“Fair market value of bitcoin: halving effect”

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FAIR MARKET VALUE OF BITCOIN: HALVING EFFECT

Abstract

The purpose of this article is to analyze the effect that halving has on the fair market value of bitcoins. The main hypothesis of the study is that the decline in the cost of miners' remuneration for mining is a significant factor that affects the price of cryptocurrencies. The article examines the factors that regulate the issuing process. The significance of a limited supply of bitcoin is detailed in the article, as well as the mechanism for the implementation of the issue of new bitcoins. The study compares the historical inflation data of the US dollar and the projected data on the inflation of bitcoin. The article analyzes the main technical element of cryptocurrency – halving – when the miner's reward is halved. This analysis includes the mathematical methods of statistical data processing. Research results show that reducing remuneration by half every four years leads to an increased market value of the cryptocurrency. This relationship is clearly illustrated by the Kendall rank correlation method.The results of the study can have a significant impact on the fundamental assessment of bitcoin and can also enable investors to assess any of the existing and operating cryptocurrencies according to this method.

Keywords cryptocurrency, bitcoin, emission, inflation, halving

JEL Classification E31, E42, G15

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INTRODUCTION

Many significant problems in the global financial system were exposed in the 2008 economic crisis. The recession also gave incentives to create an alternative structure for the world economy. Thus, changes were made, and new economic tools and technologies began to be used.

Bitcoin has been attracting more and more attention from economists, politicians, and traders since its introduction in 2009. In particular, the cryptocurrency started to dominate in the financial press, due to its phenomenal growth in market value and the number of transactions made.

Bitcoin's success has inspired many cryptocurrency projects based on various Blockchain technologies. Since the beginning of 2017, leading cryptocurrencies, such as litecoin, dash, monero, have gone up in price by several thousand percent, resulting in a substantial increase in trading volumes. By 2018, cryptocurrency market capitalization has increased from 18 to 830 billion US dollars. In addition, daily trading volume with various cryptocurrencies has increased from several thousand to hundreds of thousands of dollars, and sometimes even to millions of US dollars.

Therefore, an intriguing question arises: what is the fundamental reason for price changes of crypto assets in the long run? This issue is crucial for two reasons. Firstly, there is no suitable model for assessing the impact that bitcoin emission has on its price. Secondly, the majority of cryptocurrency market participants use technical analysis as their

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trading strategy, which stresses the importance of trends, trading volumes, and volatility levels in the process of making trading decisions. At the same time, halving – remuneration reduction – is completely ignored, despite being an important technical aspect in functional analysis of bitcoin.

The study of the interdependence between the reduction of mining expenses and the cost of a bitcoin can provide useful information for crypto assets market participants (investors, miners, etc.). If an investor understands the mechanism of issuing new bitcoins, he/she can use this knowledge to adjust portfolios or create new investment and hedging strategies. In turn, miners appreciate halving and its positive impact on the value of bitcoin, which will allow for planning the sale of bitcoins more carefully, covering mining expenses.

When investors face macroeconomic uncertainty, information about technical aspects, that have a direct impact on the market price of cryptocurrencies will help them choose the right time and amount of necessary cryptocurrencies for their portfolio adjustments based on their preferences regarding risk.

1. LITERATURE REVIEW AND THEORETICAL BASIS

In their works, Mba, Pindza, and Koumba (2018) and Briere, Oosterlinck, and Szafarz (2015) consider the possibility of further diversifying cryptocurrency-based investment portfolios for private and institutional investors. For example, if an investor who had 100 thousand US dollars at the beginning of 2011 decided to invest 1% of his funds in bitcoins, he would have earned an average annual yield of 298.64% for 8 years, and his total capital would have increased from 100 thousand US dollars to 7.06 million US dollars[1].

Many scientists have been studying bitcoin from multiple perspectives ever since it appeared. Corbet, Lucey, Urquhart, and Yarovaya (2018) and Dierksmeier and Seele (2018) addressed the issue of classifying cryptocurrencies, determining whether they are a medium of exchange and payment or just a speculative investment.

Yi, Xu, and Wang (2018) conducted a study related to the correlation between cryptocurrencies and traditional assets and assessed whether cryptocurrencies could be used as a hedging or diversification asset.

The vast majority of economic literature concerning bitcoin and cryptocurrencies, in general, is dedicated to studying economic factors, such as the market power of supply and demand, production cost of cryptocurrencies, the influence of the public interest through mass media. Chaim and Laurini (2018), Balcilar, Bouri, and Gupta (2017) emphasized price volatility and opportunities in trading correlation strategies. However, little research has been done on the effects that technical elements of a separate cryptocurrency have on its market value.

Supporters of the traditional theory believe that investors should look for investment and hedging opportunities on a certain market by evaluating the effectiveness of other markets. However, such strategies are not beneficial in the current state of the cryptocurrency market. This is due to the difference between cryptocurrencies' underlying technologies along with its market environment and traditional financial assets (stocks, bonds, etc.). Dorfleitner and Lung (2018) give a more detailed discussion on this topic in their work.

Bitcoin operates on blockchain technology, which involves the formation of blocks containing information about transactions users carry out within a network. Each new block generated by a network is built into a chain of blocks, which contains information not only about new transactions, but also all previously conducted operations (Brühl, 2017). This technology allows for a structured database, leaving it in the public domain. Moreover, this technology of distributed registries excludes spoofing, identity theft, data deletion, and it does not allow interested persons to violate the property rights of the owners.

1 The author's calculations.

It is worth noting, however, that the primary purpose of Bitcoin is to create an alternative method of making transactions. This approach essentially eliminates intermediaries out of the money-flow chain (like banks and other financial institutions) between buyers and sellers, as well as the need for government bodies to control and regulate activities of financial organizations. As stated by Nakamoto (2008), the structure of peer-to-peer data transport is based on the idea of equality of all participants in a network. This eliminates the need to drag and synchronize special servers, decreasing the odds of performance deterioration of any given system. The result is that every network participant is both its client and server for storing data. This process allows bitcoin to have full independence in network connectivity.

