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Price Volatility of Bitcoins in India – An Empirical Analysis of Bitcoin Prices

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Cryptography is a type of computer technology that is used for ensuring security, hiding information, and more. Bitcoins is the most recognized cryptocurrency. It is a person to person virtual currency which is used for online transactions. In this paper, an attempt has been made to analyses the price volatility of bitcoins. Further, a detailed content analysis has been presented in this paper. This study considers a study period of 8 and half years ranging from 19th June 2010 to 31st December 2018. Bitcoins prices were considered as variable to study the volatility of Bitcoins prices. Unit Root analysis is employed to check the Stationarity of the data series of bitcoins prices. ARCH Test, Volatility Clustering, ARCH, GARCH, TARCH and EGARCH have been used to analyze the price volatility. It was found that good news has more effect on the volatility of Bitcoins price returns than the bad news.

Keywords: *Bitcoins, Cryptocurrency, Price, Volatility, Block chain Technology, GARCH, TGARCH*

I. INTRODUCTION

Cryptocurrency or virtual currency represents a standard of value, which is exchangeable for goods or services, and it is created from a code that holds monetary value. Cryptocurrency economy is under the surveillance of the peer to peer network. It is independent of any central authority or government control. Cryptocurrency is derived from two words, that is, crypto and currency, as it is a cryptographically encrypted currency. Cryptography is a type of computer technology that is used for ensuring security, hiding information, and more. Cryptocurrency, therefore, protects transactions and also hides the identity of its users. It is a mode of exchange that is cheaper and faster as it doesn't involve intermediaries like banks or government for the transaction, but users can transact directly with each other and instead of storing it with the banks and paying a fee for storing, the users can store cryptocurrency with themselves. There are various types of cryptocurrencies like Bitcoins (BTC), Litecoin (LTC), Ethereum (ETH), Ripple (XRP), Bitcoin cash (BCH), Ethereum Classic, Zcash

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(ZEC), Cardano (ADA), NEM, Stellar, NEO, IOTA, Dash, Monero (XMR), TRON and EOS. From all of the above, Bitcoins is the most recognized cryptocurrency.

Bitcoin is the first decentralized cryptocurrency introduced by pseudonymous developer Satoshi Nakamoto in 2009. It is a person to person virtual currency which is used for online transactions. Bitcoins were created to eliminate the role of mediators that is banks or government while transacting online. It is a digital currency which can be used to make transactions around the world, without having to go through the banking process, nor disclosing the user's identity. Bitcoins are being traded privately as well as on the Exchanges. With Bitcoins gaining market share, many businesses across the world have started to adopt Bitcoins as a substitute for payment, even though it doesn't have legal status. From all the nations, Japan was the first country to legalise the use of Bitcoins. The United States has taken Bitcoins positively, but its government agencies are trying to avert illegal Bitcoins transactions. In a similar way, there are several countries that are open to the usage of Bitcoins like Canada, Germany, Australia, United Kingdom, Finland, Bulgaria, Belgium, Brazil, Canada, Croatia, Czech Republic, Cyprus, Denmark, France, Hong Kong, Israel, Italy, Ukraine, New Zealand, Norway, Poland, Singapore, Slovenia, South Korea, Spain, Switzerland, Sweden, Turkey, etc. The countries where Bitcoins is illegal are China, Russia, Vietnam, Bolivia, Columbia, Bangladesh, Kyrgyzstan and Ecuador.

Bitcoins transactions are processed by an extensive distribution network of computers using special software. So whenever a deal occurs, that is the buying and selling of Bitcoins, the system records the senders as well as the receiver's Bitcoins address and the amount transferred. It helps to track the history of the Bitcoins, stop people from making copies of the Bitcoins or undoing of transactions. The addresses and the amount transferred is then entered on a ledger record called blockchain. A blockchain is updated multiple times in a single day, and this update is sent on every computer that processes Bitcoins. All the Bitcoins transactions are verified through cryptography, and this verification process is carried out by Bitcoins miners. After the miners identify a certain number of sales, they earn Bitcoins.

