

THE DAY-OF-THE-WEEK EFFECT ON THE EXAMPLE OF 82 CRYPTOCURRENCIES

Introduction

Efficient market hypothesis (EMH), introduced by Fama in 1970¹, belongs to the most important paradigms of the traditional financial theories. According to this hypothesis, efficient market was defined as a market with a large numbers of rational individuals, maximizing their profit and actively competing with each other and trying to predict future market value of specific securities, and where all relevant information is freely available to investors².

There are enormous literature investigating calendar effects such us day-of-the-week effect, Month of the year effect, the January effect, the December effect, the Mid-year effect, the Holiday effect, the Halloween effect, which all were analyzed by various researchers³. Calendar effects represent an evidence

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¹ E. Fama, *Efficient capital markets; a review of theory and empirical work*, "Journal of Finance", Vol. 25, 1970, pp. 383-417.

² M. Latif, S. Arshad, M. Fatima, S. Rarooq, *Market efficiency, market anomalies, causes, Evidences and some behavioral aspects of market anomalies*, "Research Journal of Finance and Accounting", Vol. 2, 9-10/2011, pp. 1-14.

³ For example: R. Aggarwal, P. Rivoli, *Seasonal and day-of-the week effects in four emerging stock markets*, "Financial Review", Vol. 24, 1989, pp. 541-550; A. Agrawal, K. Tandon, *Anomalies or illusions?: Evidence from stock markets in eighteen countries*, "Journal of International Money and Finance", Vol. 13, 1994, pp. 83-106; E. Barone, *The Italian stock market: Efficiency and calendar anomalies*, "Journal of Banking and Finance", Vol. 14, 1990, pp. 493-510; D. Boudreaux, *The monthly effect in international stock markets: evidence and implications*, "Journal of Financial and Strategic Decisions", Vol. 8, 1/1995, pp. 15-20; A. Gu, *The declining January effect: Evidence from U.S. equity markets*, "Quarterly Review of Economics and Finance", Vol. 43, 2003, pp. 395-404; K. Kato, S. Schwarz, W. Ziemba, *Day of the weekend effects in Japanese stocks*, "Japanese Capital Markets", Ballinger, New York 1990; W. Schwert, *Anomalies and market efficiency*, "Simon School of Business Working Paper" no. FR 02-13, 2002, pp. 1-15; M. Smirlock, M. Starks, *Day-of-the-week and intraday effects in stock returns*, "Journal of Financial Economics", Vol. 17, 1986, pp. 197-210; P. Sutheebanjard, W. Premchaiswadi, *Analysis of calendar effects: Day-of-the-week effect on the Stock Exchange of Thailand (SET)*, "International Journal of Trade, Economics and Finance", Vol. 1, 2010, pp. 2010-2023.

against Efficient Market Hypothesis. The similar debate is still on the efficiency of cryptocurrency market, and possibility of such calendar effect negates the belief on the efficiency of cryptocurrency market.

The number of scientific research regarding the effectiveness of the cryptocurrency market has been growing. Meanwhile, the analysis involving calendar anomalies is not robust. Kurihara and Fukushima (2017) investigated the day-of-the-week anomaly in Bitcoin rates of return using the logarithmic rates of return and regression model with dummy variables and proved the presence of significant weekend effect⁴. Decourt et al. (2017) using Student t-test and comparing average rates of return on Mondays and on others day of the week, found the Monday returns to be significantly higher⁵.

Previous research focused on the calculation of close-close (C-C) rates of return. This article attempts to fill this gap and takes into consideration other types of rates of return: overnight (close-open, Ov), open-open (O-O) and open-close (O-C). Each of the four analyzed rates of return can be used in the process of building transaction systems.

The purpose of the article is to analyze the occurrence of one of the types of calendar effects, i.e. the day of the week on the example of four types of rates of return of 82 cryptocurrencies (in relation to USD). In the first part, the normal distribution of four types of logarithmic rates of return was proceeded. The second part analyzes the rates of return for individual days of the week. The last part of the paper reveals percentage analysis of cases when rates of return were positive, broken down into: (i) types of prices (C-C, Ov, O-O, O-C) and (ii) days of the week.

Literature review

Caporale and Plastun (2019) taking into account various statistical methods, such as average analysis, Student t-test. The analysis of variance (ANOVA), the Kruskal Wallis test, as well as regression analysis found evidence of Monday effect in Bitcoin, while in other cryptocurrencies, the day-of-the-week-effect was not observed⁶. Durai and Paul (2018) asserted the weekly calendar anomaly found in Bitcoin is responsible for the arguments on market efficiency level of Bitcoin, since weekly effect could bias the estimate of market efficiency⁷.

⁴ Y. Kurihara, A. Fukushima, *The market efficiency on Bitcoin: a weekly anomaly perspective*, "Journal of Applied Finance & Banking", Vol. 7, 3/2017, pp. 57-64.

⁵ F. Decourt, U. Chohan, M. Perugini, *Bitcoin returns and the Monday effect*, "Horizontales Empresariales", Vol. 16, 2017, pp. 4-14.

⁶ G. Caporale, A. Plastun, *The day of the week effect in the cryptocurrency market*, "Finance Research Letters", Vol. 31, 2019, pp. 258-269.

⁷ S. Durai, S. Paul, *Calendar anomaly and the degree of market inefficiency of Bitcoin*, Madras School of Economic Working Paper No. 168/2018, pp. 8-12.