Bitcoin's key ideas include, as previously discussed, independence from intermediaries and regulators and the autonomy of the network functioning. However, bitcoin's intent, according to its creator (or creators), was to eliminate the chief, in their opinion, the disadvantage of modern money equivalents – inflation. The idea of perfect money, which in the long run does not lose its value, was fully realized in this cryptocurrency and significantly contributed to its success. Therefore, in order to prevent inflation, the code of cryptocurrency originally had several basic regulating principles:

1) limited issue;
2) increase/decrease in complexity of mining;
3) remuneration halving for the generated block.

Let us examine the three factors in further detail:

1. The Central Bank is the single regulatory body, which carries out and supervises the entire issue of monetary funds in a centralized monetary system. It prints new banknotes based on the data on goods and services produced in the country. This controls the money supply and prices, given a prosperous and stable monetary policy has been established, like many researchers proved in energy forecasting (Nyangarika, Mikhaylov, & Tang, 2018; Nyangarika, Mikhaylov, & Richter, 2019a; Meykhard, 2019; Mikhaylov, 2019).

In a decentralized monetary system, human intervention in the process of currency issuance is reduced to zero. However, the release of new bitcoins into circulation is totally under control of a special cryptographic algorithm, which follows the rules of peer-to-peer networks. This algorithm determines the frequency, time, and amount of issued monetary units (Sauer, 2016). Any attempts to modify the amount of issuance of new monetary units will be cryptographically rejected (Nelson, 2018; Mikhaylov, 2018b).

The creation of bitcoin units epitomizes the issuance of legal-tender coins on a predetermined algorithm. The algorithm's imposed limit on the maximum possible amount of bitcoins is 21 million coins (Nakamoto, 2008).

The issuance of new bitcoins follows the completion of forming new blocks of transactions. The frequency, with which the blocks are generated, is constant: six blocks per hour. The amount of mined coins by bitcoin network gets reduced in a geometric progression: every 210 thousand mined bitcoin blocks, the amount of mined bitcoin blocks next cycle will be reduced by 50%, which corresponds to a four-year issue cycle. As a result, the algorithm determining bitcoin issuance develops a clear timetable, according to which the number of issued bitcoins will never exceed more than 21 million coins (Table 1).

2. The rate of complexity is essential to the process of cryptocurrency production. Aside from the fact that this indicator helps miners determine which equipment must be used for the extraction of cryptocurrency and what power it needs to possess, the complexity of mining regulates the pace at which bitcoins are issued.

Every 2016 blocks found in the bitcoin network, the difficulty of mining is recalculated. If miners found one block of transactions every 10 minutes, as the developer (developers) of the network originally intended, in order to maintain the planned issuance of 21 million coins, locating this quota of blocks would take two weeks. The work of Böhme, Christin, Edelman, and Moore (2015) indicates that when 2016 blocks are found in a timeframe shorter than the intended, the complexity of the

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Table 1. Bitcoin emission

Source: www.coinmarketcap.com, Thomson Reuters, the author's calculations.

Year	Bitcoin blocks by cumulative totals	Block remuneration, bitcoin	The amount of mined bitcoins	The amount of mined bitcoins of the maximum emission, %	The amount of mined bitcoins by cumulative totals
2009	210,000	50	10,500,000.00	50%	10,500,000.00
2012	420,000	25	5,250,000.00	25%	15,750,000.00
2016	630,000	12.5	2,625,000.00	12.5%	18,375,000.00
2020	840,000	6.25	1,312,500.00	6.25%	19,687,500.00
2024	1,050,000	3.125	656,250.00	3.125%	20,343,750.00
2028	1,260,000	1.5625	328,125.00	1.5625%	20,671,875.00
2032	1,470,000	0.78125	164,062.50	0.78125%	20,835,937.50
2036	1,680,000	0.390625	82,031.25	0.390625%	20,917,968.75
2040	1,890,000	0.1953125	41,015.63	0.1953125%	20,958,984.38
2044	2,100,000	0.09765625	20,507.81	0.09765624%	20,979,492.19
2048	2,310,000	0.048828125	10,253.91	0.048828143%	20,989,746.09
2052	2,520,000	0.0244140625	5,126.95	0.0244140476%	20,994,873.05
2056	2,730,000	0.01220703125	2,563.48	0.01220704762%	20,997,436.52
2060	2,940,000	0.006103515625	1,281.74	0.00610352381%	20,998.718.26
2064	3,150,000	0.0030517578125	640.87	0.00305176191%	20,999,359.13
2068	3,360,000	0.0015258789063	320.43	0.00152585714%	20,999,679.57
2072	3,570,000	0.0007629394531	160.22	0.00076295238%	20,999,839.78
2076	3,780,000	0.0003814697266	80.11	0.00038147619%	20,999,919.89
2080	3,990,000	0.0001907348633	40.06	0.00019076191%	20,999,959.95
…	…	…	…	…	…
2140	6,930,000	0.00	≈ 0.001222534	100%	21,000,000.00

mining algorithm increases. And vice versa, if finding 2016 blocks takes significantly more time, the complexity of the mining algorithm decreases. The network supports the uniform generation of bitcoins by using this algorithm and does not allow the creation of more coins than originally planned (Lopatin, 2019a; Denisova, 2019).

The increase and decrease of the complexity of mining depend on the hash rate of the network and the amount of time spent on finding the previous 2016 blocks. Hash rate is a unit that measures the effective capacity of equipment that is used for cryptocurrency mining. Hash rate starts to grow when new members join the process of extracting bitcoins (Lopatin, 2019b; Denisova, Mikhaylov, & Lopatin, 2019).

When new members connect their equipment to the network, they increase the computing power, which leads to a reduction of the amount of time it takes to find a transaction block. Thus, we can make the following conclusion: the higher the hash rate of the network, the greater the number of miners involved in the extraction of cryptocurrency, and hence, the less time it takes to find a transaction block. All this leads to an increase in the complexity of mining. On the contrary, the reduction of hash rate indicates that fewer miners are involved in the process of mining, which means that the time to find a transaction block increases, and the complexity of the network decreases (Nyangarika, Mikhaylov, & Richter, 2019b).

