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## The Indian Bitcoin market: A feasibility study

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### Abstract

A 21st century investor faces a variety of avenues to invest his/her money in. Some provide assured return, while others are risky and provide a higher return as additional compensation for the risk taken. Markets are overflowing with derivatives, bonds, stocks and so on. Amidst these ordinary and commonly known options available to the usual investor, a new, enigmatic alternative has arisen - cryptocurrency. This paper studies this relatively new and vastly volatile recourse (Bitcoin in particular) and compares its investment potential to that of the other commonly well-known choices - Gold, Stocks, Oil and Gas and Real Estate using descriptive analysis and Markowitz's mean-variance efficiency model.

**Keywords:** Bitcoin, Blockchain, Cryptocurrency, Investment, Volatility

### Introduction

The creation of the internet has led to the introduction of countless applications, which would've seemed like sorcery to the average person just a couple of decades ago. Ranging from using it as a research tool, to communication, shopping, news, and even entertainment, it would appear that nearly every major task can be achieved via the Internet. However, there was one arena in particular where it was difficult to replace a real-world concept with an Internet tool - the concept of currencies.

Although one could transact online using credit cards and the like, many wished to completely replace real-world currency with a virtual one. But, as is with any computer-based application, any program on a computer can be duplicated with the click of a button. Thus, any virtual currency could be easily duplicated at no cost to the user, effectively doubling the amount of money they hold. Thus, virtual currency remained a pipe-dream for a long period of time.

In 2008, however, a research paper was published by a person (or perhaps a group of people) going by the pseudonym „Satoshi Nakamoto“. It described a virtual currency system where “Bitcoins” are created as a reward in a competition in which users offer their computing power to verify and record bitcoin transactions into the blockchain. This activity is referred to as mining and successful miners are rewarded with transaction fees and newly created bitcoins. Besides being obtained by mining, bitcoins can be exchanged for other currencies, products, and services. When sending bitcoins, users can pay an optional transaction fee to the miners. This may expedite the transaction being confirmed. Thus, the only way to generate bitcoins is to mine for it. The supply of Bitcoins is consistent and is expected to stop around the year 2140, with about 21 million bitcoins in circulation.

Compared to bitcoin, other asset classes such as gold, stocks, oil and gas and real estate have been around for a much longer period of time. Not only that, these assets are very popular and can provide high rates of returns if dealt with the right investing acumen.

Bitcoins are traded peer-to-peer with no intermediary in between. Bitcoin address, the location to which bitcoins are sent is not linked to any real-world address of the user. As such, it can be hard to trace bitcoins back to the parties involved in a bitcoin transaction. However, all transactions on a blockchain are public. The blockchain is a public ledger that records all bitcoin transactions.

Nowadays, it has been observed that more and more miners are joining together to form mining pools, increasing their computational resources to mine blocks more frequently and

efficiently. Further, more and more specialised equipment is being used for mining Bitcoin, to the point that unless a miner is using such equipment, they're unlikely to break even in their operations. Given how the concept of investing in various „financial products“ is catching on, one may wonder - Why not look towards newer, potentially more lucrative products? Although virtual currencies are exactly that - currencies known to have massive swings in prices, with Bitcoin, for instance, rising from a little less than \$20 to more than \$1200 in nearly a single year, and then back down. In addition, it is also quite easy to liquidate them. So why not just use them as an asset? This paper seeks to answer this question using the virtual currency of Bitcoin as base.

### **Analysing an Investment Opportunity - The Markowitz's Model**

Harry Markowitz, in 1950s formed an astounding mechanism determining which stock would be included in the portfolio on the basis of having the highest returns against a certain risk. This emerging concept was widely accepted by academics and researchers around the globe.

In Markowitz's Model, an investor selects a portfolio at time  $t-1$  that produces a stochastic return at  $t$ . The model assumes investors are risk averse and, when choosing among portfolios, they care only about the mean and variance of their one-period investment return. As a result, investors choose „mean-variance-efficient“ portfolios, in the sense that the portfolios minimize the variance of portfolio return, given the expected return and maximise the expected return given the variance. Thus, the Markowitz approach is often called the „mean-variance model“. It uses an algebraic condition on asset weights in mean-variance efficient portfolios. We shall be using this model to analyze the viability of Bitcoin as an asset class in India.

### **Literature Review**

There are three main related research articles on the Bitcoin transaction graph that were published within the last few years. The work carried out by focuses on time-varying dynamics of the network structure and the degree of anonymity. Using data of the period 03/01/2009 to 06/01/2013, the authors discovered that the entity sizes and the overall pattern of usage became more stationary in the last 12 to 18 months, which reduces the anonymity set. The authors also show that the number of dormant coins is important to quantify anonymity. Inactive entities hold many of these dormant coins and thus further reduce the anonymity set.