Mbanga (2019) proved the evidence of higher volatility clustering on Fridays Bitcoin returns⁸. Similarly, Ahron and Qadan (2018) analyzing calculating Bitcoin rates of return in the period of 2010-2017 and using the least squares, and volatility modelling, found evidence of weekly anomaly in both returns and volatility bias the estimate the market efficiency⁹. Yaya and Ogbonna (2019) investigating day-of-the-week effect on 13 main cryptocurrencies in the period of 09.08.2015 to 05.01.2019, and applying fractional integration regression approach with dummy variables, discovered that the fractional d dimensions were significant in the following cryptocurrencies: Doge, Ethereum, Maidsafecoin, Ripple, Stellar and Verge implying their market inefficiency. According to the authors there was no day-of-the-week effect on Bitcoin market¹⁰.

Urquhart (2016)¹¹ adopted daily data in order to examine the informational efficiency of Bitcoin during the period from 01.08.2010 to 31.07.2016, analyzing two subperiods and employing statistical tests of Ljung and Box, the run test (Wald and Wolfowitz (1940)¹²), the Bartels test (1982)¹³, the variance ration of Lo and MacKinlay (1988)¹⁴, the wild bootstrapped test of Kim (2009)¹⁵, the BDS test proposed by Brock et al. (1996)¹⁶ and the Hurst exponent (1951)¹⁷. The author proved the Bitcoin market to be no efficient. Nadarajah and Chu (2017) taking into consideration Bitcoin data from 01.08.2010 to 31.07.2016, dividing the sample into two subperiods (01.08.2010-21.07.2013 and 01.08.2013 -31.07.2016) and implementing eight different statistical test, found no evidence of inefficiency of analyzed cryptocurrency¹⁸.

⁸ C. Mbanga, *The day-of-the-week patterns of price clustering in Bitcoin*, "Applied Economics Letters", Vol. 10, 26/2019, pp. 807-811.

⁹ D. Ahron, M. Qadan, *Bitcoin and the day-of-the-week effect*, "Finance Research Letters", 2018, 10.1016/j.frl.2018.12.004, pp. 1-25.

¹⁰ O. Yaya, A. Ogbonna, *Do we expect day-of-the-week effect in returns and volatility of cryptocurrency?*, MPRA Paper No. 91429, 2019, pp. 1-8.

¹¹ A. Urquhart, *The inefficiency of Bitcoin*, "Economics Letters", Vol. 148, 2016, pp. 80-82.

¹² A. Wald, J. Wolfowitz, *On a test whether two samples are from the same population*. "Annals of Mathematical Statistics", Vol. 11, 1940, pp. 147-162.

¹³ R. Bartels, *The rank version of von Neumann's ratio test for randomness*, "Journal of the American Statistical Association", Vol. 77, 1982, pp. 40-46.

¹⁴ A. Lo, C. MacKinlay, *Stock market process do not follow random walks: evidence form a simple specification test*, "Review of Financial Studies", Vol. 1, 1988, pp. 41-66.

¹⁵ J. Kim, *Automatic variance ratio test under conditional heteroscedasticity*, "Finance Research Letters", Vol. 6, 2009, pp. 179-185.

¹⁶ W. Brock, J. Scheinkman, W. Dechert, B. LeBaron., *A test for independence based on the correlation dimension*, "Econometric Reviews", Vol. 15, 1996, pp. 197-235.

¹⁷ H. Hurst, *Long-term storage capacity of reservoirs*, "Transactions of the American Society of Civil Engineers", Vol. 116, 1951, pp. 770-799.

¹⁸ S. Nadarajah, J. Chu, *On the efficiency of Bitcoin*, "Economics Letters", Vol. 160, 2017, pp. 6-9.

Bariviera et al. (2018) based on the daily data covering the period of 18.08.2011 to 15.02.2017, studying long-range dependence of Bitcoin, returns and volatility, employing the Hurst exponent by using Detrended Fluctuation Analysis (DFA) and overlapping sliding windows, concluded that during the 2011-2014 period, Bitcoin's exhibited persistence, but after 2014 the tendency toward efficiency was observed¹⁹. Aggarwal (2019) examined efficiency of Bitcoin markets by employing daily prices from the period 19.07.2010 to 20.03.2018 and using serial correlation coefficient test, unit root tests and ARCH test, proved the analyzed cryptocurrency to be inefficient²⁰.

Caporale et al. (2018) employed daily data concerning the four cryptocurrencies with the highest market capitalization (Bitcoin, Litecoin, Ripple, Dash) for the biggest time span possible up to 2017²¹. The used methodology based on the R/S Hurst analysis and fractional integration. Results indicated that the level of persistence was not stable over time, especially in case of such cryptocurrency as Litecoin. According to the Hurst exponents, Bitcoin, Litecoin as well as Dash resulted to be more efficient, whereas Ripple was not.

Kaiser (2019) used the daily data for Bitcoin, Bitcoin Cash, Cardano, Dash, Ethereum, IOTA, Litecoin, NEO, Ripple and Monero in order to examine seasonality patterns in their returns, volatility, trading volume and a spread estimator, testing for (i) the Monday effect, (ii) the weekend effect, (iii) the January effect, (iv) the turn-of-the month effect and (v) Halloween effect²². The author proved that the Monday and reverse January effects were presented on the Bitcoin market.

Data and methods

The research is divided into three parts. The calculation were proceeded concerning 82 cryptocurrencies (see Appendix 1). The data comes from the stooq.pl website. All cryptocurrencies were quoted at least over the horizon from 18.01.2018 to 31.12.2019. i.e. approx. 2 years. For other cryptocurrencies, the available data covered a shorter time horizon, therefore they were not included in the analysis. The last session considered in the process of calculating rates of return was 31.12.2019.

