
Y8-RCI: A Bitcoin Regime Change Indicator

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Abstract. Since its first appearance in 2009 Bitcoin became an increasingly mature class of investment with a double-digit volatility on both the long and the short side. Various statistical techniques may help to estimate the next up or down movement of Bitcoin but the randomness of hundreds of different input parameters complicate the problem. We propose a single indicator that signals regime changes of Bitcoin with an attractive risk/reward ratio based on machine learning models. This indicator can be used for both risk management and active investment.

1. Introduction

Bitcoin is roughly 50% of the US\$2.0 trillion crypto market. Whilst the price of Bitcoin increased from 0.07 US\$ to 68.000 US\$ within the past years investors need to evaluate Bitcoin's risk/reward ratio on a daily basis the later they invest into this cryptocurrency. Both institutional and private investors need to deal with a high volatility on a day-to-day basis. Given their shift in paradigm from traditional approaches to currency, cryptocurrencies have garnered much interest over the past few years and this has led to periods of high growth and fall in their value. Especially Bitcoin drove excessive discussions on social media meaning that retail investors force speculation with this asset.

Forecasting tomorrow's Bitcoin price could lead to multiple output parameters such as a high, a low, an open, a close price and the expected volatility. To reduce the complexity of our machine learning models we reduce the output parameter of the *YUCE-8 Regime Change Indicator* (Y8-RCI or $Y8_{RCI}$) to a Boolean value:

$$Y8_{RCI}(t) = \begin{cases} 0 & \text{if } price(t+n) \text{ is expected } > price(t) \\ 1 & \text{if } price(t+n) \text{ is expected } < price(t) \end{cases}$$

From a risk management perspective, a change in value of $Y8_{RCI}(t) = 0 \rightarrow Y8_{RCI}(t+1) = 1$ indicates an increased risk for an existing long position in Bitcoin.

From an active investment perspective, a change in value of $Y8_{RCI}(t) = 1 \rightarrow Y8_{RCI}(t+1) = 0$ indicates a good opportunity for a long position in Bitcoin.

2. Data

The data used for the further analysis of $Y8_{RCI}$ starts on August 2nd, 2015 and includes the daily Open, High, Low and Close prices of Bitcoin:

Date_	Open	High	Low	Close
2015-02-08 23:00:00	223.389	223.977	217.019	220.11
...
2021-12-11 23:59:58	47370.9	49740.3	46856.2	48839.8

The input data used for calculating $Y8_{RCI}$ includes 284 different parameters such as volatility and total Bitcoin supply. The $Y8_{RCI}$ value at timestep t is determined without knowing the future prices after t . The $Y8_{RCI}$ machine learning algorithm is subject to intellectual property and won't be discussed in this article. We will analyse the output of this algorithm to determine its accuracy.

Figure 1 and 2 display the historical closing prices of Bitcoin coloured in green ($Y8_{RCI}(t) = 0$) and red ($Y8_{RCI}(t) = 1$).



Figure 1: The closing price of Bitcoin displayed in log-scale (green: $Y8_{RCI} = 0$, red: $Y8_{RCI} = 1$)

2. Analysing the returns of Bitcoin

In order to determine the accuracy of $Y8_{RCI}$ we will analyse the future return rates of the first 3 closing prices after each day ($change_1$, $change_2$, $change_3$):

Date_	Close	change_1	change_2	change_3	$Y8_{RCI}$
2021-11-02 23:59:00	63523.3	-0.0100593	-0.0368177	-0.035354	0
2021-11-03 23:59:00	62884.3	-0.0270303	-0.0255517	-0.0232089	0
2021-11-04 23:59:00	61184.5	0.00151967	0.0039276	0.0627116	0
2021-11-05 23:59:00	61277.5	0.00240428	0.0610991	0.104555	0
2021-11-06 23:59:52	61424.8	0.058554	0.101906	0.0915977	1

Figure 2 shows the distribution of future return values of the change values at $t+1$, $t+2$ and $t+3$ where $Y8_{RCI}$ has a value of 0. The dataset contains 1418 occasions with $Y8_{RCI} = 0$. The distribution shows mean values > 0 .