Focus on anonymity in the Bitcoin network, analyzing the topology of the transaction and user network based on data of the time interval from 03/01/2009 to 12/07/2011. The authors adopt a preprocessing step to construct the user network. In order to improve the anonymity analysis, the researchers propose several methods including the integration of external information that is mainly held by businesses and other services which accept Bitcoin as payment. They show that it is possible to associate IP addresses from a public service with the recipient's public keys and link it to previous transactions.

In the third paper by the main focus lies on non-dynamic statistical properties of the transaction graph. The authors analyzed data of the period from 03/01/2009 to 13/05/2012, using various statistics such as distributions of addresses,

incoming BTCs, balances of BTCs, number and size of transactions, and most active entities. They found that the majority of Bitcoins is not in circulation and that most of the transactions amount to a rather modest sum (less than 10 BTC). The researchers also analyzed the largest transactions in the network (greater than 50,000 BTCs) and determined their flows. They showed that most of these transactions are successors of the initial ones. Another interesting finding is that the transaction flows reveal some characteristic behaviors such as long chains, fork merge, and binary tree-like distributions.

In the article “Can Bitcoin Become a Major Currency?” the authors describe the way of development of bitcoins and analyze whether the cryptocurrency is to become the primary means of payment for goods and services, replacing the familiar to USD the world currency.

The authors of the article “Can We Stabilize the Price of a Cryptocurrency?: Understanding the Design of Bitcoin and Its Potential to Compete with Central Bank Money” also consider cryptocurrency to compete with other currencies, and explain that cryptocurrency is not growing even faster because of high volatility of its prices.

In the article “An Analysis of Bitcoin Exchange Rates” (Jacob B. Smith, 2016) <sup>[14]</sup>, the author wonders whether the exchange rates of cryptocurrencies have an impact on the economy,

or, on the contrary, the economy affects the prices of bitcoins, creating its volatility. We also found the article "Analysis of Bitcoin Transaction Flows to Reveal Usage and Geographic Patterns" which refers to the importance of the study of bitcoin transactions and their impact on economy and analyzes geographical patterns of cryptocurrency flows.

In his seminal paper on Portfolio Theory, Harry Markowitz (1952) <sup>[12]</sup> demonstrated that under certain conditions, an investor's portfolio selection can be reduced to balancing two important aspects: the portfolio's expected return, and the risk or variance of the portfolio. Due to the risk reduction potential of diversification, portfolio investment risk, measured as its variance, depends upon both individual asset return variances as well as the „covariances“ of pairs of assets. Markowitz asserts that selection of a portfolio should be determined by overall risk-reward characteristics, as opposed to merely compiling portfolios with securities having attractive risk-reward features individually.

### **Research Gap**

The papers mentioned above largely lay down how Bitcoin operates, its independence, hedging capabilities and other uses. This paper will look at bitcoin from the point of view of an Indian Investor, who wishes to know whether Bitcoin can be considered a viable asset compared to other, more traditional assets such as equities, bonds, etc.

### **Objectives and Hypothesis**

This paper seeks to look at Bitcoin as an asset class, comparing its returns, volatility and its investability to other asset classes. In doing so, this paper looks to determine whether Bitcoin can be treated as a viable asset to invest in, its risk-reward profile, as well as its future prospects in case of India.

For the purpose of this research paper, the null and alternate hypotheses are defined as follows:

**H0:** Inclusion of Bitcoin in your portfolio increases the overall portfolio risk

**H1:** Inclusion of Bitcoin in your portfolio does not have an impact on the overall portfolio risk

## Methodology

### Data

The research paper uses 5 asset classes to test its hypothesis:

1. S&P BSE 500
2. S&P BSE OIL & GAS
3. HDFC Gold ETF
4. S&P BSE Realty
5. Bitcoin

For the purpose of this study, the value of bitcoin has been taken from bitcoincharts.com. For the historical values of gold, the historical values of HDFC Gold ETF has been used as a proxy, as no suitable Gold Index is available in India. The S&P BSE 500 index is designed to be a broad representation of the Indian market. Consisting of the top 500 companies listed at BSE Ltd., the index covers all major industries in the Indian economy. The S&P BSE Oil & Gas index comprises constituents of the S&P BSE 500 that are classified as members of the oil & gas sector as defined by the BSE industry classification system and is used to track the prices of Crude Oil. The S&P BSE Realty index comprises constituents of the S&P BSE 500 that are classified as members of the real estate sector as defined by the BSE industry classification system. In addition, all data represents values between 1st April, 2016 and 31st March, 2018. After the collection of data, it was organised and then ran through a number of tests, mainly, Descriptives, Correlation and Efficiency Frontier.