II. PRESENT STATUS OF BITCOINS IN INDIA

Since September 2019, there was an absolute ban on bitcoins being traded as a digital currency in India. The "Banning of Cryptocurrency and Regulation of Official Digital Currency Bill 2019" draft has proposed a 10-year prison sentence for anyone who "mines, generates, holds, sells, transfers, disposes of, issues or deals in cryptocurrencies". The Reserve Bank of India had banned the trading of crypto currencies in India stating that it could be a threat to the banking system prevailing in India in a circular issued on 6th April 2018. RBI directed all the entities to stop dealing in virtual currencies.

In March 2020, Supreme Court of India quashed RBI's curb and allowed the trading in Cryptocurrency in India and giving it legal status. With the positive move

from the Indian Government, many new businesses are expanding its operations in India and planning to infuse capital into Indian crypto ecosystem. Global Software Company Hashcash consultants are planning to inject $10 million in the Indian crypto industry (news.bitcoins.com). The businesses that had shut its operations after RBIs ban are entering into business. Finally, both the Government and RBI have confirmed that crypto currencies including Bitcoins are legal in India.

III. LITERATURE REVIEW

Grinberg (2012) discuss the sustainability of Bitcoins currency and similarity of Bitcoins with its competition such as PayPal and digital gold currencies, finding out that Bitcoins has a significant position as a micropayment and in the virtual world of commerce, it is a substitute currency for gold. *Barber, Boyen et al. (2012)* explores the success of Bitcoins and ways in which it can become a lasting stable currency, finding that Bitcoins popularity, simplicity, flexibility and decentralisation makes it easy to hold and though enough to destabilize. By assessing the economic properties as well as the implementation of Bitcoins, *Lavorschi (2013)* analyses the theoretical principles underlying the Bitcoins and the study shows that the Bitcoins largely meets the role of natural money of gold and silver, in compliance with the free market's behaviour. *Plassaras (2013)* examines Bitcoins which is a decentralized, partially unidentified and largely unregulated digital currency, and finds that there's a possibility that Bitcoins can intimidate the global economic stability for which International Monetary Fund was created to protect. *Bollen (2013)* examines the legal status well as the regulatory status of virtual currencies and found out that Bitcoins users, that is intermediaries and market operators, who buy and sell Bitcoins in exchange for regular currency are bound by general commercial and contractual law. *Ober, Katzenbeisser et al. (2013)* empirically study important global properties of the Bitcoins transaction graph and assess the implications of the properties on practical level of anonymity. The study found that the merging of public addresses by simultaneous usage of several addresses is the most important challenge to Bitcoins anonymity. *Yermack (2014)* examines whether Bitcoins can be a real currency and finds that even though Bitcoins are not issued by the sovereign state it can establish itself as a bona fide currency if its value is stable. To know the speculative gain, moral purposes, spending power and criminal applications of Bitcoins, *Christopher (2014)* explores the appeal and danger of investing in Bitcoins and found that even though there are authorized uses of Bitcoins, it is convincing only to a certain segment of the population. For ordinary people to use Bitcoins there should be proper apps and accounts of the technology, they should know how it works, the exchange rates should be stable and last they should trust that Bitcoins will retain value. *Joancomart (2014)* study the issues of Bitcoins system and review Bitcoins anonymity research papers and found that Bitcoins system uses Bitcoins