3. As was mentioned previously, the total output of bitcoins is limited to 21 million coins. When the last block out of the 210 thousand limit set by the system is found, the reward for the next found block, according to the plan, is halved. The reward for finding a block of transactions has decreased two times in the ten years that bitcoin has existed.

So, on November 28, 2012, the number of new bitcoins that the network generates had reached its limit, and the reward was reduced from 50 BTC to 25 BTC and in early July of 2016 – from 25 BTC to 12,5 BTC. The following reduction of remuneration (halving) is estimated to take place in May of the year 2020.

In addition to influencing the overall earnings of miners, halving that occurs once every four years significantly affects the process of issuing new bitcoins (Table 1). This directly affects the market value of cryptocurrency. So, participants of the bitcoin network who mined 100 BTC per month, and then sold them to offset their production costs, begin to produce two times fewer coins after remuneration halving, which leads to a decrease in the supply of the "new" bitcoins in the market. With the same level of demand and twice-decreased supply side, the market starts to react by increasing the market value of cryptocurrency. The same opinion is shared by Kroll, Davey, and Felten (2013) and Nair and Cachanosky (2017). They write that at the same level of demand and twice-decreased supply side, the market starts to react by increasing the market value of cryptocurrency.

2. METHODS

The period from November 1, 2010 to December 31, 2018 (98 months) was taken in order to analyze the impact of halving on the value of bitcoin. This time frame was divided into weekly intervals indicating the historical opening and closing prices.

In order to reduce the impact of price volatility and improve the quality of the obtained results, the following method of estimation did not include the weekly maximum and minimum price values for the selected period. This kind of search data helped reduce the impact of high price volatility that the cryptocurrency market is prone to. A characteristic feature of bitcoin that distinguishes it from government-issued fiat currencies is its limited issuance. The maximum possible amount of bitcoins that may exist will never exceed the mark of 21 million cryptocurrency units (Nakamoto, 2008).

A miner gets rewarded for each found transaction unit/block (blocks are generated every 10 minutes). The amount of remuneration is fixed and occurs after 210 thousand transaction blocks are found. The reduction of payment is always twofold – from 50 BTC to 25 BTC (November 2012), from 25 BTC to 12.5 BTC (July 2016), and so on.

The award received by miners is called emission. When the bitcoin system was launched, when it was not so popular, the award for the found transaction block was 50 BTC. For one hour, the system produced a turnover of 300 BTC or 7200 BTC per day. For the entirety of 2009, 2,625,000 BTC were released into circulation, which is 12.5% of the sum of the maximum issuance of bitcoin. By the end of 2012, 210 thousand blocks of transactions were found. This marked a decline in emissions by half to 25 BTC for each new-found block. In this regard, the system began to generate 150 BTC per hour or 3600 BTC per day, and 1,312,500 BTC per year (Mikhaylov, 2018a; Mikhaylov, Sokolinskaya, & Nyangarika, 2018; Mikhaylov, Sokolinskaya, & Lopatin, 2019).

The process of remuneration reduction will continue forever. However, by the year 2140, bitcoin supply would peak, and the overall supply will total 21 million cryptocurrency units. After that, miners, whose computer power will be used to locate blocks of transactions, will be receiving remuneration only from the commission or fees paid by the members of the system when making payments in cryptocurrency. The process of issuing new bitcoins units will stop (Figure 1).

With limited issuing of cryptocurrency, the inflation level of a bitcoin invariably falls with every passing year. This is because the algorithm of remuneration halving (twofold payment reduction) is embedded in the foundation of the system. The presence of this algorithm within the system of bitcoins gives way for the progressive decrease in the level of remuneration, which results in a smaller supply of coins (Table 2).

Bitcoin issuance can be easily predicted since the system is algorithmic, and nobody will ever be able to influence the results of emission.

Constant reduction of bitcoin issuance by 50 percent every four years leads to the reduction of bitcoin inflation. Therefore, by 2025, the level of inflation will be less than 1% and will amount to 0.83% per year. And by 2037, it will be less than 0.1%. By the year 2053, the inflation rate would drop to a level that will be completely invisible.

If we make a comparative analysis with fiat currencies that are prone to inflation, the advantage of bitcoins becomes so evident, that it is undeniable.

The US dollar was taken for the comparative analysis of inflation levels during the period from 1914 to 2014 (100 years). Bitcoin inflation data are taken from Table 2.

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Source: www.coinmarketcap.com, Thomson Reuters, the author's calculations.

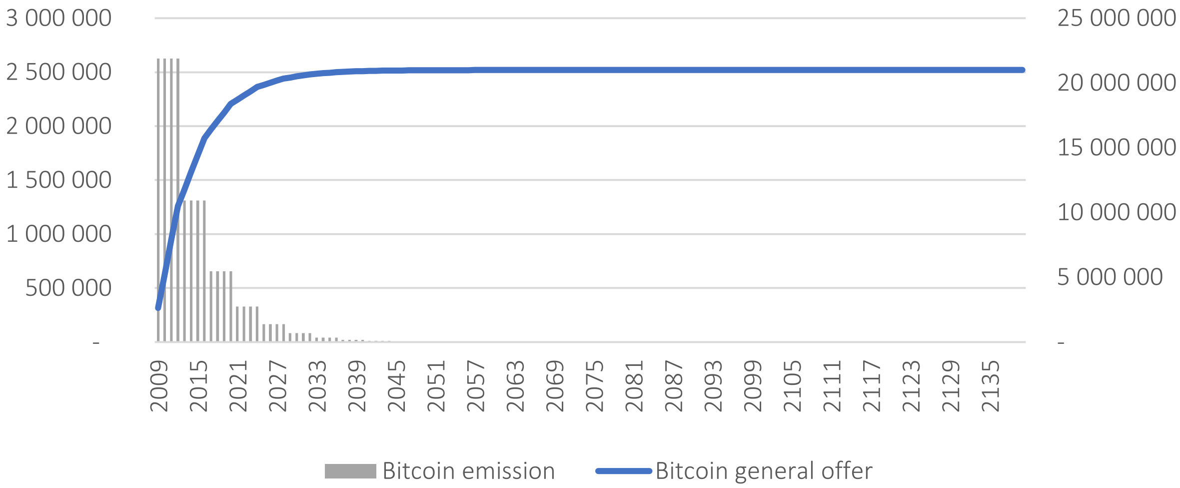

Figure 1. Bitcoin emission for the years 2009–2140

Table 2. Bitcoin inflation

Source: www.coinmarketcap.com, Thomson Reuters, the author's calculations.