¹⁹ A. Bariviera, M. Basgall, W. Hasperue, M. Naiouf, *Some stylized facts of the Bitcoin market*, "Physica A: Statistical Mechanics and Its Applications", Vol. 494, 2017, pp. 82-90.

²⁰ D. Aggarwal, *Do Bitcoins follow a random walk model?*, "Research in Economics", Vol. 73, 2019, pp. 15-22.

²¹ G. Caporale, L. Gil-Alana, A. Plastun, *Persistence in the cryptocurrency market*, "Research in International Business and Finance", Vol. 46, 2018, pp. 141-148.

²² L. Kaiser, *Seasonality in cryptocurrencies*, "Finance Research Letters", Vol. 31, 2019, pp. 232-238.

The paper consist of three parts:

In the first part, the test for normality of returns distribution will be exemplified with the use of the Jarque-Barre test.

In the second part, the test for equality of two average rates of return will be executed for rates of return in two populations. Assuming, that if the first population is composed of the rates of return calculated for the session on the specific day of a week (e.g. Monday) , then the second population determines the rates of return for all remaining sessions (e.g. from Tuesday until Sunday). The study in the second part of the article was conducted with the use of the Kruskal-Wallis parametric test.

In case of two populations, the null hypothesis H_0 and alternative hypothesis H_1 regarding equality of rates of return in two populations, can be formulated as follows:

$$\begin{aligned} H_0: E(\bar{r}_1) &= E(\bar{r}_2) \\ H_1: E(\bar{r}_1) &\neq E(\bar{r}_2) \end{aligned} \quad (1)$$

where:

\bar{r}_1 –average rate of return in the first population,

\bar{r}_2 –average rate of return in the second population

The Kruskal-Wallis test statistics is given by formula²³:

$$H = \frac{12}{N(N+1)} \sum_{i=1}^g n_i \bar{r}_i^2 - 3(N+1) \quad (2)$$

where:

N – total number of observations across all groups,

$\bar{r}_i = \frac{\sum_{j=1}^{n_i} r_{ij}}{n_i}$ – average rank of all observations in group i ,

n_i – number of observation in group i ,

r_{ij} – the rank (among all observations) of observation j from group i ,

g – number of observations groups.

In all analyzed cases, the p -values will be calculated. If the p -value is less than or equal to 0.05, then the hypothesis H_0 is rejected in favor of the hypothesis H_1 . Otherwise, there is no reason to reject hypothesis H_0 .

For each of the analyzed cryptocurrencies the following logarithmic rates of return will be calculated:

- a) Close – Close (C-C, last session close vs previous session close),

²³ A. Vargha, H. Delaney, *Kruskal-Wallis test and stochastic homogeneity*, “Journal of Educational and Behavioral Statistics”, Vol. 23, 2/1998, pp. 170-192.

- b) Overnight (Ov, last session open vs previous session close),
- c) Open – Open (O-O, last session open vs previous session open),
- d) Open – Close (O-C, last session close vs last session open).

The third part contains analysis of percentage when a given type of returns was positive (or negative) for each cryptocurrency and day of the week. Then, a summary statement was created for different days of the week and different types of returns.

Results

The analysis of normal distribution of rates of return

The analysis of the distribution of normality of returns for individual cryptocurrencies clearly proved, that for most of the analyzed cases the null hypothesis was rejected in favor of the alternative hypothesis – see Table 1. The lowest rejection rate of the null hypothesis (82.93%) was registered for Wednesday C-C returns. In turn, the highest percentage (100.00%) occurred for particular days of the week and concerned overnight rates.

Table 1. **The number and percentage of cases when the null hypothesis regarding the normality of returns distribution was rejected**

| Day of the week | Monday | | | | Tuesday | | | | Wednesday | | | | Thursday | | | |
|---|--------|--------|-------|-------|---------|--------|-------|-------|-----------|--------|-------|-------|----------|--------|-------|-------|
| | C-C | Ov | O-O | O-C | C-C | Ov | O-O | O-C | C-C | Ov | O-O | O-C | C-C | Ov | O-O | O-C |
| Rate of return | | | | | | | | | | | | | | | | |
| Number of cases of rejection of the null hypothesis | 81 | 82 | 78 | 81 | 81 | 82 | 81 | 78 | 68 | 82 | 78 | 72 | 78 | 82 | 70 | 81 |
| Percentage of cases when the null hypothesis was rejected | 98.78 | 100.00 | 95.12 | 98.78 | 98.78 | 100.00 | 98.78 | 95.12 | 82.93 | 100.00 | 95.12 | 87.80 | 95.12 | 100.00 | 85.37 | 98.78 |

| Day of the week | Friday | | | | Saturday | | | | Sunday | | | |
|---|--------|--------|-------|-------|----------|--------|-------|-------|--------|--------|-------|-------|
| | C-C | Ov | O-O | O-C | C-C | Ov | O-O | O-C | C-C | Ov | O-O | O-C |
| Rate of return | | | | | | | | | | | | |
| Number of cases of rejection of the null hypothesis | 79 | 82 | 81 | 80 | 82 | 82 | 80 | 81 | 78 | 82 | 81 | 78 |
| Percentage of cases when the null hypothesis was rejected | 96.34 | 100.00 | 98.78 | 97.56 | 100.00 | 100.00 | 97.56 | 98.78 | 95.12 | 100.00 | 98.78 | 95.12 |

C-C: close-Close, Ov: Overnight, O-O: Open-Open, O-C: Open-Close.