addresses to perform and receive payments which can reveal some information of the owner. The Bitcoins anonymity is analyzed by collect information from P2P network, and since this network is dynamic in nature, analysis is difficult and therefore results on Bitcoins anonymity are not optimistic. While documenting empirical regularities related to the usage of Bitcoins, *Badev and Chen (2014)* examines the usage of Bitcoins as a method of payment and found that less than 50% of the total Bitcoins in circulation are used in transactions. Most of the transactions which have small value are related to online gambling services. *Gup (2014)*, the study shows the evolution of the method of payments. Methods of payments have been continuously evolving since 2200 BC. From gold and silver being replaced with paper money and then fiat money, methods of payments evolved to checks, credit cards and different forms of electronic payments like Bitcoins which are very volatile in nature. *Perugini and Maioli (2014)* analyzed the structural considerations and financial evaluation of Bitcoins and found that the value of Bitcoins increased due to its structured investments that led to its success on the internet. By using an autoregressive jump – intensity *Gronwald (2014)* empirically analyses Bitcoins prices. The analyses showed that Bitcoins prices are characterised by extreme movements of price and conditional heteroscedasticity. *Dyhrberg (2016)* uses asymmetric GARCH methodology used to investigate gold, to explore the hedging capabilities of Bitcoins. The results show that Bitcoins can be used as a hedge against stocks in the Financial Times Stock Exchange Index and the American dollar in the short-term.

IV. METHODOLOGY

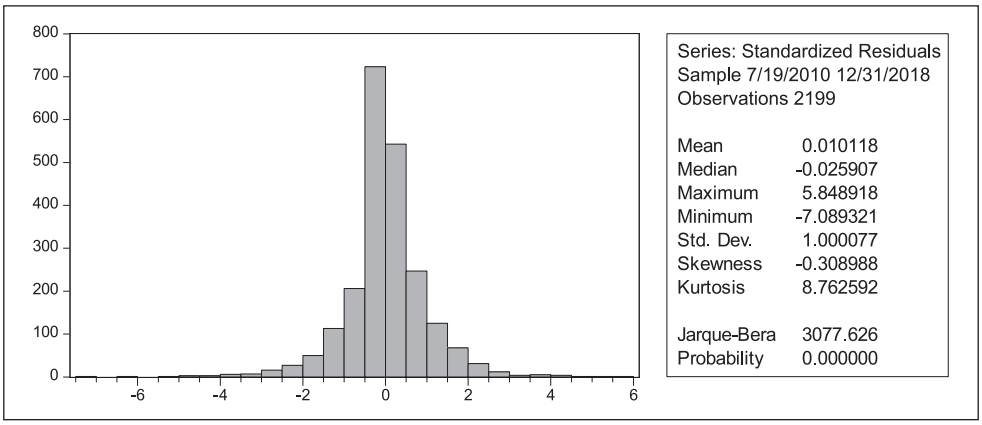
Based on the extensive literature survey done, in this paper, an attempt has been made to analyses the price volatility of bitcoins. Further, detailed content analysis has been presented in this paper. This study considers a study period of 8 and half years ranging from 19th June 2010 to 31st December 2018. Bitcoins prices were considered as variable to study the volatility of Bitcoins prices. This study is based on secondary data. The Daily data on Bitcoins prices is collected from Bloomberg database to examine the price volatility. While the research papers are collected from SSRN, DOAJ, JSTOR and Research Scholar for exploring the past studies on Bitcoins. The study has a sample size of 2199 observations from June 2010 to December 2018. Unit Root analysis is employed to check the Stationarity of the data series of bitcoins prices. ARCH Test, Volatility Clustering, ARCH, GARCH, TARCH and EGARCH has been used to analyze the price volatility. Volatility clustering is used to check whether large changes are followed by large changes and small changes are followed with small changes. If large changes are not followed by large changes and small changes are not followed by small changes, then there is no volatility clustering. Autoregressive conditional heteroskedasticity (ARCH), Generalized autoregressive conditional

heteroskedasticity (GARCH), Threshold ARCH (TARCH) and general exponential GARCH (EGARCH) model is used to measure the volatility of time series data that exhibit varying volatility. The study uses serial correlation to check whether a serial correlation exists or not and Q statistics to check whether it is significant or not.