Year	Bitcoin emission	Total supply of bitcoins	Bitcoin inflation, %	Year	Bitcoin emission	Total supply of bitcoins	Bitcoin inflation, %
2009	2625000	2 625 000,00	–	2075	40,05432	20 999 799,73	0.00019
2010	2625000	5 250 000,00	100.00	2076	40,05432	20 999 839,78	0.00019
2011	2625000	7 875 000,00	50.00	2077	20,027161	20 999 859,81	0.00010
2012	2625000	10 500 000,00	33.33	2078	20,027161	20 999 879,84	0.00010
2013	1312500	11 812 500,00	12.50	2079	20,027161	20 999 899,86	0.00010
2014	1312500	13 125 000,00	11.11	2080	20,027161	20 999 919,89	0.00010
2015	1312500	14 437 500,00	10.00	2081	10,01358	20 999 929,90	0.00004768
2016	1312500	15 750 000,00	9.091	2082	10,01358	20 999 939,92	0.00004768
2017	656250	16 406 250,00	4.166	2083	10,01358	20 999 949,93	0.00004768
2018	656250	17 062 500,00	4.000	2084	10,01358	20 999 959,95	0.00004768
2019	656250	17 718 750,00	3.846	2085	5,0067902	20 999 964,95	0.00002384
2020	656250	18 375 000,00	3.7037	2086	5,0067908	20 999 969,96	0.00002384
2021	328125	18 703 125,00	1.7857	2087	5,0067908	20 999 974,97	0.00002384
2022	328125	19 031 250,00	1.7544	2088	5,0067908	20 999 979,97	0.00002384
2023	328125	19 359 375,00	1.7241	2089	2,5033954	20 999 982,48	0.00001192
2024	328125	19 687 500,00	1.6949	2090	2,5033954	20 999 984,98	0.00001192
2025	164062,5	19 851 562,50	0.8333	2091	2,5033954	20 999 987,48	0.00001192
2026	164062,5	20 015 625,00	0.8264	2092	2,5033954	20 999 989,99	0.00001192
2027	164062,5	20 179 687,50	0.8197	2093	1,2516977	20 999 991,24	0.00000596
2028	164062,5	20 343 750,00	0.8130	2094	1,2516977	20 999 992,49	0.00000596
2029	82031,25	20 425 781,25	0.4032	2095	1,2516977	20 999 993,74	0.00000596
2030	82031,25	20 507 812,50	0.4016	2096	1,2516977	20 999 994,99	0.00000596
2031	82031,25	20 589 843,75	0.4000	2097	0,6258489	20 999 995,62	0.00000298
2032	82031,25	20 671 875,00	0.39841	2098	0,6258489	20 999 996,24	0.00000298
2033	41015,63	20 712 890,63	0.19841	2099	0,6258489	20 999 996,87	0.00000298
2034	41015,63	20 753 906,25	0.19802	2100	0,6258489	20 999 997,50	0.00000298
2035	41015,63	20 794 921,88	0.19763	2101	0,3129244	20 999 997,81	0.00000149
2036	41015,63	20 835 937,50	0.19724	2102	0,3129244	20 999 998,12	0.00000149
2037	20507,82	20 856 445,31	0.09843	2103	0,3129244	20 999 998,44	0.00000149
2038	20507,82	20 876 953,13	0.09833	2104	0,3129244	20 999 998,75	0.00000149
2039	20507,82	20 897 460,94	0.09823	2105	0,1564622	20 999 998,90	0.000000745
2040	20507,82	20 917 968,75	0.09814	2106	0,1564622	20 999 999,06	0.000000745
2041	10253,91	20 928 222,66	0.04902	2107	0,1564622	20 999 999,22	0.000000745