## Method

### A. Descriptive Analysis

As a first step, we calculate the following descriptives with respect to the daily returns earned on the category of investments that we have chosen i.e. Bitcoin, Stock, Real Estate, Gold and Oil and Gas:

- Mean: It depicts the average of the daily returns earned on various investments. A higher mean will naturally be one vote in favour of that investment over the others.
- Annual Mean: Daily returns are annualised using the following formula to find the annual mean: (Mean Returns)\*250 [Assuming 250 trading days per year].
- Median: Median is the value that occurs in the middle of a series arranged in ascending order. While it is not a robust indicator of an investment's potential, it does help in decision making to some extent.
- Maximum: It depicts the highest value in a series
- Minimum: It depicts the lowest value in a series
- Maximum and minimum values are basically an indicator of the range in which the returns from an investment can fall.
- Standard Deviation: It is the square of the deviations of the values in a series from the central value (i.e. mean). It is an indicator of the risk that an investor undertakes when he/she decides to invest in an asset.
- Annualized Historical Volatility: This is a more robust indicator of the risk undertaken by an investor. It is calculated using the formula: [SQRT(250)]\*[Standard

Deviation], using the same assumption of 250 trading days.

- Skewness: It measures the degree to which the values in a series depart from the central value.
- Kurtosis: Kurtosis measures the height and peakedness of the frequency curve of a series.
- Skewness and kurtosis are indicators of risk that an investor undertakes as well.
- Sharpe Ratio: It is the average return earned in excess of the risk-free rate per unit of volatility or total risk. Subtracting the risk-free rate from the mean return, the performance associated with risk-taking activities can be isolated.

### B. Correlation

Correlation Analysis has been done using basic MS Excel formula of "=CORREL". This method gives the Karl Pearson's Coefficient of Correlation for the two variables in question. It can be used for finding out multiple correlation too.

### C. Markowitz Portfolio Technique

Two separate portfolios are made and then analysed - with and without bitcoin. This is down as follows:

Daily Returns of the Index - The daily return of each index has been taken as  $A2/A1 - 1$  where A2 is the closing price of the index on a given day and A1 is the closing price of the index on the previous day. This shows the proportional increase or decrease in the closing price of the given day as compared to the previous day.

The Average Daily Return for each Index is then computed by taking an average of all closing prices.

The Annualized Return is calculated by multiplying the Average Return by 250 (assuming 250 trading days every year). This is followed by forming the covariance matrix of the annualized returns for the the four indices, and another matrix for the indices with bitcoin.

The variance of a portfolio combination of securities is equal to the weighted average covariance of the returns on its individual securities. For simplicity, this is explained using the following equation for a portfolio of 2 stocks:

$$\text{Var}(r_p) = \sigma_p^2 = \sum_{i=1}^n \sum_{j=1}^n w_i w_j \text{Cov}(r_i, r_j)$$

Where

$r_p$  = Return on portfolio p

$r_i, r_j$  = Return on ith security, return on jth security

$w_i, w_j$  = Proportion of funds invested in security i, Proportion of funds invested in security j  
Covariance can also be expressed in terms of the correlation coefficient as follows:

$$\text{Cov}(r_i, r_j) = \rho_{ij} \sigma_i \sigma_j = \sigma_{ij}$$

where  $\rho_{ij}$  = correlation coefficient between the rates of return on security i and the rates of  $\sigma_i$ , and  $\sigma_j$  return on security j, and, represent their standard deviations.

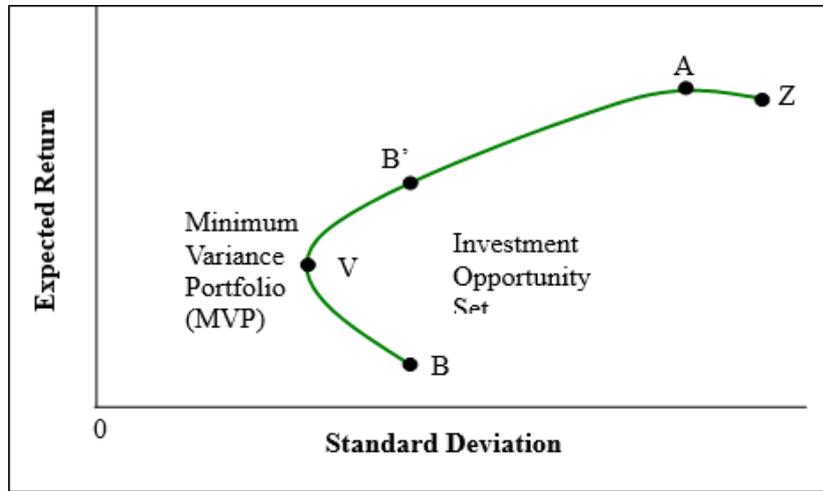
Overall, the estimate of the mean return for each security is its average value in the sample period; the estimate of variance is the average value of the squared deviations around the sample average; the estimate of the covariance is the average value of the cross-product of deviations

