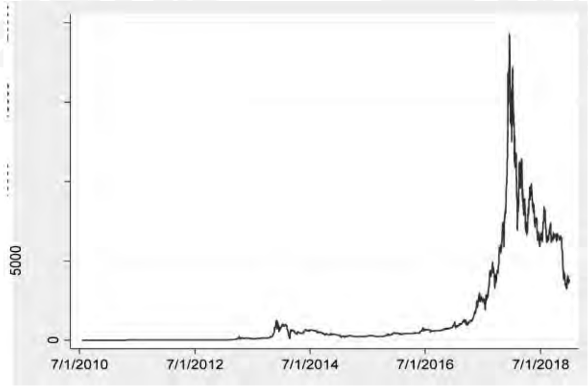
Figure 6 News Impact Curve for USD Return Index during (2007-2017)



4.6 Bitcoin Market Decline Impact of 2018

Bitcoin market has suffered sharp decline in its value during 2018, in which the price falls from around USD 19,345.5 on 16 December 2017 to reach USD 3,709.4 on 31 December 2018, which represents about 80.82 % of the market value deterioration as exhibited in figurer 7 below.

Figure 7 the Price Movement of Bitcoin Currency during July 2010 to December 2018



Some economists and financial analysts believe that Bitfinex investors had been artificially inflating the Bitcoin price to cause the dramatic upswings in 2017 by engaging in wash trades, which basically involves buying and selling a cryptocurrency to create the impression of activity. Other financial analysts have attributed much of the activity to the general risk of regulation and legislative enforcement. They believed that investing in cryptocurrencies markets is highly speculative and the market is largely unregulated. Therefore, this dramatically negative change in the Bitcoin market price gibes rise to the question of whether this downward movement in bitcoin market was due to price of bitcoin finding its true level or it is artificially inflated by speculative activity. In other words, is the price volatility due to the characteristics of the Bitocin asset itself or attributable to the market risk? This study therefore expands the analysis to include bitcoin data of 2018, in order to confirm whether the high volatility of the Bitcoin currency reflected the symmetric or asymmetric effect.

Table 9 below reports the estimated coefficients results of symmetric and asymmetric effects of bitcoin market returns series of four GARCH models specifications over the period 2010 to 2018. Table 9 shows that the estimated coefficients of α and β parameters are statistically significant at 1% and 5% in all GARCH specifications, indicating that the daily return suggests time-varying volatility and this volatilely was due more to the features of bitcoin currency itself rather than market forces.

Table (9): Estimated Result of GARCH (1, 1), EGARCH (1, 1), APGARCH (1, 1), and T-GARCH (1, 1) Models for Bitcoin Market Return Index during (2010-2018)

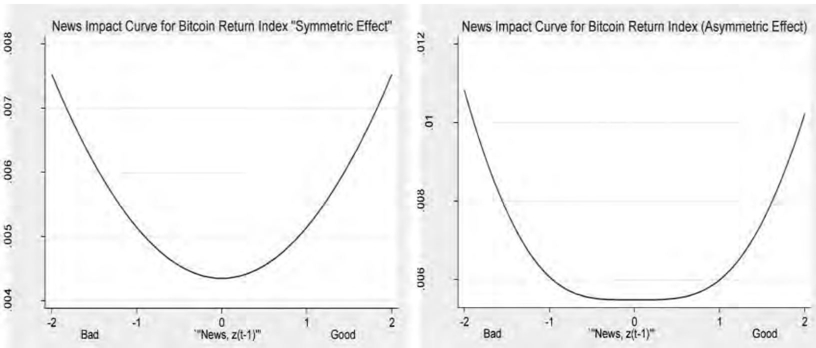
Symmetric Information		Asymmetric Information		
Coefficient	GARCH (1,1)	E-GARCH (1,1)	APGARCH(1,1)	T-GARCH (1,1)
Mean				
μ (constant)	0.28451 ***	0.99532	0.21706 ***	0.25251 **
Variance				