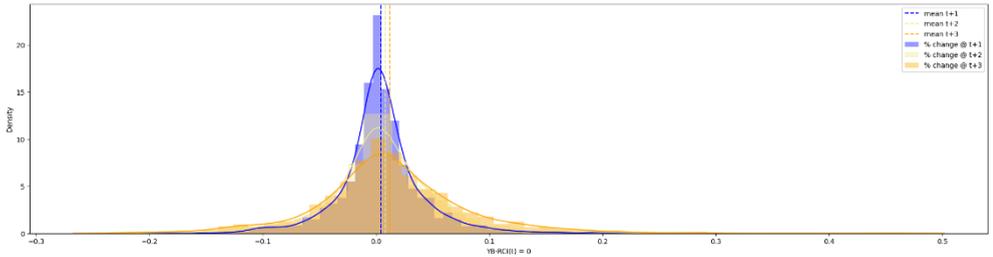


Figure 2: Returns of Bitcoin closing prices at t+1, t+2, t-3 where $Y8_{RCI}(t) = 0$

Figure 3 shows the distribution of future return values of the change values at t+1, t+2 and t+3 where $Y8_{RCI}$ has a value of 1. The dataset contains 1078 occasions with $Y8_{RCI} = 1$. The distribution shows mean values > 0 , too.

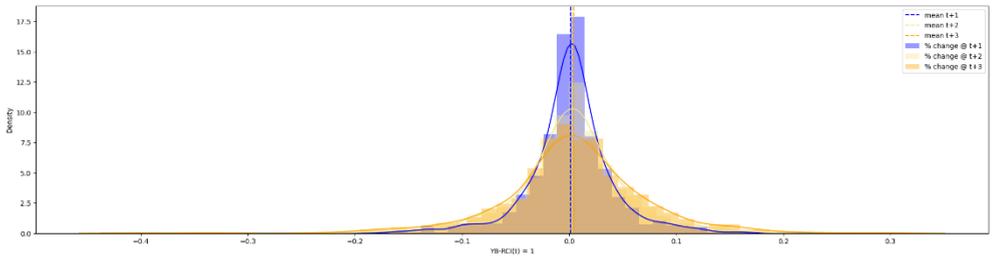


Figure 3: Returns of Bitcoin closing prices at t+1, t+2, t-3 where $Y8_{RCI}(t) = 1$

A simple look at the future return values does not indicate a majority of positive returns for $Y8_{RCI} = 0$ or a majority of negative returns of $Y8_{RCI} = 1$. Therefore it's necessary to analyse the movements within each regime.

3. Analysing the regimes

Every regime change is indicated by $Y8_{RCI}(t) = 0 \rightarrow Y8_{RCI}(t + 1) = 1$ or $Y8_{RCI}(t) = 1 \rightarrow Y8_{RCI}(t + 1) = 0$. Between each regime changes we have a series of open, high, low and closing prices for each day. In total we can identify the following parameters since 2015-02-08:

number of series with $Y8_{RCI} = 0$	97
number of series with $Y8_{RCI} = 1$	96
mean duration of each series with $Y8_{RCI} = 0$	14.61
mean duration of each series with $Y8_{RCI} = 1$	10.98

This data leads to the following conclusions:

- There is an equal distribution of up and down regimes
- The average up regime lasts longer than a down regime
- A bearish investor only has 75% of the time a bullish investor has

A next step is to analyse the data series within each regime change (figure 4): We will measure the return from the start of each series (S) to its highest value (H), its lowest value (L) and its final value (E). S is the closing price of the first day within each series. H is the highest price and L the lowest price of Bitcoin within the same series. E is the closing price of Bitcoin of the last day within this series. The results are:

		min	max	mean
$Y8_{RCI}(t) = 0$	S → E	0.8217	2.5816	1.1165
	S → H	1.0022	2.8022	1.2153
	S → L	0.7086	0.9959	0.9398
$Y8_{RCI}(t) = 1$	S → E	0.5572	1.2127	0.9803
	S → H	1.0034	1.3741	1.0743
	S → L	0.4093	0.9979	0.8965