After forming the covariance matrix, we set the return on investment desired. MS Excel Solver is then used to recommend the optimum weights for the portfolio by minimizing variance to attain the specified return.

**Markowitz Efficiency Frontier**

Securities can be plotted on a risk-return graph and on joining the so-formed points, we get a line known as the

Efficiency Frontier. It delineates all possible portfolio combinations (excluding the risk-free rate) which minimizes risk for a level of return. Alternatively, it shows the maximum return which can be earned for a given level of risk. For simplicity, continuing the example of a two asset portfolio set as above, its efficiency frontier may be as follows:



The line passing through A and B represents all possible combinations of risk and return for the portfolios formed by those two assets. Portfolios located in the north-west region of the frontier are desirable to investors as they indicate high return (north) and low risk (west). In the given figure, on comparing B'' and B, it is evident that an investor would always prefer B'' over B because the former offers a higher return at the same level of risk. Similarly, an investor would always prefer V over B because V offers both lower risk and higher return. As a matter of fact, V is the Minimum Variance Portfolio because it is the one which offers the

lowest level of risk (measured by standard deviation) Hence, it is clear that any point below the point V is inefficient. The curve VA is thus the efficient frontier, offering the highest return for a given level of risk (alternatively, offering the lowest risk for a given level of return). The choice of portfolio will vary based on investor risk behavior

**Results and Analysis**

**Descriptive Analysis**

Following is the result of our descriptive analysis:

S&P BSE 500		HDFC Gold ETF	S&P BSE Oil and Gas	S&P BSE Realty	Bitcoin Price
Mean Return	0.069%	0.015%	0.102%	0.130%	0.727%
Annual Mean Return	17.292%	3.748%	25.507%	32.541%	181.780%
Median Return	0.099%	0.000%	0.096%	0.166%	0.517%
Maximum Return	0.520%	0.224%	2.763%	8.818%	33.327%
Minimum Return	-2.982%	-3.760%	-3.041%	-10.235%	-20.111%
Std. Dev.	0.733%	0.783%	0.972%	1.731%	5.226%
Annualized Historical Volatility	11.596%	12.382%	15.370%	27.377%	82.626%
Skewness	-0.60888204	0.42509877	-0.040693964	-0.555491247	0.563066424
Kurtosis	1.6119567	5.51541838	0.046719155	4.645493744	5.6317336
Sharpe Ratio	14.23707314	-3.961408975	19.19297332	14.83739577	33.47466385

- Mean returns and annual mean returns of Bitcoin are much higher than those of other assets, with the annual returns of Bitcoin touching a staggering 181%. This indicates, prima facie, that bitcoin appears to be a good option when compared to others and this figure is bound to attract any investor. It is noteworthy to see that these returns are high even after a period of drastic fall in bitcoin prices which says a lot about this asset.
- However, Bitcoin presents the banal trade-off that every investor has to face - the risk- return trade off. The range and the standard deviation of returns (53.43% and

- 5.22% respectively), present a situation that no average investor would invest a significant amount in in this risk averse environment.
- An 82% chance of losing the money invested (as indicated by volatility) is sure to dissuade any investor from investing in this asset. Skewness and Kurtosis levels are very high, though are still comparable with other assets. So they do not offer much evidence in support or against the Bitcoin as an investment.
- It is important to note that the high levels of return and volatility noticed in Bitcoin are comparable to the trends seen in new Financial Innovations and in a bubble like atmosphere. It goes on to suggest that

Bitcoin is still in nascent stages and is definitely one vote in favour of the theory that bitcoin could turn into a larger bubble in future.

- Overall, the descriptives theoretically prove that Bitcoin is a new and risky asset in the investment universe.