ω (constant)	1.6295	0.02681	13.215	1.6269
α (Arch effect)	0.14796 ***	0.30065 ***	0.1326**	0.13527 ***
β (Garch effect)	0.815604***	0.9353 ***	0.73104***	0.81605***
γ (Leverage effect)		*-0.0303*	0.0198	0.02401
$\alpha+\beta$	0.96356	1.23595	0.86364	0.95132
Log likelihood	-9385.3496	-9517.971	-9354.824	-9384.4178
Akaike Info. Criterion (AIC)	6.01688	6.10251	5.9986	6.01692
Schwarz Info. Criterion (SIC)	6.02463	6.11219	6.0102	6.02661
ARCH-LM test statistics Prob. Chi-square	8.17891 0.99278	0.00064 0.97980	0.00267 0.9587	6.9923 0.9933

*Note: *** and ** denotes significant at 1% and 5% significance level.*

In other words, the findings indicated that Bitcoin market volatility is symmetric informative and has long memory to persist in the future. Furthermore, the symmetric volatility is found to show greater sensitivity to its past values (lagged) than to the new shock of the market values. However, asymmetric informative response of volatility to the negative and the positive shocks does not exist in Bitcoin market or in other word, there is no leverage effect. This is confirmed by the negative insignificant values of γ asymmetric coefficients in Table 9 at level significant of 5%. This suggests that Bitcoin currency is not artificially inflated, but it is dropping closer to its true level as it is being artificially propped up. Similarly, in Figure 8, the News-impact Curve of Bitcoin in GARCH (1, 1) model shows that good and bad shocks are similar in size and increase the conditional variance by the same amount, which confirms the persistence of symmetric effect. While the right plot of News-Impact Curve in APGARCH (1,1) model displays that negative market shocks has slightly more effect on the conditional variance of the return series comparing to the positive shock but statistically insignificant and confirms that bitcoin currency can play an appropriate asset to hedge against market risk.

Figure 8: News-Impact Curve for Symmetric and Asymmetric effects for Bitcoin Currency over the Period 2010 to 2018



5.0 Conclusion and Discussion

In this study, we examined the capability of the new crypto assets in relation to the characteristics of high-quality liquid assets for Basel III requirements' Liquidity Standards. In other words, the study explores whether the Bitcoin currency is qualified to be included in the HQLA stock. The Bitcoin assets' characteristics were examined in terms of low level of risk (i.e. High credit standing of the issuer, low duration, legal risk, inflation risk and denomination in a convertible currency with low forex risk); ease and predictability of valuation (the ability to be priced easily and with a degree of certainty); low correlation with risky assets; listed on a developed and recognized exchange; active and sizable market; and low volatility. The study applied the GARCH family models such as GARCH (1, 1), EGARCH (1, 1), APGARCH (1, 1) and TGARCH (1, 1) model to examine the volatility structure of Bitcoin currency compared to the recommended traditional assets in the U.S. financial Market. Traditional assets include; stocks (DJI, NDI, and S&P), bonds (3-month Treasury bill rate), and coin and banknotes (Dollar index).

The findings indicated that Bitcoin currency fulfils the requirements of HQLA standards in terms of good credit standing of the issuer, minimal duration, reduced inflation risk and denomination in a convertible currency with minimal forex risk, ease and predictability of valuation; minimal correlation with risky assets; listed on an established and recognized exchange and active and sizable market. However, in terms of legal risk, crypto assets are still exposed to many legality risks such as lack of regulations and consumer protection against fraud, lack of central control, tax evasion and treatment and monetary policy. The risks of legality and recognition are still being weighed while consideration by legal authorities of many countries around the world is underway. The attitude of countries have been divided into three groups: favorable, undecided, and unfavorable, but the number of countries which have legally started recognizing the crypto-currencies as payment system (as an exchange medium) or an alternative asset investment has increased enthusiastically and this has a positive impact on its intrinsic value. Hence the legality risk will be eliminated in the future when the market is matured enough as its intrinsic value improves with the increase of its usefulness. This is due to the fact that real currency does not need strong regulation to be accepted and recognized, instead it needs only strong intrinsic value that makes it globally recognized and accepted among the users. Thus, the fact remains that crypto-currencies continue to be at the forefront of the modern day technological advancement of block-chain and its possible applications.