Table 2 (cont.). Bitcoin inflation

Year	Bitcoin emission	Total supply of bitcoins	Bitcoin inflation, %	Year	Bitcoin emission	Total supply of bitcoins	Bitcoin inflation, %
2042	10253,91	20 938 476,56	0.04900	2108	0,1564622	20 999 999,37	0.000000745
2043	10253,91	20 948 730,47	0.04897	2109	0,0782311	20 999 999,45	0.000000372
2044	10253,91	20 958 984,38	0.04895	2110	0,0782311	20 999 999,53	0.000000372
2045	5126,953	20 964 111,33	0.02446	2111	0,0782311	20 999 999,61	0.000000372
2046	5126,953	20 969 238,28	0.02446	2112	0,0782311	20 999 999,69	0.000000372
2047	5126,953	20 974 365,23	0.02445	2113	0,0391156	20 999 999,73	0.000000186
2048	5126,953	20 979 492,19	0.02444	2114	0,0391156	20 999 999,77	0.000000186
2049	2563,477	20 982 055,66	0.01222	2115	0,0391156	20 999 999,80	0.000000186
2050	2563,477	20 984 619,14	0.01222	2116	0,0391156	20 999 999,84	0.000000186
2051	2563,477	20 987 182,62	0.01222	2117	0,0195578	20 999 999,86	0.000000093
2052	2563,477	20 989 746,09	0.01221	2118	0,0195578	20 999 999,88	0.000000093
2053	1281,738	20 991 027,83	0.00611	2119	0,0195578	20 999 999,90	0.000000093
2054	1281,738	20 992 309,57	0.00611	2120	0,0195578	20 999 999,92	0.000000093
2055	1281,738	20 993 591,31	0.00611	2121	0,0097789	20 999 999,93	0.000000047
2056	1281,738	20 994 873,05	0.00611	2122	0,0097789	20 999 999,94	0.000000047
2057	640,8691	20 995 513,92	0.00305	2123	0,0097789	20 999 999,95	0.000000047
2058	640,8691	20 996 154,79	0.00305	2124	0,0097789	20 999 999,96	0.000000047
2059	640,8691	20 996 795,65	0.00305	2125	0,0048894	20 999 999,97	0.000000023
2060	640,8691	20 997 436,52	0.00305	2126	0,0048894	20 999 999,97	0.000000023
2061	320,4346	20 997 756,96	0.00153	2127	0,0048894	20 999 999,98	0.000000023
2062	320,4346	20 998 077,39	0.00153	2128	0,0048894	20 999 999,98	0.000000023
2063	320,4346	20 998 397,83	0.00153	2129	0,0024447	20 999 999,98	0.000000012
2064	320,4346	20 998 718,26	0.00153	2130	0,0024447	20 999 999,99	0.000000012
2065	160,2173	20 998 878,48	0.00076	2131	0,0024447	20 999 999,99	0.000000012
2066	160,2173	20 999 038,70	0.00076	2132	0,0024447	20 999 999,99	0.000000012
2067	160,2173	20 999 198,91	0.00076	2133	0,0012224	20 999 999,99	0.000000006
2068	160,2173	20 999 359,13	0.00076	2134	0,0012224	20 999 999,99	0.000000006
2069	80,10864	20 999 439,24	0.00038	2135	0,0012224	20 999 999,99	0.000000006
2070	80,10864	20 999 519,35	0.00038	2136	0,0012224	21 000 000,00	0.000000006
2071	80,10864	20 999 599,46	0.00038	2137	0,0006112	21 000 000,00	0.000000003
2072	80,10864	20 999 679,57	0.00038	2138	0,0006112	21 000 000,00	0.000000003
2073	40,05432	20 999 719,62	0.00019	2139	0,0006112	21 000 000,00	0.000000003
2074	40,05432	20 999 759,67	0.00019	2140	0,0006112	21 000 000,00	0.000000003

The fundamental differences between these inflationary indicators are noticeable when conducting comparative analysis (Figures 2, 3). The US dollar, representing government-issued fiat currencies, shows moderate inflation for over 100 years. However, the inflation rate exceeded 10% three times in the period of 1968–1983 (Brown, 2017). Deflation can also be observed, but it occurred at a time when the gold standard was used. Deflation had not occurred after the gold standard was canceled by President Nixon in 1971 (Fratianni & Hauskrecht, 1998).

Bitcoin data are more predictable. Inflation shows a steady downward trend with every passing year.

As mentioned earlier, the rate of remuneration within the bitcoin network is directly influenced by halving (twofold reduction of remuneration). It is hard to imagine that halving is the technical element that exerts a significant influence on the market value of bitcoins.

The first halving in the bitcoin system occurred in the middle of November in 2012. The number of new units generated by the network when finding a transaction block was reduced from 50 BTC to 25 BTC, which greatly affected the supply of bitcoins in the market. When halving happened, the market price was $12.5 for a bitcoin. A year later, a new price maximum was set at $1150 for a bitcoin. Since halving oc-

http://dx.doi.org/10.21511/imfi.16(4).2019.07

Source: www.coinmarketcap.com, Thomson Reuters.

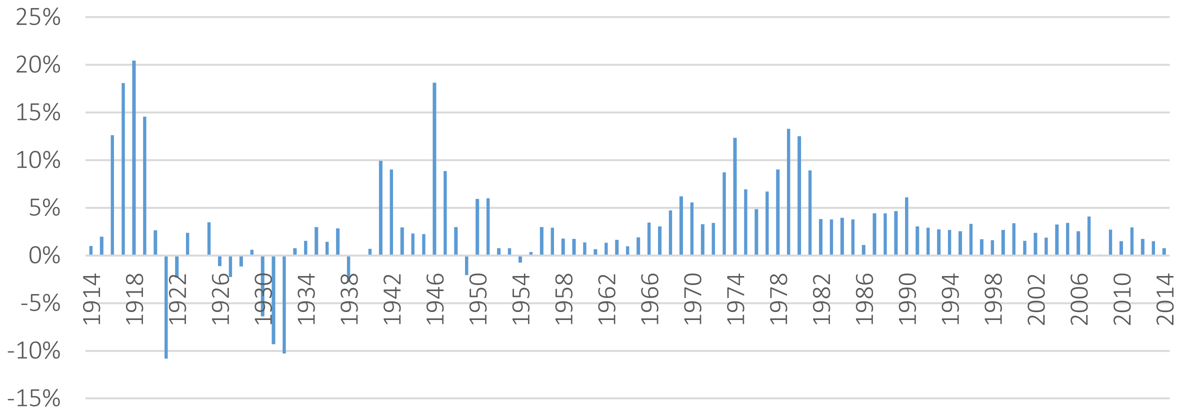

Figure 2. US dollar inflation 1914–2014, %

Source: www.coinmarketcap.com, Thomson Reuters, the author's calculations.

