

BITCOIN IN LIGHT OF THE PORTFOLIO THEORY

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Abstract

The aim of this article is to examine what effect the inclusion of bitcoin in the cluster of potential investment assets would/will have on the potential and frontier portfolios. Calculations made based on the daily data of the last 5 years support that bitcoin, when mixed with „classic” investment assets, pushes the efficient portfolio curve upward, therefore the investors may create portfolios with higher expected return at a given risk level. The close to zero correlation with other assets may also be considered as a positive characteristic, the lasting of which seems to be well-founded at the moment. Of course, the conclusions must be considered carefully due to the high level of both evaluation and regulatory uncertainty regarding bitcoin.

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1 BITCOIN AND THE PORTFOLIO THEORY

1.1 Introduction

Nowadays, cryptocurrencies, and among them bitcoin, constitute an unavoidable topic. While the new type of virtual currency attracts more and more attention among investors and information technology experts, the financial profession, in its narrow sense, is basically sceptical.

The reason for this, is primarily the extreme volatility and price increase, which, to say the least, is not usual in the traditional asset classes also including commodity market products often producing extreme yields. This market uncertainty is caused, among others, by the fact that by now, more than two thousand different cryptocurrencies entered the „stage” without any historical preliminary. That today the currency of a certain state holds a stable value against other currencies or products and services, can be attributed partly to the economic history of the given state (e.g. it has never been bankrupt; predictable and credible monetary policy) and to a certain historical continuity of the goods-currency relation.

Contrary to this, the cryptocurrencies dropped, independently of states, into a long existing system without the market participants having substantiated expectations regarding the future price trends of these currencies. Bitcoin's price surged from 400-500 dollars to 20,000 dollars within two years, to which, as a natural reaction, the financial profession called out bubble. The question, however, arises if the 500-dollar or the 20,000-dollar price represents any kind of fundamental value. What is sure, is that if we divide the M3 monetary aggregate of the euro-zone, (11,868 billion EUR) with the 16.8 million bitcoins currently in circulation, then at 706,000 EUR/BTC and 1.20 USD/EUR exchange rates we end up with a nearly 850,000-dollar exchange rate (ECB 2018). Of course, the USD/EUR rate is also not determined by the proportion of the monetary aggregates, however, the example might show well the insecurity we are facing when trying to evaluate bitcoin. At the moment, one of the main obstacles to the development and spreading of cryptocurrencies is the high diversity of state regulations (which ranges from the explicit ban (Bolivia) to the actual issuing of cryptocurrency (Venezuela)). Since the condition of the exchange rates' stabilization is that the given currencies are widely spread, and the precondition for that is predictability, we are somewhat facing a chicken-and-egg situation, the solution (the henhouse) to which would be the acknowledgement, or possibly support, by the state as a first step.

Until then, since the money function of bitcoin is highly questionable, it can be considered primarily as an investment asset. This work, therefore, endeavours to examine how the return - risk characteristics of the „classic“ investment portfolio are affected by the inclusion of bitcoin as a potential investment asset.

1.2 Literature

Several papers have been published about bitcoin as investment asset in the past few years. According to the results of Chen – Pandey (2014), bitcoin is capable of fulfilling the money functions limitedly, however, it may increase the efficiency of investment portfolios. The essay of Eisl et al. (2015) points out that by including bitcoin in the portfolio, the conditional value at risk (CV@R) of the portfolio increases, but this is more than compensated by the additional yield of bitcoin, therefore, bitcoin must be part of optimal portfolios. By analysing the weekly data of 2010-2013, Brière et al. (2015) shows the diversification effect of cryptocurrencies and the low correlation compared to other asset classes, including traditional (bonds, shares, currency) and alternative asset classes (commodities, hedge-funds, real estate). Dyhrberg (2016) presents cryptocurrency as a hedging instrument against the FTSE share index, as a parallel between bitcoin and gold. Bouri et al. (2017a) deemed to have found a negative correlation between the volatility of bitcoin and the implied volatility of the stock

markets (VIX). The finding of Bouri et al. (2017b) somewhat modulates the view on its hedging capacity, but as a diversification asset, bitcoin stands its ground. In their evaluation, they also point to the cyclicity of the favourable attributes of bitcoin.

The literature, therefore, basically supports the view that bitcoin should be considered as a diversification/efficiency-enhancing asset, and that in certain cases it proves to be a sufficient hedging asset. Furthermore, all authors draw attention to the shortness of the examinable period, and to the valuation uncertainty arising from this.