Source: own calculations.

The null hypothesis was not rejected for the following cryptocurrencies (*p-value* shown in parenthesis):

A) Close-close returns:

1. Monday: Byte Coin (0.3038);
2. Tuesday: ByteBall Bytes (0.0898);
3. Wednesday: Aion (0.4308), Ark (0.7227), Bitcoin Gold (0.1363), ByteBall Bytes (0.3061), Chain Link (0.2795), Factom (0.4083), Gas (0.1385), Loopring (0.0591), Nebulas (0.5818), Neo (0.0991), Populous (0.1634), Qash (0.1237), Quantstamp, (0.6001), Wax (0.8856);
4. Thursday: Enigma (0.2662), Gxshares (0.0978), Quantstamp (0.6674), Request Network (0.0510);
5. Friday: Basic Attention (0.0823), Kuvoin (0.1671), Partici (0.2512);
6. Sunday: Aion (0.5892), Dent (0.2358), Partici (0.4680), Rchain (0.0550).

B) Open-open returns:

1. Monday: Aion (0.8087), Dent (0.1110), Nebio (0.1105), Partici (0.7731);
2. Tuesday: Byte Coin (0.1318);
3. Wednesday: Aion (0.4595), ByteBall Bytes (0.7928), Quantstamp (0.2266), Salt, (0.0896);
4. Thursday: Binance (0.0517), Bitcoin Gold (0.1224), ByteBall Bytes (0.7605), Chain Link (0.1409), Cindicator (0.0906), Factom (0.7732), Gas (0.1277), Nebulas (0.3725), Neo (0.1043), Populous (0.6892), Quantstamp (0.7943), Wax (0.6334);
5. Friday: Nebuls (0.1699);
6. Saturday: Dragon Chain (0.0550), Partici (0.4252);
7. Sunday: Bancor (0.5078).

C) Open-close returns:

1. Monday: Byte Coin, (0.0318);
2. Tuesday: Aion (0.7833), Ark (0.1940), Basic Attention (0.2156), ByteBall Bytes (0.6802);
3. Wednesday: Aelf (0.1004), Aion (0.4113), Ark (0.1008), Bitcoin Gold (0.1221), ByteBall Bytes (0.0948), Nebulas (0.6406), Neo (0.0979), Populous (0.5451), Qash (0.1183);
4. Thursday: Nebulas (0.2255);
5. Friday: Kucoin, (0.0687), Partici (0.2913);
6. Saturday: Enigma (0.7672);
7. Sunday: Aion (0.6466), Dent (0.1019), Neblio (0.3570), Partici (0.1527).

Due to the fact that the distribution of return rates, for the majority of cryptocurrencies, is not normal, in the second part of the research the Kruskal-Wallis test was chosen to verify statistical hypotheses.

The analysis of day-of-the-week effect

The null hypothesis regarding equality of two average rates of return was rejected for the following cryptocurrencies (*p-value* shown in parenthesis):

A) Close-close:

1. Monday: Aelf (0.0269), Aion (0.0026), Icon (0.0241), Rchain (0.0159);
2. Tuesday: Partici (0.0499);
3. Wednesday: Factom (0.0074), Tenx (0.0307);
4. Thursday: Ardor (0.0135), Bitcoin Cash (0.0168), Cardano (0.0066), Dent (0.0122), Dragon Cash (0.0064), Iconomi (0.0093), Iostoken (0.-391), Nxt (0.0049), Populous (0.0063), Power Ledger (0.0311), Qtum (0.0230), Status (0.0431), TrueUSD (0.0048), Waves (0.0474);
5. Friday: Dent (0.0119);
6. Saturday: Aeternity (0.0024), Aion (0.0004), Ardor (0.0250), Augur (0.0356), Bancor (0.0087), Binance (0.0171), Bitcoin Cash (0.0208), Bitshares (0.0270), ByteBall Bytes (0.0060), Cardano (0.0032), Chaina Link (0.0191), Decred (0.0128), Factom (0.0365), Gxshares (0.0051), Komodo (0.0070), Loopring (0.0155), Medibloc (0.0410), Nebulas (0.0246), Neo (0.0357), Nxt (0.0067), Partici (0081), Pivx (0.0269), Populous (0.0078), Power Ledger (0.0024), Qash (0.0024), Quanstam (0.0034), Rchain (0.0046), ReddCoin (0.0050), Request Network (0.0277), Salt (0.0031), Steem (0.0002), Straits (0.0012), SysCoin (0.0004), Walton (0.0003), Waves (0.0026);
7. Sunday: Icon (0.0177), Rchain (0.0112), Smart Cash (0.0432), Tether (0.0239).

B) Overnight:

1. Thursday: Funfair (0.0452), Maker (0.0396), Walton (0.0173);
2. Friday: DigiByte (0.0244), Rchain (0.0496);
3. Saturday: Aion (0.0481), Dent (0.0263), Ethereum Classic (0.0439), Smart Cash (0.0105).