This data leads to the following conclusions:

- The average price development from one regime change to the next (S → E):
 - is positive for series with a value of $Y8_{RCI}(t) = 0$
 - is negative for series with a value of $Y8_{RCI}(t) = 1$
- The average negative price development within one series (S → L):
 - is approx. -6% for series with a value of $Y8_{RCI}(t) = 0$
 - is approx. -10% for series with a value of $Y8_{RCI}(t) = 1$
- The maximum loss from start to low (S → L) within a series is approx. 29% for series with a value of $Y8_{RCI}(t) = 0$ and is approx. 59% for series with a value of $Y8_{RCI}(t) = 1$.
- The maximum gain from start to high (S → H) within a series is much higher for series with a value of $Y8_{RCI}(t) = 0$ as for series with a value of $Y8_{RCI}(t) = 1$.

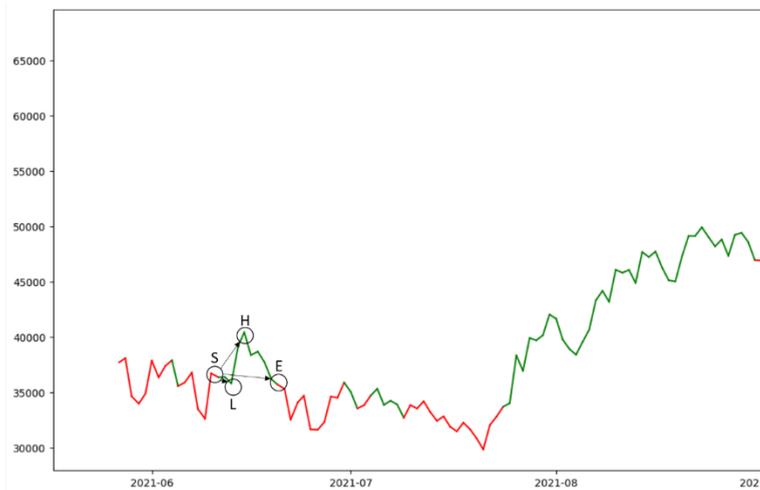


Figure 4: Measuring the returns from the start of a series (S) to its low (L), its high (H) and its end price (E)

At this point we know that the aimed indication of $Y8_{RCI}$ regarding the future price movement of Bitcoin seems to be right. What we don't know is, how many timesteps within each new series are following the indicated price movement. We'll call this the *hit rate* of a series. The hit rate will tell us, how many Bitcoin prices within a series are higher than the price of S if $Y8_{RCI} = 0$, and how many prices are lower than S if $Y8_{RCI} = 1$. The result of this examination is:

mean hit rate for $Y8_{RCI} = 0$	0.64
mean hit rate for $Y8_{RCI} = 1$	0.48

Another question is how many series failed indicating the future price movement completely. That's the case when for example a series with a length of 10 days and with $Y8_{RCI} = 0$ only produces negative returns while a value of $Y8_{RCI} = 0$ expected at least some positive returns. We'll call this the *fail rate* of a series:

fail rate of $Y8_{RCI} = 0$	21/97 = 21,65%
fail rate of $Y8_{RCI} = 1$	31/96 = 32,29%

This data leads to the following conclusions:

- A value of $Y8_{RCI}(t) = 0$ indicates an upward price movement with a higher accuracy than a value of $Y8_{RCI}(t) = 1$ indicates a downward price movement.
- Less than 50% of all indicated downward movements are correct while 64% of the indicated upward price movements are right.
- In approx. 21% of all cases with an indicated upward price movement ($Y8_{RCI}(t) = 0$) the Bitcoin price fell below the price of starting point S for the whole series.
- In approx. 32% of all cases with an indicated downward price movement ($Y8_{RCI}(t) = 1$) the Bitcoin price increased above the price of starting point S for the whole series.