1.3 Modern Portfolio Theory

The framework of Modern Portfolio Theory is defined by the following relations. The value-weight of the i -th asset in portfolio P is denoted by w_i . The sum of weights equals 1:

$$\sum_{i=1}^n w_i = 1, \quad (1)$$

and the expected return of the portfolio is:

$$E(r_p) = \sum_{i=1}^n w_i E(r_i), \quad (2)$$

where $E(r_p)$ is the expected return of the portfolio, while $E(r_i)$ is the expected return of the i -th asset. I took the average of daily returns calculated with the help of relation (2) as 'expected return', then I calculated a yearly return from this value assuming 365 days.

$$r_{ann.} = (1 + E(r_p))^{365} - 1, \quad (3)$$

where $r_{ann.}$ is the yearly effective return of the given portfolio.

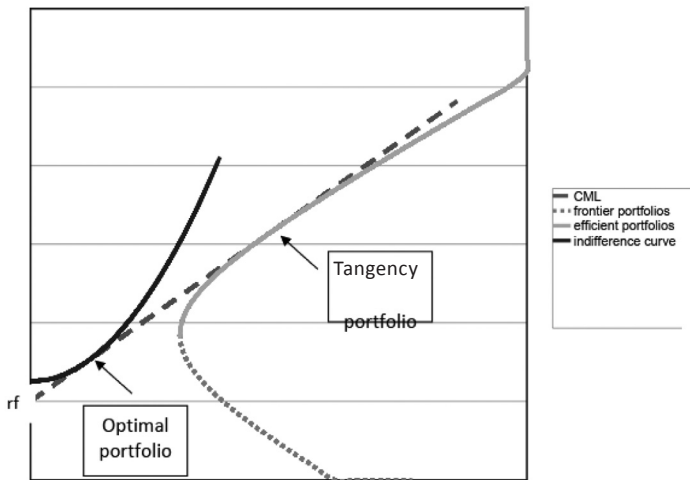
The variance of the portfolio's return is described by the following equation:

$$\sigma_p^2 = \sum_{i=1}^n \sum_{j=1}^n w_i w_j COV r_i r_j. \quad (4)$$

From the portfolios that may be characterized based on formula (3) and formula (4), the portfolios with minimum volatility at a given return may be considered as frontier portfolios, while the portfolios with maximum return at a given volatility may be considered as effective portfolios. Although, this paper does not focus on

utility-maximization, according to the theory, rational investors search for the maximum expected utility portfolio in the cluster of effective portfolios, or next to risk-free investment and loan possibilities, on the Capital Market Line created from the combination of the so-called tangency portfolio and risk-free asset. This is demonstrated on Chart 1.

Chart 1
Investment decision in modern portfolio theory



Source: own edition

2 EMPIRICAL RESULTS

2.1 Investment assets and data

The primary aim of this paper is to examine how a well-diversified portfolio is affected by adding bitcoin to it. I chose to include in the “classic” portfolio the following assets (Bloomberg symbols in brackets): S&P500 stock index (SPX), MSCI World index (MXWO), gold (XAU Currency), Bloomberg Commodity index (BCOM Index), Brent Crude oil (Co1 Comdty) and the S&P Global Developed Sovereign Bond index (SPFIDSLT Index). The daily closing prices of bitcoin (XB-TUSD Currency) and the daily closing prices of the other assets in dollars, were downloaded from the Bloomberg terminal for the period between January 1, 2013 and December 29, 2017. From the 1,304 daily closing prices, I calculated effective daily returns using the following equation:

$$r_{i,t} = \frac{P_{i,t}}{P_{i,t-1}} - 1, \quad (5)$$

where $P_{i,t}$ is the daily closing price of the i -th asset on the t -th day.

2.2 Statistical attributes

First, I examined the correlations between the returns of the different assets, which are shown in Table 1.

Table 1
Correlation of daily returns

	XBTUSD Curncy	XAU Curncy	SPX	MXWO	BCOM INDEX	CO1 Comdty	SPFIDSLT Index
XBTUSD Curncy	1.00						
XAU Curncy	0.00	1.00					
SPX	-0.02	-0.09	1.00				
MXWO	-0.01	-0.04	0.90	1.00			
BCOM INDEX	0.02	0.32	0.25	0.34	1.00		
CO1 Comdty	0.00	0.07	0.31	0.34	0.74	1.00	
SPFIDSLT Index	0.04	0.28	-0.18	-0.17	-0.07	-0.16	1.00

Source: own edition

It is immediately apparent that bitcoin basically shows zero correlation with the other assets, therefore, presumably it will have a diversification effect once added to the portfolio. Important information may be derived from the return-volatility data computed for each asset (Table 2).

Table 2
Return and volatility of assets

	XBTUSD Curncy	XAU Curncy	SPX	MXWO	BCOM INDEX	CO1 Comdty	SPFIDSLT Index
return	1274%	-5%	20%	14%	-11%	-7%	4%
volatility	97%	15%	12%	10%	12%	32%	2%
return/ volatility	13.07	-0.34	1.68	1.39	-0.92	-0.21	1.66

Source: own edition

The stupendous return of bitcoin per volatility unit is, at once, obvious. Later, we will see that those assets that have a high return/volatility ratio will be among the effective portfolios.