C) Open-Open:

1. Monday: Ardor (0.0405), Funfair (0.0303), Icon (0.0135), Smart Cash (0.0369);
2. Tuesday: Aelf (0.0388), Aion (0.0228), Funfair (0.0215), Komodo (0.0419), Qash (0.0327), Rchain (0.0360), ReddCoin (0.0250);

3. Thursday: Factom (0.0356), Tenx (0.0212);
4. Friday: Ardor (0.0045), Bitcoin Cash (0.0159), Cardano (0.0059), Dent (0.134), Dragon Chain (0.0148), Funfair (0.0239), Ionomi (0.0030), Populous (0.0125), Qtum (0.0259), TrueUSD (0.0115), Waves (0.0384);
5. Saturday: Dent (0.0040), Hshares (0.0327);
6. Sunday: Aeternity (0.0066), Aion (0.0020), Bancor (0.0284), Bitcoin Cash (0.0218), ByteBall Bytes (0.0099), Cardano (0.0020), Chain Link (0.0318), Gxshares (0.0201), Komodo (0.0150), Loopring (0.0340), Neo (0.0208), Nxt (0.0322), Partici (0.0166), Pivx (0.0222), Populous (0.0214), Power Ledger (0.0077), Qash (0.0029), Quanstamp (0.0096), Rchain (0.0126), ReddCoin (0.0136), Salt (0.0034), Steem (0.0011), Straits (0.0006), SysCoin (0.0008), Walton (0.0036), Waves (0.0063).

D) Open-Close:

1. Monday: Aelf (0.0379), Aion (0.0027), Hshares (0.0304), Icon (0.0210), Komodo (0.0407), Nexus (0.0486), Qash (0.0347), Rchain (0.0347), ReddCoin (0.0350);
2. Wednesday: Factom (0.0094), Tenx (0.0235);
3. Thursday: Ardor (0.0079), Bitcoin Cash (0.0161), ByteCoin (0.0485), Cardano (0.0055), Dent (0.0132), Dragon Chain (0.0104), Funfair (0.0289), Ionomi (0.0085), Iostoken (0.0414), Populous (0.0101), Qtum (0.0162), TrueUSD (0.0133), Waves (0.0483);
4. Friday: Dent (0.0122), Hsahres (0.0416);
5. Saturday: Aeternity (0.0021), Aion (0.0009), Ardor (0.0185), Augur (0.0403), Bancor (0.0040), Binance (0.0238), Bitcoin Cash (0.0208), Bitshares (0.0262), ByteBall Bytes (0.0036), Cardano (0.0031), Chain Link (0.0213), DecRed (0.0032), Gxshares (0.0099), Komodo (0.0035), Loopring (0.0175), Neo (0.0336), NXT (0.0105), Parici (0.0067), Pivx (0.0195), Populous (0.0089), Power Ledger (0.0027), Qtum (0.0022), Quantstamp (0.0043), Rchain (0.0089), Reddcoin (0.0177), Salt (0.0027), Steem (0.0002), Straits (0.0012), Syscoin (0.0002), Walton (0.0006), Waves (0.0045);
6. Sunday: Icon, (0.0106), Rchain (0.0089), SiaCoin (0.0405), SmartCash (0.0389), Tether (0.0229).

A summary list of cases where the null hypothesis was rejected is presented in Table 2.

Table 2. The number and percentage of cases when the null hypothesis regarding the day-of-the-week was rejected

| Day of the week | Monday | | | | Tuesday | | | | Wednesday | | | | Thursday | | | |
|-----------------|--------|------|------|-------|---------|------|------|------|-----------|------|------|------|----------|------|------|-------|
| | C-C | Ov | O-O | O-C | C-C | Ov | O-O | O-C | C-C | Ov | O-O | O-C | C-C | Ov | O-O | O-C |
| Rate of return | | | | | | | | | | | | | | | | |
| Number of cases | 4 | 0 | 4 | 9 | 1 | 0 | 7 | 0 | 2 | 0 | 0 | 2 | 15 | 3 | 2 | 14 |
| Percentage | 4.88 | 0.00 | 4.88 | 10.98 | 1.22 | 0.00 | 8.54 | 0.00 | 2.44 | 0.00 | 0.00 | 2.44 | 18.29 | 3.66 | 2.44 | 17.07 |

| Day of the week | Friday | | | | Saturday | | | | Sunday | | | |
|-----------------|--------|------|-------|------|----------|------|------|-------|--------|------|-------|------|
| | C-C | Ov | O-O | O-C | C-C | Ov | O-O | O-C | C-C | Ov | O-O | O-C |
| Rate of return | | | | | | | | | | | | |
| Number of cases | 1 | 2 | 12 | 2 | 35 | 4 | 2 | 31 | 4 | 0 | 26 | 5 |
| Percentage | 1.22 | 2.44 | 14.63 | 2.44 | 42.68 | 4.88 | 2.44 | 37.80 | 4.88 | 0.00 | 31.71 | 6.10 |

C-C: close-Close, Ov: Overnight, O-O: Open-Open, O-C: Open-Close.

Source: own calculations.

The highest number of rejections of the null hypothesis was recorded during the weekend, and the lowest for working days – see Table 3.

Table 3. The highest and the lowest numbers and percentage of cases when the null hypothesis regarding the day-of-the-week was rejected for different types of returns

| Number and percentage of cases when the null hypothesis was rejected | | | | |
|--|-----------------|------------------------------------|-----------|----------|
| Rate of return | C-C | Ov | O-O | O-C |
| Max | 42.68% | 4.88% | 31.71% | 37.80% |
| Min | 1.22% | 0.00% | 0.00% | 0.00% |
| Day of the week with the highest and lowest percentage of the null hypothesis rejections | | | | |
| Rate of return | C-C | Ov | O-O | O-C |
| Max | Saturday | Saturday | Sunday | Saturday |
| Min | Tuesday, Friday | Monday, Tuesday, Wednesday, Sunday | Wednesday | Tuesday |

C-C: close-Close, Ov: Overnight, O-O: Open-Open, O-C: Open-Close.