V. ANALYSIS OF PRICE VOLATILITY OF BITCOINS

This paper studies the relationship between volatility and the returns of Bitcoins prices. Many studies have tried to estimate the volatility of the prices of Bitcoins. Many empirical studies use different kinds of models to examine the price volatility of Bitcoins. In this study, ARCH family models are compared and the best model is used. The ARCH family models include ARCH, GARCH, TARCH and EGARCH.

Figure 1
Histogram
Descriptive Statistics of the Daily Returns on Bitcoin Prices during the period of the study



Source: Authors Compilation

Figure 1 shows the basic statistics which help to narrate the daily returns data of prices of Bitcoins for the period July 2010 to December 2018. The average return of the prices of Bitcoins over the period of study is shown by the mean value which is 1.01%. While the maximum value (5.84%) shows the highest return the minimum value (-7.08%) shows the lowest return during the period. The huge difference between the maximum and minimum returns indicates a high level of fluctuation in the prices of Bitcoins.

The standard deviation is high that is, 1.00 (100%) which shows that Bitcoins price is highly volatile. Skewness value is measured to determine the symmetrical distribution of the data wherein cases of the normal distribution, the value of skewness is zero, but the results show a negative value which means the daily returns have a greater tendency to fall.

The benchmark value for kurtosis is 3. The degree of kurtosis as per the study is 8.76 which exceeds the benchmark therefore it is a leptokurtic distribution which shows the presence of extremely large values and outliers.

Jarque-Bera statistics are used to test the null hypothesis that the returns are normally distributed, and alternative hypothesis that the returns are not normally distributed. The probability value for the statistic is zero which means that it is statistically significant at the 1% level. Therefore the null hypothesis is rejected and the alternative hypothesis is accepted, thereby concluding that the return series is not normally distributed.

Test for Stationary

The stationary and non-stationary of the series were tested using Augmented Dickey-Fuller (ADF) unit root test. The data were found to have no unit root and therefore stationary at the level form. Hence the study estimated ARCH family models which are useful for handling the time varying properties of the data.

Table 1
ADF Unit Root Test

Null Hypothesis: LOG_RETURN has a unit root			
Exogenous: None			
Lag Length: 3 (Automatic - based on SIC, maxlag=25)			
		T-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-20.17217	0.0000
Test critical values:	1% level	-2.566016	
	5% level	-1.940968	
	10% level	-1.616602	

Source: Authors Compilation

Table 1 depicts that the t-statistic is more than the test critical values at all the levels of significance, that is 1%, 5% and 10% and it suggests that ADF test rejects the null hypothesis and accepts alternate hypothesis. The results reveal that the data is in stationary at levels. Therefore the data fulfils the condition to be stationary in order to run ARCH family models.

Test for Running Arch Family Models

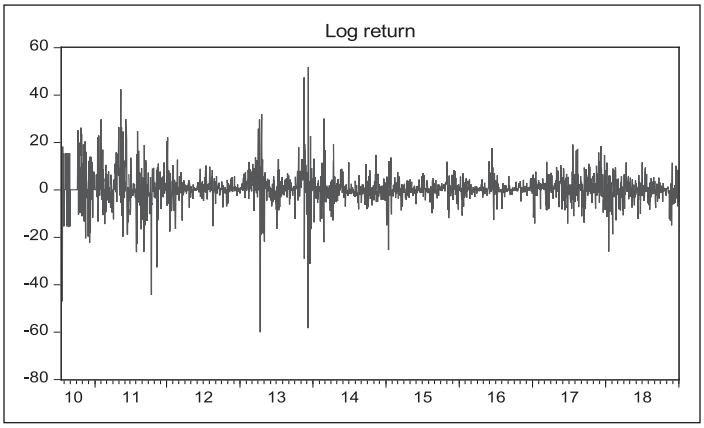
To run the ARCH family model two guidelines must be fulfilled, that is:

- Volatility Clustering
- ARCH effect

Test for Volatility Clustering

Volatility clustering meaning low volatility period is followed by a low volatility period and a high volatility period is followed by a high volatility period.