2.3 Frontier portfolios

As a next step, using the covariance table computed based on formula (4), I determined two frontier portfolios, that is, portfolios with minimum volatility at the given return for each case. In case of those portfolios that also included bitcoin, with 10% and 40% expected returns, while in case of portfolios not including bitcoin, with 5% and 15% expected returns. Table 3 summarizes the weights and volatility-return characteristics of the so created frontier portfolios.

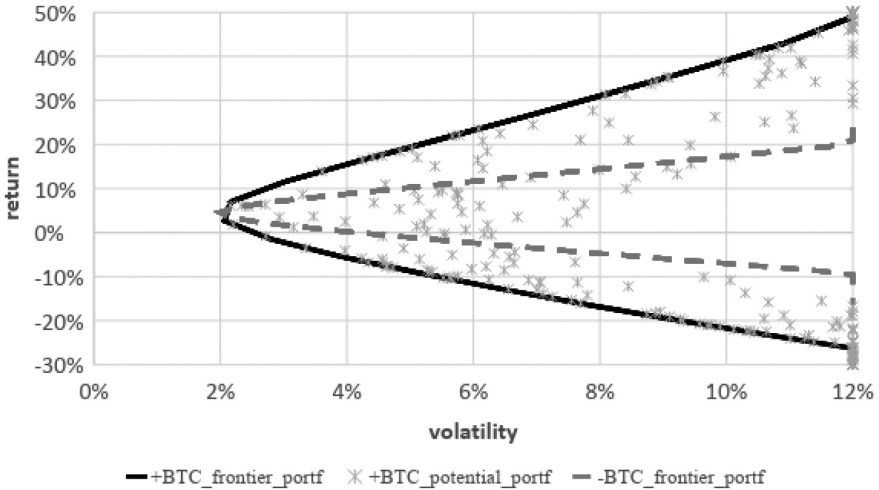
Table 3
Frontier portfolios including bitcoin (+BTC) and excluding bitcoin (-BTC)

		w weights									
		XBTUSD Curncy	XAU Curncy	SPX	MXWO	BCOM IN- DEX	COI Comdty	SPFIDSLT Index	sum	volatility	return
+BTC	frontier portfolio (r=10%)	0.02	0.00	0.12	0.00	0.00	0.00	0.86	1.00	2.7%	10.0%
	frontier portfolio (r=40%)	0.09	0.00	0.40	0.00	0.00	0.00	0.50	1.00	10.2%	40.0%
-BTC	frontier portfolio (r=5%)	0.00	0.00	0.10	0.00	0.00	0.00	0.90	1.00	2.0%	5.0%
	frontier portfolio (r=15%)	0.00	0.00	0.73	0.00	0.00	0.00	0.27	1.00	8.4%	15.0%

Source: own edition

Based on the table, it can be seen that after optimization, basically, the S&P bond index, the S&P500 stock index and bitcoin remain among the potential portfolios.

Following this, I placed the portfolios created by combining frontier portfolios in different ratios linearly, which are frontier portfolios as well, in the volatility – return space as shown on Chart 2.

Chart 2**Frontier portfolios including bitcoin (+BTC) and excluding bitcoin (-BTC)**

Source: own edition

In the chart, I indicate with points the further random weighted portfolios also including bitcoin, which picture well the expansion caused by bitcoin among the potential portfolios. Evidently, along the volatility – return dimension estimated based on the daily data of the past 5 years, bitcoin significantly improves the cluster of effective portfolios, i.e. portfolios with higher return potential are available at a given risk level compared to a world without bitcoin. It can also be seen, that the volatility of the portfolio with global minimum volatility cannot be reduced, which is not a surprise, considering the extreme volatility of bitcoin.

3 CONCLUSIONS

Although, the results are encouraging, it is important to emphasize those risks that call for caution. In the last five years used as sampling period, the price of bitcoin was quite positive and, as a consequence, the average return of bitcoin as well. Especially due to the valuation difficulties emphasised in the introduction above, it is quite hard to predict, for how long will the bitcoin be able to lavishly push up the effective portfolio curve. However, what may be a reason for optimism among investors considering bitcoin, is the zero, or close-to-zero, correlation compared to other assets. The lack of correlation is especially highly valued in cases when a negative sentiment evolves on the stock market and correlations may increase

(e.g. between shares). In such cases, the value added by active portfolio management strategies can prevail even less, but the inclusion of a non-correlating element in the portfolio may help the fund manager to achieve a positive alpha. Since currently the value and valuation of bitcoin cannot be linked particularly to any economic sector or geographical area, its uncorrelation to other assets may presumably subsist in the longer run. Although, the legal status of bitcoin makes its placement somewhat difficult among the asset categories, and at the moment very few fund management policies would make it possible to invest in cryptocurrencies, eventually, in my opinion, it is at least worth considering such possibility.

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