Source: own calculations.

Table 4. The highest percentage of rejections of the null hypothesis, where the main criterion for division is the type of interest rate (C-C, Ov, O-O and O-C)

| Rate of return | C-C | Ov | O-O | O-C | Total (all rates of return) |
|----------------|--------|--|---------|--------|-----------------------------|
| Percentage | 42.86% | 14.29% | 42.86% | 42.86% | 32.14% |
| Cryptocurrency | Rchain | Aion, Dent, Digibyte, Ethereum, Funfair, Maker, Rchain, Status, Walton | Funfair | Rchain | Rchain |

C-C: close-Close, Ov: Overnight, O-O: Open-Open, O-C: Open-Close.

Source: own calculations.

Table 4 contains the name of the cryptocurrency with the highest percentage of cases when the null hypothesis was rejected, broken down into four types of returns. On its basis, it can be concluded that this situation occurred most often for Rchain, before Funfair. The percentage of rejection of the null hypothesis for C-C returns, cumulated for all week days was the highest in the case of Rchain and equal to 42.86%. The same result was obtained in the case of O-O rates and O-C rates for Funfair and Rchain, respectively. The lowest one (14.29%) was registered for Ov returns in case of the following cryptocurrencies: Aion, Dent, Digibyte, Ethereum, Funfair, Maker, Rchain, Status, Walton. In other words, it can be stated that taking into consideration cumulated percentage of null hypothesis rejection for a specific type of return, the day-of-the-week effect was most common for Rchain and Funfair.

The analysis percentage of cases when the rate of return was positive

The analysis of cases when the percentage of positive returns for cryptocurrencies and days of the week was greater than 60% (Appendix 2), clearly indicates the accumulation of such results over the weekend. For all types of rates of return (except for C-C on Sunday), this percentage was greater than zero. On business days, most often one type of rate of return (Tuesday: Ov, Wednesday: Ov and Thursday: Ov) or at most two types of returns (Monday: Ov and O-O) were recorded, when the percentage was greater than 60%. The exception was Friday, when for three types of rates of return (C-C, Ov and O-C), the percentage of positive rates of return was higher than 60%. The situation is quite different when the percentage of positive returns is lower than 40%. For each analyzed day, e.g. business day or weekend and each type of returns, this percentage was greater than 0% but lower than 40%. By analogy, it can conclude for negative rates of return.

In Appendix 3, the names of cryptocurrencies, as well as the highest and lowest values of the occurrence of positive rates of return for each day and each type of returns are displayed. The incidence of positive returns was higher than 60% for following cases (the name of the cryptocurrency and percentage in brackets):

- a) Monday: Ov (EOS - 60.00%) and O-O (Ardcor - 61.31%);
- b) Tuesday: Ov (Neo - 3.64%);
- c) Wednesday: C-C (TrueUSD - 60.00%) and Ov (OmiseGo - 70.00%);
- d) Thursday: Ov (Waves - 66.67%);
- e) Friday: C-C (Mediblock - 60.08%), Ov (TrueUSD - 80.00%) and C-C (Mediblock - 61.78%);

- f) Saturday: C-C (Power Ledger - 63.39%), Ov (Tether - 80.00%), O-O (Mediblock - 61.51%) and O-C (Bancor - 62.81%);
- g) Sunday: Ov (Reddcoin - 75.00%), O-O (Loopring - 63.03%).

In turn, a frequency lower than 30% was found only for Ov rates of return for the following days (the name of the cryptocurrency and percentage in brackets): Monday (Tether – 12.50%), Wednesday (Dentacoin - 25.00%), Thursday (TrueUSD – 25.00%) and Sunday (Bytecoin - 27.27%). For the other days of the week, this frequency oscillated in the range between 20% and 30%. Similar conclusions can be made for negative rates of return.

In turn, the highest and lowest frequencies of positive rates for each type of returns and indication of the day of the week and the cryptocurrency, are collected in Table 5.

Table 5. The highest and lowest frequencies of positive returns for various types of returns

| Rate of return | C-C | Ov | O-O | O-C |
|----------------------------|-----------------|---------------|----------------|-----------------|
| Day of the week | Saturday | Friday | Sunday | Saturday |
| The highest frequency | 63.39% | 80.00% | 63.03% | 62.81% |
| Name of the cryptocurrency | Power Ledger | TrueUSD | Loopring | Bancor |
| Day of the week | Thursday | Monday | Tuesday | Thursday |
| The lowest frequency | 30.19% | 12.50% | 31.07% | 30.19% |
| Name of the cryptocurrency | Dragon Chain | Tether | Rchain | Dragon Chain |

C-C: close-Close, Ov: Overnight, O-O: Open-Open, O-C: Open-Close.

Source: own calculations.

The highest frequencies for individual types of prices tend to accumulate around the weekend: two times Saturdays: C-C (Power Ledger) and O-C (Bancor), once Sunday (Loopring - O-O) and Friday (TrueUSD - Ov). In turn, the lowest frequencies are characteristic for Thursdays (two times: C-C and O-C, both times Dragon Chain), Tuesdays (Rchain - O-O) and Mondays (Tether - Ov).

The conclusions obtained in the section regarding the analysis of the maximum and minimum frequencies of positive returns are in line with the conclusions regarding the efficiency effected for each day of the week.