Figure 2
Volatility Graph



Source: Authors Compilation

Figure 2 depicts that, from the year 2010 to the mid year of 2011 high volatility is followed by high volatility, from mid 2011 to mid 2012 low volatility is followed by low volatility, from mid 2012 to mid 2013 high volatility if followed by high volatility, then from mid 2013 low volatility is followed by low volatility for a long time that is till mid 2016 and from mid 2016 to 2018 medium volatility is followed by medium volatility.

When low volatility is followed by low volatility and high volatility is followed by high volatility then ARCH family models can be carried on.

Test for ARCH Effect

Table 2
Heteroskedasticity Test: ARCH

F-statistic	5.284372	Prob. F(1,2196)	0.0216
Obs*R-squared	5.276487	Prob. Chi-Square(1)	0.0216

Source: Authors Compilation

Here the Probability value is less than 5%, so the null hypothesis is rejected which states that there is no ARCH effect and accept the alternative hypothesis that there is Arch effect. Since the model possesses ARCH effect, it is possible to run ARCH family models.

Comparison of ARCH, GARCH, TARCH AND EGARCH Models

In the study after running the ARCH family models that is ARCH, GARCH, TARCH and EGARCH, they are with each other compared according to their Akaike info criterion and Schwarz criterion. The model with the lowest Akaike info criterion and Schwarz criterion is selected to estimate the volatility of the prices of Bitcoins.

Table 3
Comparison of ARCH, GARCH, TARCH and EGARCH Models

	Arch	*Garch*	*Tarch*	*Egarch*
Akaike info criterion	6.077932	6.077932	6.071199	6.074183
Schwarz criterion	6.088292	6.088292	6.084150	6.087133

Source: Authors Compilation

Table 3 shows that as compared to all the ARCH family models, TARCH model has the lowest Akaike info criterion (6.071199) and the lowest Schwarz criterion (6.084150). Therefore TARCH model is further checked diagnostically to estimate the volatility of Bitcoins prices.

TARCH-Threshold Autoregressive Conditional Heteroskedasticity

Table 4
Results of TARCH Model which is also called as GIR-GARCH Model

Dependent Variable: LOG_RETURN
Method: ML - ARCH (Marquardt) - Normal distribution
Sample: 7/19/2010 12/31/2018
Included observations: 2199
Convergence achieved after 49 iterations
Presample variance: backcast (parameter = 0.7)
GARCH = C(2) + C(3)*RESID(-1)^2 + C(4)*RESID(-1)^2*(RESID(-1)<0) +
C(5)*GARCH(-1)

Variable	*Coefficient*	*Std. Error*	*z-Statistic*	*Prob.*
C	0.320219	0.089295	3.586060	0.0003
Variance Equation				
C	0.264922	0.019445	13.62397	0.0000
RESID(-1)^2	0.131222	0.006415	20.45472	0.0000
RESID(-1)^2*(RESID(-1)<0)	-0.054453	0.007684	-7.086576	0.0000
GARCH(-1)	0.898710	0.002788	322.3298	0.0000

Source: Authors Compilation

Table 4 depicts the estimated results of TARCH (1, 1) Model. The coefficients of the model are positive and since it's positive, there is leverage effect present in the

Bitcoins prices and therefore it can be said that there exists news asymmetry and since the RESID value is negative and it's statistically significant, it shows that good news has more effect on the volatility of Bitcoins prices than bad news.