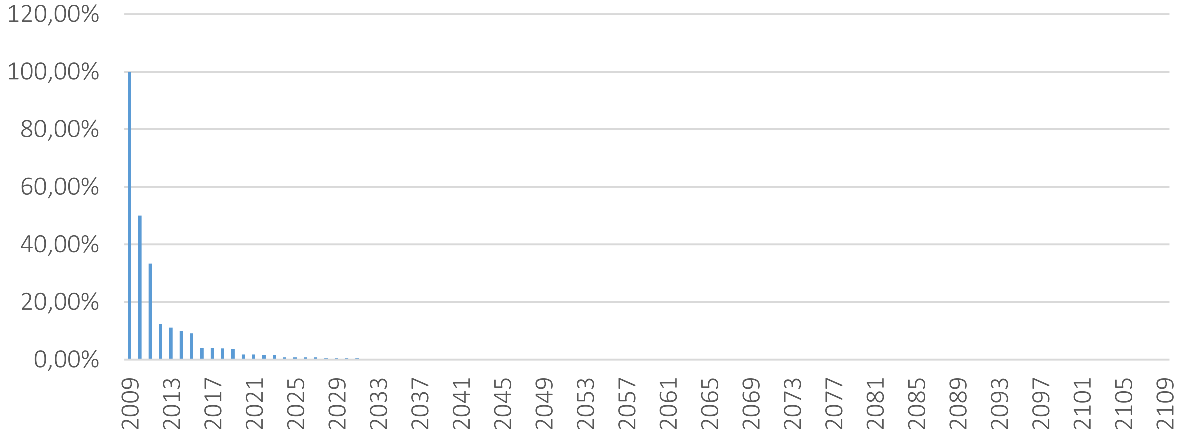

Figure 3. Bitcoin inflation 2009–2109, %

Source: www.tradingview.com

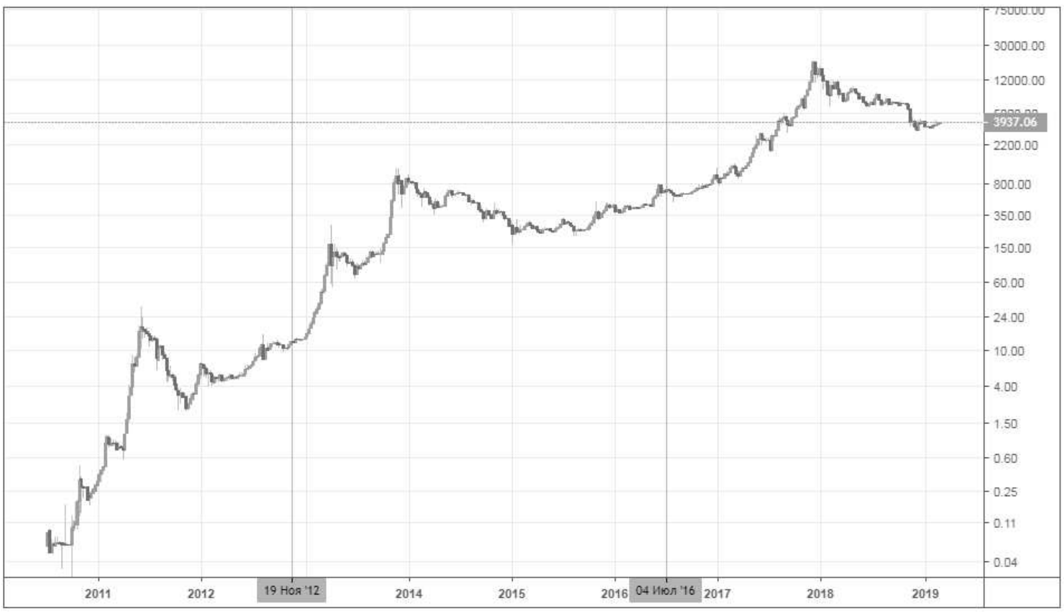

Figure 4. Logarithmic graph of the value of the bitcoin 2011–2019, US dollars

curred, the rise in the cost of one unit of a bitcoin amounted to 9200%.

After that, halving took place in early July of 2016. Compensation for the found transaction block declined from 25 BTC to 12.5 BTC. Once again, halving led to a drop in the supply of bitcoins and affected the price of cryptocurrency. At the time of halving, the market price was $670 for a unit of bitcoin. Within 520 days a bitcoin cost $19,500, which was a new high in its price. This time, halving resulted in 2910% rise in the cost of bitcoin.

Derks, Gordijn, and Siegmann (2018) wrote that market participants engaged in cryptocurrency mining (validation of payments) are forced to sell cryptocurrency in the open market in order to cover the costs (depreciation of equipment, the payment of electricity bills, staff salaries, rent, etc.). Since the level of remuneration for the found transaction block drops twofold every four years, the amount of bitcoins extracted by miners also decreases twofold from cycle to cycle. This results in a lower supply of bitcoins in the open market (Lischke & Fabian, 2016).

The next step of the analysis is to find the net trading result. The net trading result (NTR) refers to the final price value of each interval of time (weekly). In order to find the NTR, we need to detract the weekly closing price from the weekly opening price.

$$NTR = C_p - O_p, \quad (1)$$

where C_p – closing price, O_p – opening price, NTR – net trade result.

This indicator illustrates the historical results of bitcoin price changes within a weekly interval, its positive and negative price data, and price scale.

It is vital to weekly group intervals into periods, which are equal or approximately equal to one month to conduct a successful analysis. When taking historical data into account, we have 425 time intervals (weeks), which equals to 98 periods (months).

In order to achieve results, the next step is to find the average price values $\overline{x}$ for each period grouped earlier, i.e., the sum of all the values for each selected period, divided by the number of values in the selected period.

$$\overline{x} = \frac{x_1 + x_2 + \ldots + x_n}{n} = \sum_{i=1}^{n} \frac{x_i}{n}, \quad (2)$$

where $\sum x_i$ – the sum of all the values for the selected period, n – the number of intervals in the selected period, $\overline{x}$ – the average price value.

Finding data of average price values helps maximize reverse pungent speculative growth and decline of the value of bitcoins in the market. Thus, the effects that halving has on the market value of bitcoins is evident (Table 3).

Table 3. Average price change and bitcoin block remuneration

Source: www.coinmarketcap.com, Thomson Reuters, the author's calculations.