4. Combining Y8-RCI with an investment algorithm

Since its first days the price of 1 Bitcoin increased from 0.07 US\$ to a maximum of approx. 68.000 US\$. That's an enormous increase within 8 years. But with every day since its release in 2013 the next price of 1 Bitcoin was and is uncertain. It is uncertain that the price of 1 Bitcoin will be worth more than 250.000 US\$ by the end of 2022. And it is uncertain that the price of 1 Bitcoin will be worth less than 68.000 US\$ by the end of 2022.

In order to measure the theoretical strength of $Y8_{RCI}$ we need to create an algorithm which competes against Bitcoin's historical price increase itself. This algorithm can only win this race if it successfully uses Bitcoin's up- and down-movements to invest an initial balance of 100 US\$. We ignore any fees that are related to buying, selling and holding Bitcoin and only use the historical daily closing prices.

The algorithm used to invest follows a simplified rule:

1. Wait for the next regime change.
2. Go long if $Y8_{RCI}(t) = 0$. Go short if $Y8_{RCI}(t) = 1$. $Price_{INVESTED} = Price_{CLOSE}(t)$
3. Aim to take profit at $Price_{CLOSE}(t + n) \geq Price_{INVESTED} * 1.02$ as $Price_{TP}$. Aim to stop loss at $Price_{CLOSE}(t + n) \leq Price_{INVESTED} * 0.97$ as $Price_{SL}$
4. If $Price_{CLOSE}(t + n) \geq Price_{TP}$ adjust the take profit by another 2%
5. If $Price_{CLOSE}(t + n) \leq Price_{SL}$ then calculate current balance, close position at current price and goto 2

RACE #1

In the 1st race we'll start at 2015-03-17 with a closing price of 256.29 US\$. This is approx. 2,500 closing prices prior to the final price point. The final price point is 2021-12-11 with a closing price of 48,839.80 US\$. Within these years the natural price increase factor of Bitcoin is 190.5579. A theoretical investment of 100 US\$ in Bitcoin at 2015-03-17 would have a value of $100 \text{ US\$} * 190.5579 = 19,557.90 \text{ US\$}$ at 11-12-2021.

Figure 5 shows the development of the algorithm driven investment versus the buy-and-hold driven investment. The buy-and-hold loses this race in the final round against a final algorithm driven balance of 24,797.56 US\$.

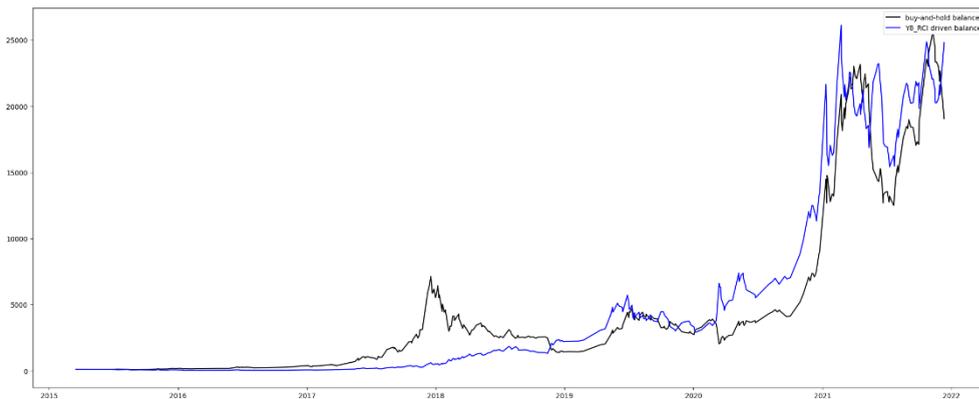


Figure 5: A buy-and-hold investment strategy vs. a $Y8_{RCI}$ driven strategy starting in 2015

RACE #2

For the 2nd race we reduce the available timeframe to approx. 1,500 closing prices. This simulates an investor who joined the Bitcoin market at 2018-01-02 with a price of 15,201 US\$. Within these years the natural price increase factor of Bitcoin is now reduced to 3.2129. A theoretical investment of 100 US\$ in Bitcoin at 2018-01-02 would have a value of 321.29 US\$ at 11-12-2021 with a Bitcoin closing price of 48,839.80 US\$.