With respect to symmetric and asymmetric volatility structure analysis of Bitcoin currency compared to other traditional assets classes, we found that the return volatility is significantly responsive to symmetric information and showed high volatility persistence with predictability behaviour in all assets classes including Bitcoin currency. However, asymmetric informative response of returns volatility to the negative and the positive shocks found statistically insignificant in Bitcoin market, indicating the absence of leverage effect. Moreover, with regard to asymmetric reaction of stocks and bonds' returns volatility to good news and bad news, we found that the returns volatility greatly and significantly responds more to negative news in the U.S. stocks and bonds markets during the period under study. The asymmetric reaction of dollar index's return volatility was found to be statistically significantly responsive to good news than negative news in the global financial market. In addition, the study extended the analysis using news impact curve to investigate the asymmetry effect implied by asymmetric GARCH models. It is of interest to note that the evidence based on the news impact curve analysis suggests that the future conditional variance of Bitcoin, stocks and bond's returns will respond more to bad shocks than good shocks, while future conditional variance of dollar index returns will respond more to good shocks.

To sum up, the findings of the study found that Bitcoin currency has the same characteristics of HQLA to such degree and owns the features of a hedge, diversifier, and safe haven assets. This is due to the absence of leverage effect in Bitcoin market, low correlation with other traditional assets classes, and statistically insignificant responsive to negative news (shock) in the global financial market. This makes its stability gradually improved and recommended to be included into HQLA stock. Therefore, the findings of this study facilitates investors both individuals and financial institutions with the appropriate information about characteristics and financial behaviour of new crypto-currencies related to traditional assets classes to improve their portfolio investment diversification strategies and enhance their liquidity risk management. For policy makers particularly, the Basel Committee of Banking Supervision (BCBS), the findings of the study may assist in evaluating the suitability of including crypto assets into HQLA stock to improve and continue developing the liquidity requirement standards in order to ensure that banks have an adequate amount of HQLA during times of financial turmoil.

One of the major limitations of this study has been data constraints, where the data used for Bitcoin currency returns analysis do not cover any global financial crisis and this could not be avoided as the new crypto-currencies were introduced right after the 2007-2008 global financial crisis. What might be interesting for further research is to examine whether the Bitcoin currency is capable of holding the characteristics of safe haven asset in the face of financial turmoil or in the event of an extreme market crash.

TRANSLITERATION TABLE

CONSONANTS

Ar=Arabic, Pr=Persian, OT=Ottoman Turkish, Ur=Urdu

	Ar	Pr	OT	UR		Ar	Pr	OT	UR		Ar	Pr	OT	UR
ء	’	’	’	’	ز	z	z	z	z	گ	–	g	g	g
ب	b	b	b	b	ڑ	–	–	–	ṛ	ل	l	l	l	l
پ	–	p	p	p	ژ	–	zh	j	zh	م	m	m	m	m
ت	t	t	t	t	س	s	s	s	s	ن	n	n	n	n
ٹ	–	–	–	ṭ	ش	sh	sh	ş	sh	ه	h	h	h[1]	h[1]
ث	th	th	th	th	ص	ṣ	ṣ	ṣ	ṣ	و	w	v/u	v	v/u
ج	j	j	c	j	ض	ḍ	ẓ	ż	ż	ى	y	y	y	y
چ	–	ch	çh	ch	ط	ṭ	ṭ	ṭ	ṭ	ة	-ah			-a[2]
ح	ḥ	ḥ	ḥ	ḥ	ظ	ẓ	ẓ	ẓ	ẓ	ال	al[3]			
خ	kh	kh	kh	kh	ع	‘	‘	‘	‘					
د	d	d	d	d	غ	gh	gh	ğ	gh					
ڈ	–	–	–	d	ف	f	f	f	f					
ذ	dh	dh	dh	dh	ق	q	q	k	q					
ر	r	r	r	r	ك	k	k/g	k/ñ	k					

[1] – when not final
[2] – at in construct state
[3] – (article) al - or 1-

VOWELS

		Arabic and Persian	Urdu	Ottoman Turkish
Long	ا	ā	ā	ā
	آ	Ā	Ā	–
	و	ū	ū	ū
	ي	ī	ī	ī
Doubled	يّ	iyy (final form ī)	iy (final form ī)	iyy (final form ī)
	وّ	uww (final form ū) uvv (for Persian)	uv	uvv
Diphthongs	و	au or aw	au	ev
	ى	ai or ay	ay	ey
Short	ـَ	a	a	a or e
	ـُ	u	u	u or ü o or ö
	ـِ	i	i	i

URDU ASPIRATED SOUNDS

For aspirated sounds not used in Arabic, Persian, and Turkish add h after the letter and underline both the letters e.g. جھ <u>jh</u> گھ <u>gh</u>

For Ottoman Turkish, modern Turkish orthography may be used.

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