Time period	Average price change per month, US dollars	Block remuneration, bitcoin	Time period	Average price change per month, US dollars	Block remuneration, bitcoin
November 2010	–0.002	50.0	December 2014	–23.13	25.0
December 2010	0.02	50.0	January 2015	–9.20	25.0
January 2011	0.12	50.0	February 2015	8.64	25.0
February 2011	0.01	50.0	March 2015	0.48	25.0
March 2011	–0.03	50.0	April 2015	–5.66	25.0
April 2011	0.55	50.0	May 2015	–2.38	25.0
May 2011	2.69	50.0	June 2015	8.58	25.0
June 2011	–0.28	50.0	July 2015	2.98	25.0
July 2011	–0.55	50.0	August 2015	–8.34	25.0
August 2011	–0.96	50.0	September 2015	–0.59	25.0
September 2011	–0.78	50.0	October 2015	23.24	25.0
October 2011	–0.40	50.0	November 2015	11.68	25.0
November 2011	–0.03	50.0	December 2015	9.23	25.0
December 2011	0.62	50.0	January 2016	–14.89	25.0
January 2012	0.12	50.0	February 2016	7.19	25.0

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Table 3 (cont.). Average price change and bitcoin block remuneration

Time period	Average price change per month, US dollars	Block remuneration, bitcoin	Time period	Average price change per month, US dollars	Block remuneration, bitcoin
February 2012	–0.20	50.0	March 2016	1.79	25.0
March 2012	0.01	50.0	April 2016	8.64	25.0
April 2012	0.05	50.0	May 2016	24.07	25.0
May 2012	0.10	50.0	June 2016	19.36	25.0
June 2012	0.38	50.0	July 2016	–8.94	12.5
July 2012	0.92	50.0	August 2016	–2.38	12.5
August 2012	–0.12	50.0	September 2016	0.30	12.5
September 2012	0.54	50.0	October 2016	19.78	12.5
October 2012	–0.28	25.0	November 2016	15.49	12.5
November 2012	0.40	25.0	December 2016	58.01	12.5
December 2012	0.22	25.0	January 2017	1.43	12.5
January 2013	1.58	25.0	February 2017	64.71	12.5
February 2013	3.34	25.0	March 2017	–44.38	12.5
March 2013	14.31	25.0	April 2017	68.52	12.5
April 2013	4.18	25.0	May 2017	232.69	12.5
May 2013	1.41	25.0	June 2017	–8.50	12.5
June 2013	–7.15	25.0	July 2017	145.76	12.5
July 2013	1.00	25.0	August 2017	347.55	12.5
August 2013	8.75	25.0	September 2017	–56.61	12.5
September 2013	–0.93	25.0	October 2017	597.70	12.5
October 2013	21.61	25.0	November 2017	955.93	12.5
November 2013	186.46	25.0	December 2017	673.93	12.5
December 2013	–11.02	25.0	January 2018	–1135.98	12.5
January 2014	–23.96	25.0	February 2018	818.57	12.5
February 2014	–60.24	25.0	March 2018	–1170.30	12.5
March 2014	–27.78	25.0	April 2018	296.73	12.5
April 2014	–5.21	25.0	May 2018	–479.63	12.5
May 2014	49.04	25.0	June 2018	–345.34	12.5
June 2014	1.44	25.0	July 2018	138.13	12.5
July 2014	–12.62	25.0	August 2018	63.95	12.5
August 2014	–26.91	25.0	September 2018	–172.67	12.5
September 2014	–31.10	25.0	October 2018	–32.64	12.5
October 2014	0.33	25.0	November 2018	–576.89	12.5
November 2014	13.63	25.0	December 2018	–62.08	12.5

3. RESULTS

Having obtained data for average price values, it is possible to build graphs for the visual assessment of halving's influence on the value of bitcoin. For an accurate estimation, two graphs have been presented, because market prices of bitcoin for the period of 2015–2018 are considerably higher than the prices over the period of 2011–2015.

Throughout 2011–2015 (Figure 5) the price peak was reached after 12 periods (12 months) and amounted to $1,150 per BTC. After that, a price correction began.

Throughout 2015–2018 (Figure 6), the price maximum was reached after 16 periods (16 months) and amounted to $19,500 for a BTC. Then price correction started again.

Source: www.coinmarketcap.com, Thomson Reuters, the author's calculations.

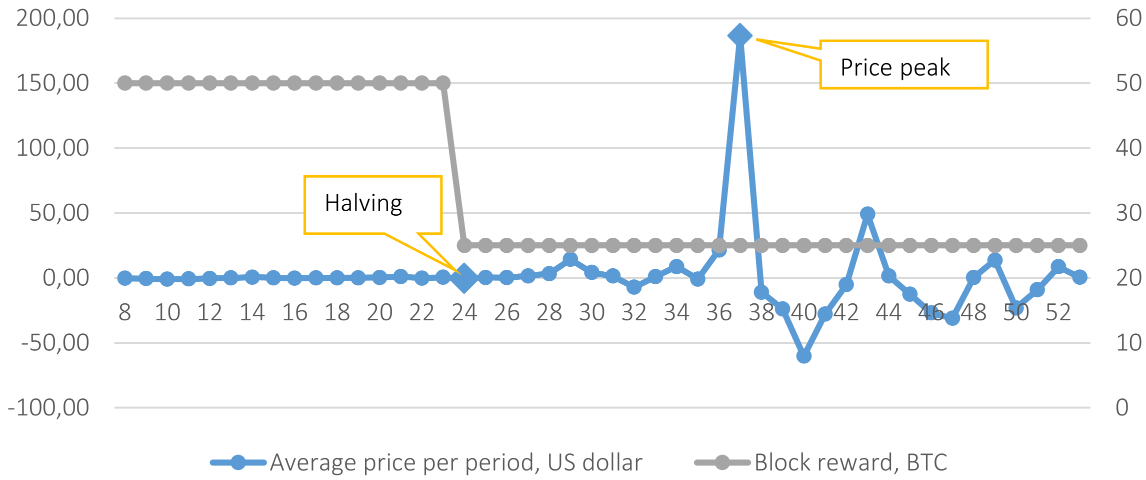

Figure 5. The effect of emission reduction of bitcoins on the price, July 2011 – March 2015

Source: www.coinmarketcap.com, Thomson Reuters, the author's calculations.