Correlogram Analysis

Table 5
Correlogram Analysis
Included observations: 2199
Included observations: 2199

Autocorrelation	*Partial Correlation*		*AC*	*PAC*	*Q-Stat*	*Prob**
| |	| |	1	0.049	0.049	5.2858	0.022
| |	| |	2	-0.008	-0.011	5.4398	0.066
| |	| |	3	0.025	0.026	6.7973	0.079
| |	| |	4	0.016	0.013	7.3588	0.118
| |	| |	5	-0.017	-0.018	7.9747	0.158
| |	| |	6	-0.009	-0.007	8.1367	0.228
| |	| |	7	0.012	0.012	8.4589	0.294
| |	| |	8	0.007	0.006	8.5568	0.381
| |	| |	9	-0.022	-0.021	9.5949	0.384
| |	| |	10	0.015	0.017	10.120	0.430
| |	| |	11	-0.025	-0.028	11.512	0.401
| |	| |	12	0.001	0.005	11.514	0.485
| |	| |	13	-0.008	-0.009	11.665	0.555
| |	| |	14	0.010	0.011	11.867	0.617
| |	| |	15	-0.004	-0.005	11.903	0.686
| |	| |	16	-0.036	-0.035	14.739	0.544
| |	| |	17	-0.029	-0.026	16.558	0.485
| |	| |	18	-0.030	-0.028	18.499	0.423
| |	| |	19	-0.020	-0.014	19.348	0.435
| |	| |	20	0.054	0.057	25.823	0.172
| |	| |	21	-0.019	-0.023	26.625	0.184
| |	| |	22	-0.030	-0.028	28.599	0.157
| |	| |	23	-0.002	-0.001	28.607	0.194
| |	| |	24	-0.011	-0.013	28.880	0.225

Autocorrelation	*Partial Correlation*		*AC*	*PAC*	*Q-Stat*	*Prob**
| |	| |	25	0.013	0.018	29.243	0.254
| |	| |	26	0.016	0.016	29.787	0.277
| |	| |	27	-0.012	-0.018	30.131	0.308
| |	| |	28	-0.018	-0.019	30.834	0.325
| |	| |	29	-0.017	-0.015	31.475	0.343
| |	| |	30	-0.026	-0.027	32.949	0.325
| |	| |	31	-0.034	-0.027	35.475	0.265
| |	| |	32	0.034	0.036	37.993	0.215
| |	| |	33	-0.008	-0.014	38.121	0.248
| |	| |	34	-0.019	-0.019	38.914	0.258
| |	| |	35	0.029	0.027	40.811	0.230
| |	| |	36	0.020	0.018	41.715	0.236

Source: Authors Compilation

Table 5 shows that out of 36 lags, 35 lags have a probability value which is greater than 5%, therefore we cannot reject null hypothesis which means there is no serial correlation. The Q statistic at each lag is not significant which means there is no significant auto correlation (or) serial correlation in the daily returns.

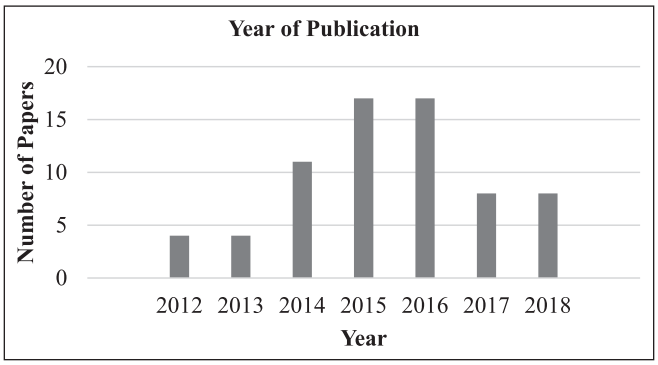
VI. CONTENT ANALYSIS

This study presents content analysis on the review of literature available on Bitcoins and cryptocurrency. This includes determining the number of papers published in a particular year from 2010 to 2018, the number of authors for each paper, the geographical distribution of the paper, the type of data used that is whether primary data or secondary data or both, type of research that is whether qualitative or quantitative and publisher of the research paper.

Publication Year

Figure 3 shows the publication year distribution of the selected research papers collected from 2012-2018. Even though Bitcoins were introduced in 2009 all the papers were published from 2012. While looking at the publication year distribution, it can be seen closely that out of the total papers (69), 4 papers (5.8 %) were published in 2012, 4 papers (5.8%) were published in 2013, 11 papers (16%) were published in 2014, 17 papers (24.6%) were published in 2015, 17 papers (24.6%) were published in 2016, 8 papers (11.6%) were published in 2017 and 8 papers (11.6%) were published in 2018. This shows an increase in the number of publication till 2015 and a drop from 2017.