**Correlation**

	Bitcoin	HDFC Gold	BSE 500	BSE Oil and Gas	BSE Realty
Bitcoin	1	-0.52	0.99	0.98	0.98
HDFC Gold	-0.52	1	-0.55	-0.64	-0.38
BSE 500	0.99	-0.55	1	0.99	0.98
BSE Oil and Gas	0.98	-0.64	0.99	1	0.95
BSE Realty	0.98	-0.38	0.98	0.95	1

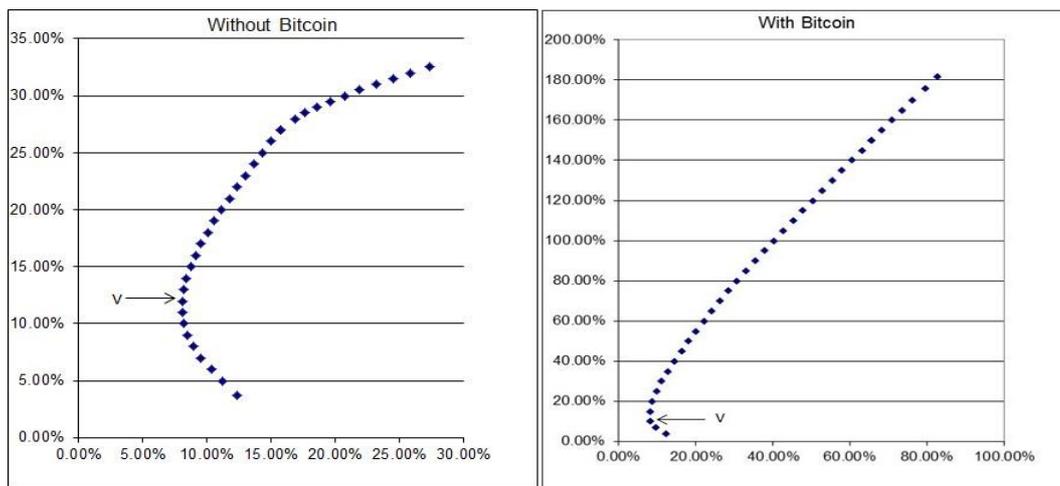
The correlation matrix indicates that, overall, Bitcoin trends agree with the market trends in general with HDFC Gold being an exception. However, this must be interpreted with caution since the period for which correlation is calculated is a mixture of bullish and bearish trends and hence it is bound to be unstable. However, high correlation is a good sign for the investors in general at this point.

**Markowitz Efficiency Frontier**

Results of the Markowitz Efficiency Frontier show the Risk-Return Trade Off for the two portfolios. While the portfolio not containing Bitcoin has its Minimum Variance Point (Least risk combination) at 12% expected return and a risk of 8.08%, the same point for the portfolio with Bitcoin is 15% expected return and a risk of 8.14%. This shows that as you add Bitcoin to the Portfolio, the overall Riskiness of

the portfolio begins to go up with simultaneous increase in the Returns on Investment.

While the maximum return that can be earned on your investment in a portfolio not containing Bitcoin is 32.545% by undertaking a risk of 27.38%, on including Bitcoin, the maximum return goes up to 181.78% by undertaking a risk of 82.63%. This proves that introduction of Bitcoin as an asset class in your portfolio increases your overall Return on the investment but at the same time, it increases your exposure to risk. The chances of not being able to get even the principal investment back increase exponentially as you increase your exposure to Bitcoin. Thus, an investor with a great risk appetite looking to maximise his returns should consider the option of investing in Bitcoin. But a prudent investor should avoid bitcoin as an investment to ensure security of his funds.



**Conclusion**

In this paper, we sought to extend the discussion of Bitcoin volatility and its comparison to different asset classes in terms of Return on Investment and Risk associated. The paper through the use of Descriptives, Correlation and Markowitz Efficiency Frontier found out that Bitcoin although reaps high Returns to the Investors but at a much higher risk. Data taken for a period of 2 years from April 01, 2016 to March 31, 2018 gives a 181.78% annual return on Bitcoin as against 17.292% of S&P BSE 500, 3.798% of HDFC ETF Gold, 25.507% of S&PBSE Oil & Gas and 32.541% of S&P BSE Realty but at nearly 4 times more risk than average Risk involved with the other assets combined. Moreover, the price of this cryptocurrency is strongly correlated to the price of other assets except HDFC ETF Gold.

From the Markowitz efficiency test, we conclude that inclusion of Bitcoin in your investment portfolio increases

the overall risk of the portfolio but at the same time increases the return as well. While the least risk in a portfolio without bitcoin is 8.08% yielding 12% Return on Investment, the same for a portfolio with Bitcoin is 8.14% for a 15% return. Thus, an investor with a big risk appetite should include Bitcoin in his portfolio to earn higher returns while a risk averse investor should shy away from investing in Bitcoin. Thus, our null hypothesis that Bitcoin increases the overall risk of the portfolio is not rejected.

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