Figure 6 and 7 show the development of the algorithm driven investment versus the buy-and-hold driven investment. The buy-and-hold loses this race far behind against a final algorithm driven balance of 5,019.12 US\$.

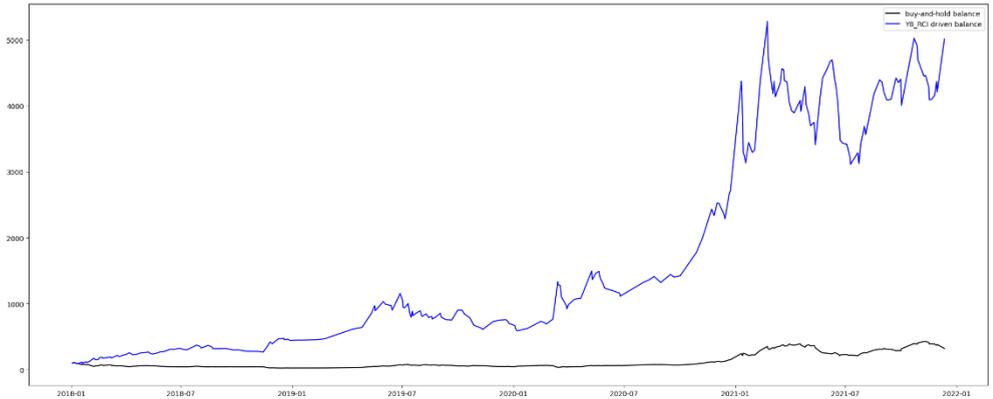


Figure 6: A buy-and-hold investment strategy vs. a $Y8_{RCI}$ driven strategy starting in 2018

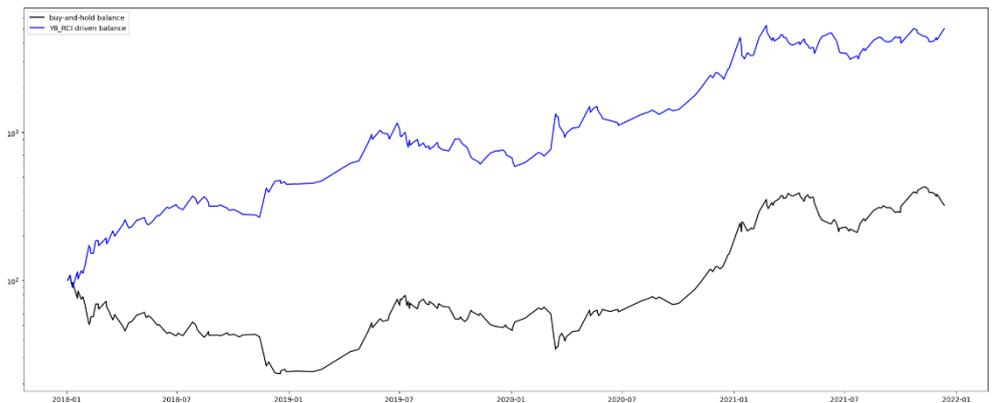


Figure 7: log-scale view on Figure 6

RACE #3

In race #3 we cut the available timeframe by half to approx. 750 closing prices. The starting point now is 2020-05-28 with a closing price of 9,570.09 US\$. The natural price increase factor of Bitcoin is now 5.1033.

Figure 8 shows, that this race is clearly won by the buy-and-hold driven investment with a final value of 510.33 US\$ vs. the algorithm driven investment with a value of 409.30 US\$.