Figure 3
Publication Year

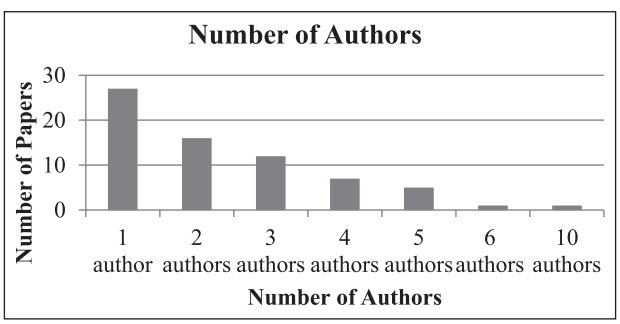


Source: Authors Compilation

Number of Authors

Figure 4 shows the number of authors of the selected papers. After looking at the number of authors for every paper it can be seen that, out of the 69 selected papers 27 papers (39.1%) are written by a single author, 16 papers (23.2%) are written by 2 authors, 12 papers (17.4%) are written by 3 authors, 7 papers (10.1%) are written by 4 authors, 5 papers (7.2%) are written by 5 authors, 1 paper (1.4%) is written by 6 authors and 1 paper (1.4%) is written by 10 authors. This shows that maximum papers are written by a single author authors while minimum papers are written by either 6 or 10 authors.

Figure 4
Number of Authors



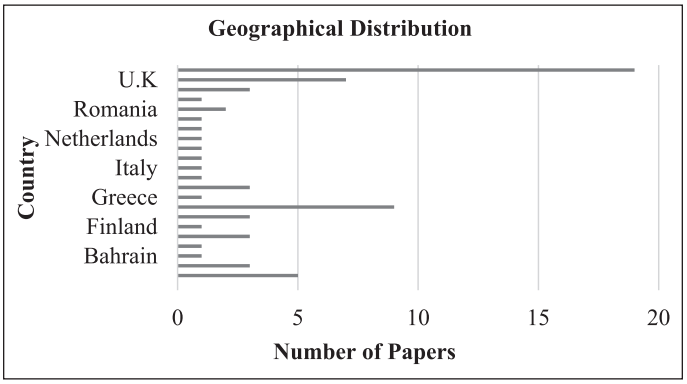
Source: Authors Compilation

Geographical Distribution

Figure 5 and Table 6 show the geographical distribution of the selected papers. The largest number of papers (27.5%) was published in the USA. After this, the two most common publication countries were Germany with 9 papers (13%) and United Kingdom with 7 papers (10.1%). The next common publication country after the United Kingdom is Australia with 5

papers (7.2%). The rest of the counties including India had 3 or fewer papers published. The geographical distribution of the selected papers shows that researchers around the world show interest in Bitcoins and Blockchain technology.

Figure 5
Geographical Distribution



Source: Authors Compilation

Table 6
Number of Papers

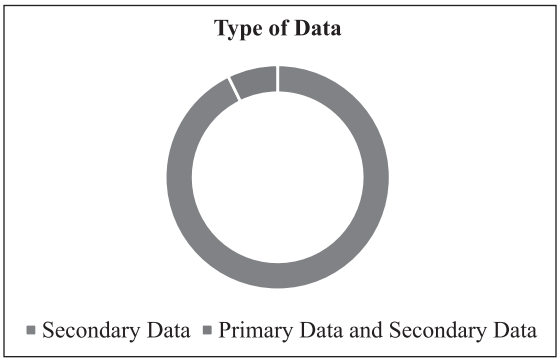
Country	*Number of Papers*
Australia	5
Austria	3
Bahrain	1
Canada	1
China	3
Finland	1
France	3
Germany	9
Greece	1
India	3
Ireland	1
Italy	1
Japan	1
Lebanon	1
Netherlands	1
New York	1
Poland	1
Romania	2
Russia	1
Spain	3
U.K	7
USA	19

Source: Authors Compilation

Type of Data

Figure 6 shows the type of data used in the selected papers that is primary and secondary data. It can be seen that 64 studies (93%) out of 69 studies use secondary data for their study while only 5 studies (7%) use primary and secondary data.