Conclusions

The most important conclusions drawn from the conducted research may be formulated as follows:

- 1) The occurrence of inefficiency on cryptocurrency market was found for different cryptocurrencies, for different days of the week and different types of return rates (C-C, Ov, O-C and O-O).
- 2) The least number of inefficiency cases were recorded for Overnight (Ov) returns, while far more inefficiencies occurred around the weekdays (Saturday, Sunday), but also on Fridays.
- 3) For the following 26 cryptocurrencies, no ineffectiveness was found for any of the type of analyzed returns and any day of the week: Ark, Basic Attention, Bitcoin, Bitcoin Gold, Cindicator, Dash, Denta Coin, Digixdao, Dogecoin, Electroneum, Enigma, EOS, Ethereum, Gas, Gnosis, Golem, Kucoin, Kyber Network, Lisk, Litecoin, Maidsafecoin, Monacoin, Neblio, OmiseGo, Tron, Wax.
- 4) In the case of Bitcoin, for all types of analyzed returns, no ineffectiveness was found on any of the days of the week.
- 5) The largest number of rejections of the null hypothesis took place for the following cryptocurrencies (regardless of the type of return): Aelf, Aeternity and Aion. In other words, they can be considered the least effective.
- 6) In turn, based on the type of return, the least effective cryptocurrencies were: Rchain before Funfair.
- 7) For several cryptocurrencies, the percentage of positive returns was clearly greater than 60% or lower than 40%.

The obtained results regarding efficiency of the Bitcoin confirm the conclusions presented in the following research: Nadarajah and Chu (2017)²⁴, Caporale et al. (2018)²⁵ and Yaya and Ogbonna (2018)²⁶. The results introduced in this paper contradict the conclusions revealed in the following articles: Caporale and Plastun (2018)²⁷, Durai and Paul (2018)²⁸, Aharon and Qadan (2018)²⁹, Urquhart (2016)³⁰ and Aggarwal (2019)³¹. For some cryptocurrencies, the obtained results confirm,

²⁴ S. Nadarajah, *On the...*, op. cit., pp. 6-9.

²⁵ G. Caporale, *Persistence in...*, op. cit., pp. 141-148.

²⁶ O. Yaya, *Do we...*, op. cit., pp. 8-12.

²⁷ G. Caporale, A. Plastun, *The day ...*, op. cit., pp. 258-269.

²⁸ S. Durai, S. Paul, *Calendar anomaly...*, op. cit., pp. 8-12.

²⁹ D. Ahron, *Bitcoin and...*, op. cit., pp. 1-25.

³⁰ A. Urquhart, *The inefficiency...*, op. cit., pp. 80-82.

³¹ D. Aggarwal, *Do Bitcoins...*, op. cit., pp. 15-22.

but for other cryptocurrencies they deny the conclusions presented in the paper of Decourt et al. (2017)³².

The results exposed in the paper can be used to create an investment strategy based on the inefficiencies of analyzed cryptocurrencies. The limitation of the study is the use of the available, relatively short investment horizon. Similar studies can be proceeded for exchange rates of one cryptocurrency for another, and not, as in this article, cryptocurrency exchange rates to USD.

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³² F. Decourt, *Bitcoin returns...*, op. cit., pp. 4-14.

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Appendix 1. Analyzed cryptocurrencies and obtained *p-values* for Kruskal-Wallis parametric test. *P-value* less than 0.05 in italics