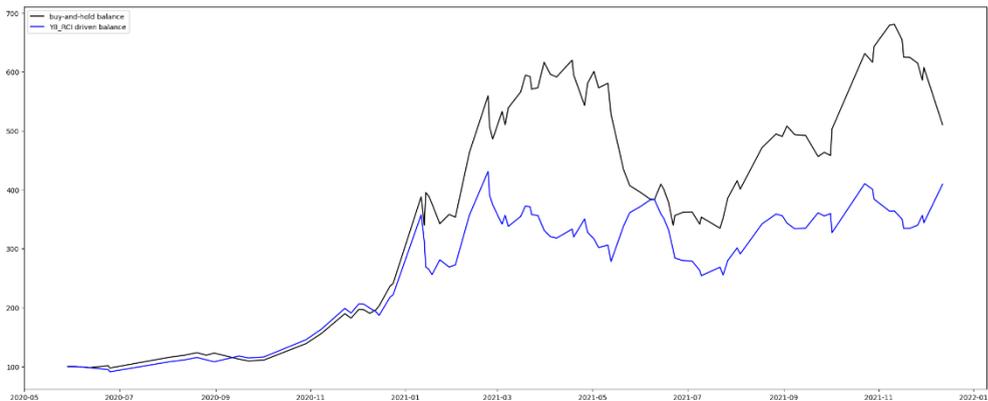


Figure 8: A buy-and-hold investment strategy vs. a $Y8_{RCI}$ driven strategy starting in 2020

RACE #4

For the final race we reduce the available timeframe to approx. 250 closing prices. The starting point now is 2021-04-30 with a closing price of 58,451.39 US\$. The natural price increase factor of Bitcoin is now 0.8342.

Figure 9 shows that the buy-and-hold loses this race with a final balance of 83.42 US\$ versus final algorithm driven balance of 126.96 US\$.

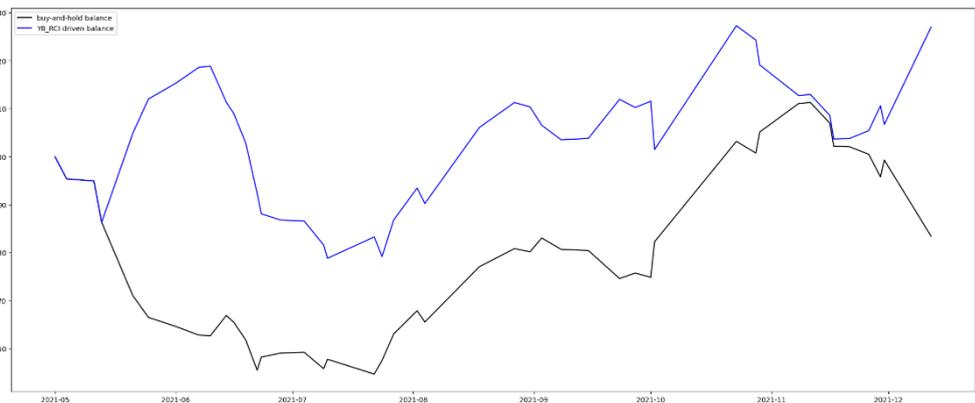


Figure 9: A buy-and-hold investment strategy vs. a $Y8_{RCI}$ driven strategy starting in 2021

5. Summary

In chapter 1 we introduced the regime change indicator $Y8_{RCI}$. This indicator is calculated by a pre-trained machine learning with 284 input parameters, that does not know the future price developments of Bitcoin. The output of this model is a Boolean value: 0 if the future prices of Bitcoin are expected to be higher than the previous day and 1 if the future prices of Bitcoin are expected to be lower than the previous day.

In chapter 2 we analysed the direct impact of a new regime change on the future price change within the next 3 days. The aim was to identify if the impact is significant. As a result, we were not able to identify a significant impact on up- and down-movements for the next 3 days after a regime change.

In chapter 3 we analysed the series of price points within each regime. We found out that regimes that indicate a positive price development of Bitcoin ($Y8_{RCI} = 0$) last longer than those that indicate a negative price development ($Y8_{RCI} = 1$). Within a series of an expected positive price development, we identified a clear correlation to $Y8_{RCI} = 0$. We identified a corresponding correlation to $Y8_{RCI} = 1$.

In chapter 4 we injected the $Y8_{RCI}$ parameter into an investment algorithm and let it compete with a buy-and-hold strategy. In 3 out of 4 races the algorithm-based investment won against the buy-and-hold strategy by far.

As a result, we can summarize that $Y8_{RCI}$ combined with a simple algorithm leads higher returns of Bitcoin investments.