Figure 6
Types of Data

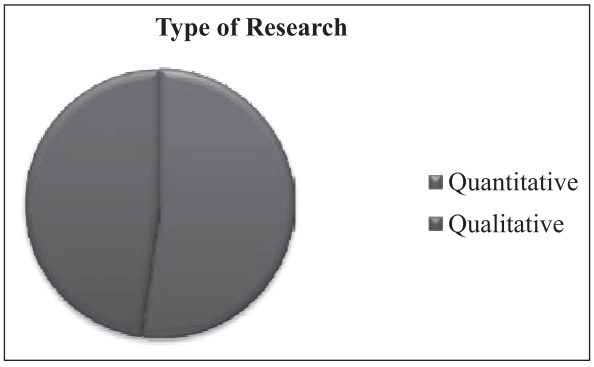


Source: Authors Compilation

Type of Research

Figure 7 shows the type of research done that is whether qualitative and quantitative. It can be seen that 33 papers (48%) are of qualitative type while 36 papers (52%) are quantitative. This shows that most of the studies are quantitative.

Figure 7
Type of Research



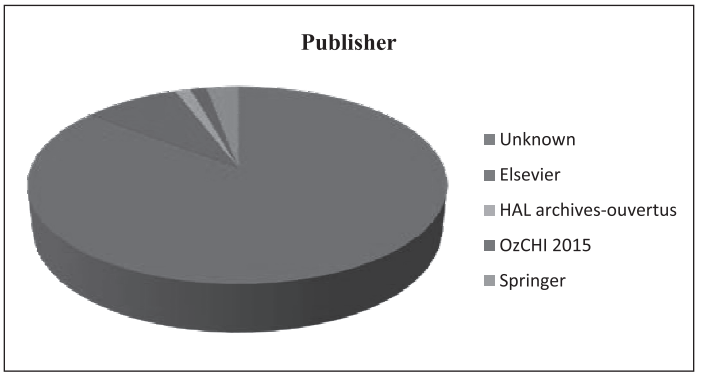
Source: Authors Compilation

Publisher

Figure 8 shows the publisher of the selected papers. It can be seen that more than half of the papers (86%) are published by an unknown publisher. While 6 papers (9%) are

published by Elsevier and 2 papers (3%) are published by Springer. 1 paper (1%) is published by HAL archives-ouvertus and 1 paper (1%) is published by OzCHI 2015.

Figure 8
Publisher



Source: Authors Compilation

VII. FINDINGS AND CONCLUSION

The study has been carried out to examine the price volatility of Bitcoins. While exploring the past studies done on Bitcoins it was found that even though Bitcoins were introduced in 2009 papers were published from 2012 and the highest number of papers were published in 2015 and 2016 where most of the papers were published in USA. The maximum number of authors for a single paper was 10 and the minimum was 1 where most of the papers were secondary and quantitative in nature.

The volatility of the prices of Bitcoins was also studied, where ARCH family models were first compared according to the lowest Akaike info criterion and Schwarz criterion. TARCH Model was selected as it had the lowest Akaike info criterion and Schwarz criterion. It was found that good news has more effect on the volatility of Bitcoins price returns than the bad news. The results also show that the data is not serially correlated. The descriptive statistics show that a high level of fluctuations in the prices of Bitcoins exists, the daily returns have a greater tendency to fall, a presence of extremely large values and outliers exists and the Bitcoins price return series is not normally distributed.

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