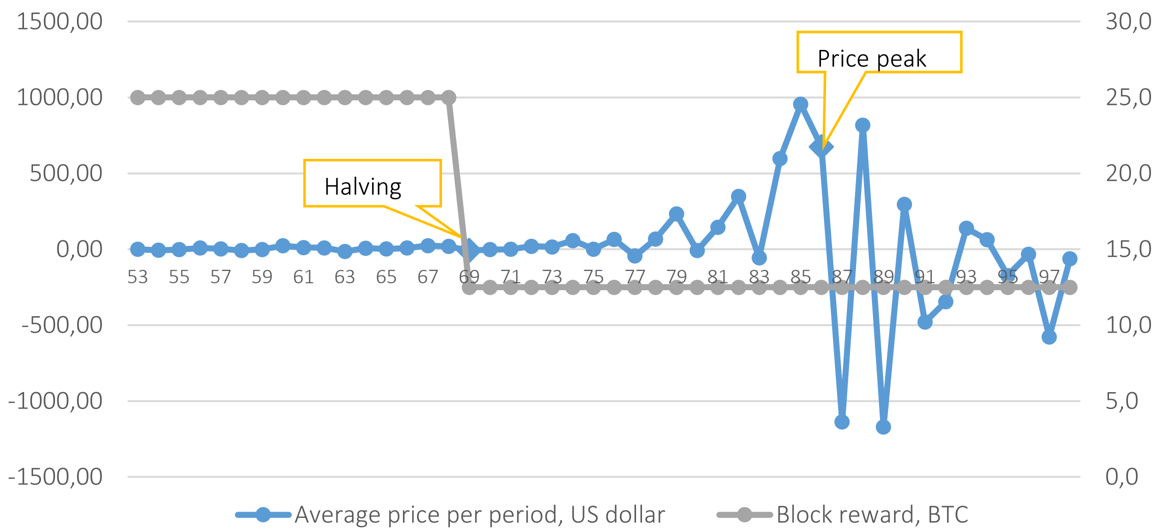

Figure 6. The effect of emission reduction of bitcoins on the price, April 2015 – November 2018

According to the data obtained, it is easy to see that after halving, the price over the next four periods was still at the previous levels in both cases. With the onset of the fifth period, price volatility started to increase. Either way, the market needed an interim period of five months for the onset of reactions to halving.

To validate the impact of halving on the value of bitcoins, the rank correlation coefficient by Kendall was analyzed.

Kendall rank correlation coefficient is calculated by the following principles:

1) comparing each characteristic feature according to their sequence number (ascending, descending);

2) defining differences between ranks;

3) calculating the coefficient correlation according to the formula:

$$\tau = \frac{P - Q}{\frac{1}{2} N(N-1)}, \quad (3)$$

where P – the amount of coincidences, Q – the amount of inversions, N – the number of periods;

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4) calculating the critical point according to the following formula:

$$T_{kp} = z_{kp}\sqrt{\frac{2(2n+5)}{9n(n-1)}}, \quad (4)$$

where n – the sample size, z_{kp} – the critical point of the bilateral area, which can be calculated using the following Laplace function table:

$$\Phi(z_{kp}) = \frac{1-\alpha}{2}, \quad (5)$$

where α – the significance level.

If $|\tau| < T_{kp}$ – the rank correlation between the quality characteristics is insignificant. If $|\tau| > T_{kp}$ – there is a significant rank correlation between the quality of characteristics.

Let us compare every feature and define the difference between ranks (X – is the average price change per month, USD, Y – is the remuneration for the block).

Let us calculate the correlation coefficient:

$$\tau = \frac{3028-1725}{\frac{1}{2}98(98-1)} = 0.27. \quad (6)$$

Let us find the critical point z_{kp}:

$$\Phi(z_{kp}) = \frac{1-0.05}{2} = 0.475. \quad (7)$$

It is possible to execute the following calculations using the Laplace function table: $z_{kp} = 1.96$. Consequently, the critical point is determined by completing these operations:

$$T_{kp} = 1.96\sqrt{\frac{2(2\cdot 98+5)}{9\cdot 98(98-1)}} = 0.13. \quad (8)$$

Let us compare the results: 0.27 > 0.13.

The rank correlation between estimates of two types of data is important because the correlation coefficient $(\tau = 0.27)$ is bigger than the critical point $(T_{kp} = 0.13) - \tau > T_{kp}$. Kendall rank correlation coefficient mathematically confirms the relationship between the changes in remuneration and average price values of bitcoins for the selected 98 periods, which confirms the author's hypothesis.

4. DISCUSSION

Judging from the presented data, bitcoin is fundamentally a more attractive asset than fiat currency. Being an asset, which is less prone to inflation, and assuming that the current price volatility decreases, bitcoin has a chance to become an asset, which the population will use as a storage of value, without the fear of money devaluation through inflation.

Today, or tomorrow, or in 10 years' time, the number of bitcoins in circulation cannot exceed 21 million units. Therefore, over time, the cost of bitcoin, ceteris paribus, should increase by at least the amount of the depreciation of the traditional currencies.

Having an algorithm of remuneration halving in its programme code, the bitcoin system creates a limited supply of new coins, which allows the production of cryptocurrency up to the year 2140, without exceeding the maximum supply of 21 million coins (Nakamoto, 2008).

CONCLUSION

Halving is a technical element, which has a direct impact on the market supply of new coins. Reducing remuneration every four years for each found transaction block, halving simultaneously reduces the overall issuance of new bitcoins twofold, which leads to an increase in the market value of cryptocurrency. Analysis of the effect that halving Bitcoin issuance has for the periods of 2011-2015 and 2015-2018 clearly shows that in both cases, it took the cryptocurrency five months to properly react to the halving that had occurred. The correlation between the level of remuneration from mining and the market price is confirmed by the Kendall rank correlation method. The correlation coefficient (τ = 0.27) is greater than the critical point (T_kp = 0.13), which suggests that the rank correlation between the level of remuneration and the market price is significant. The Kendall method can be used to conduct a comparative analysis of remuneration and market value of other cryptocurrencies.

Although bitcoin was established as a payment system, eliminating intermediaries from the money relationship chain, it is unlikely to become popular among the population as an instrument of payment (Hong, 2016; Ciaian, Rajcaniova, & Kancs, 2016). However, bitcoin is not subject to depreciation as the national currency is, it also does not depend on the control and regulating public bodies. All this makes it a good tool for savings.

The program code of the bitcoin system features an algorithm that cuts the reward from mining in half (halving). Moreover, it creates such a limited supply of new coins that cryptocurrency mining will be possible up until the year 2140, whilst still not exceeding the maximum supply of 21 million coins.

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