| Cryptocurrency | First date | Monday | | | Tuesday | | | Wednesday | | | Thursday | | | Friday | | | Saturday | | | Sunday | | | | | | | | | |
|-----------------|------------|--------|--------|--------|---------|--------|--------|-----------|--------|--------|----------|--------|--------|--------|--------|--------|----------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| | | C.C. | Ov. | O.O. | C.C. | Ov. | O.O. | C.C. | Ov. | O.O. | C.C. | Ov. | O.O. | C.C. | Ov. | O.O. | C.C. | Ov. | O.O. | C.C. | Ov. | O.O. | | | | | | | |
| Aelf | 05.01.2018 | 0.0269 | 0.1532 | 0.6838 | 0.0379 | 0.6530 | 0.6601 | 0.0388 | 0.7298 | 0.9486 | 0.8100 | 0.7314 | 0.9755 | 0.9447 | 0.1730 | 0.8036 | 0.8608 | 0.4921 | 0.2442 | 0.7735 | 0.6230 | 0.1296 | 0.0748 | 0.3477 | 0.2442 | 0.5321 | 0.9460 | 0.2650 | 0.5149 |
| Aerinity | 30.05.2017 | 0.1920 | 0.5182 | 0.2196 | 0.1218 | 0.3449 | 0.5266 | 0.0880 | 0.0439 | 0.9696 | 0.6991 | 0.6966 | 0.9065 | 0.1777 | 0.6319 | 0.0038 | 0.1194 | 0.9229 | 0.9568 | 0.1406 | 0.9355 | 0.0624 | 0.6055 | 0.8790 | 0.0021 | 0.4500 | 0.2850 | 0.0666 | 0.2691 |
| Aion | 05.01.2018 | 0.0926 | 0.6226 | 0.6589 | 0.0927 | 0.3099 | 0.3351 | 0.0928 | 0.4055 | 0.7172 | 0.1272 | 0.5572 | 0.6008 | 0.7113 | 0.5857 | 0.5585 | 0.7644 | 0.2884 | 0.0558 | 0.8985 | 0.3654 | 0.0994 | 0.0481 | 0.3056 | 0.0099 | 0.7894 | 0.1594 | 0.0920 | 0.5933 |
| Akash | 15.10.2016 | 0.8803 | 0.2221 | 0.0405 | 0.7377 | 0.8019 | 0.8184 | 0.8077 | 0.8003 | 0.4000 | 0.7498 | 0.7755 | 0.8537 | 0.0132 | 0.9893 | 0.5746 | 0.0079 | 0.0743 | 0.3312 | 0.0045 | 0.1379 | 0.0250 | 0.9153 | 0.1708 | 0.0185 | 0.2441 | 0.2479 | 0.0531 | 0.1024 |
| Ark | 22.03.2017 | 0.5541 | 0.3571 | 0.3923 | 0.3454 | 0.3342 | 0.5129 | 0.2699 | 0.8005 | 0.9696 | 0.6172 | 0.5661 | 0.8417 | 0.3333 | 0.6303 | 0.8710 | 0.1679 | 0.1188 | 0.9036 | 0.1127 | 0.0626 | 0.2165 | 0.8634 | 0.0665 | 0.1911 | 0.8634 | 0.2563 | 0.3364 | 0.5955 |
| Augur | 04.10.2016 | 0.5340 | 0.7821 | 0.7228 | 0.5896 | 0.4215 | 0.4661 | 0.7409 | 0.8422 | 0.8668 | 0.7103 | 0.5689 | 0.8623 | 0.3416 | 0.9224 | 0.8756 | 0.3404 | 0.3449 | 0.9896 | 0.3403 | 0.3486 | 0.0576 | 0.6516 | 0.4133 | 0.0403 | 0.5416 | 0.2864 | 0.0671 | 0.7677 |
| Bancor | 15.07.2017 | 0.1340 | 0.5992 | 0.5668 | 0.1546 | 0.8233 | 0.3423 | 0.0895 | 0.8612 | 0.8912 | 0.1257 | 0.4025 | 0.3330 | 0.6951 | 0.2047 | 0.9547 | 0.5087 | 0.1804 | 0.3430 | 0.3088 | 0.3677 | 0.0057 | 0.2996 | 0.2690 | 0.0040 | 0.8071 | 0.1812 | 0.0284 | 0.4984 |
| Basic Attention | 01.06.2017 | 0.9837 | 0.5774 | 0.6941 | 0.8276 | 0.5130 | 0.5481 | 0.7029 | 0.6560 | 0.4189 | 0.9757 | 0.7613 | 0.4122 | 0.5849 | 0.6517 | 0.5481 | 0.4502 | 0.4022 | 0.9707 | 0.3146 | 0.3718 | 0.1042 | 0.6150 | 0.2687 | 0.1312 | 0.8065 | 0.1787 | 0.2791 | 0.8781 |
| Bitcoin | 08.09.2017 | 0.4639 | 0.4781 | 0.2393 | 0.5852 | 0.6901 | 0.1975 | 0.9164 | 0.9671 | 0.2224 | 0.4720 | 0.7319 | 0.1130 | 0.4683 | 0.6524 | 0.0987 | 0.6047 | 0.3018 | 0.6349 | 0.7825 | 0.3120 | 0.0771 | 0.4275 | 0.4088 | 0.0238 | 0.0846 | 0.4197 | 0.0598 | 0.1277 |
| Bitcoin Cash | 17.07.2010 | 0.9566 | 0.2980 | 0.5363 | 0.9661 | 0.4929 | 0.6880 | 0.9661 | 0.4938 | 0.4182 | 0.2043 | 0.5094 | 0.4159 | 0.3000 | 0.1549 | 0.4049 | 0.2984 | 0.8004 | 0.2060 | 0.2985 | 0.7973 | 0.8338 | 0.2061 | 0.7292 | 0.8383 | 0.5483 | 0.4397 | 0.8292 | 0.5462 |
| Bitcoin Gold | 01.08.2017 | 0.0644 | 0.1302 | 0.2598 | 0.0667 | 0.8062 | 0.2243 | 0.0660 | 0.8902 | 0.4881 | 0.4975 | 0.8597 | 0.8447 | 0.0165 | 0.1715 | 0.4719 | 0.0167 | 0.2519 | 0.2433 | 0.0159 | 0.2549 | 0.0208 | 0.5431 | 0.2599 | 0.0208 | 0.2485 | 0.5849 | 0.0218 | 0.2463 |
| Bitcoin Prime | 24.10.2017 | 0.9013 | 0.5283 | 0.9855 | 0.8925 | 0.3082 | 0.1427 | 0.8355 | 0.3201 | 0.0419 | 0.8205 | 0.2118 | 0.4009 | 0.1943 | 0.1198 | 0.4446 | 0.1845 | 0.4456 | 0.4842 | 0.2092 | 0.3398 | 0.0771 | 0.8988 | 0.3067 | 0.0777 | 0.9436 | 0.3145 | 0.0672 | 0.9548 |
| Bisq | 26.01.2015 | 0.4609 | 0.1008 | 0.6142 | 0.1638 | 0.2837 | 0.6200 | 0.1587 | 0.8677 | 0.7974 | 0.2097 | 0.1910 | 0.7845 | 0.2402 | 0.2767 | 0.4617 | 0.0961 | 0.0751 | 0.7466 | 0.0098 | 0.0506 | 0.0270 | 0.7524 | 0.0536 | 0.0262 | 0.5772 | 0.2623 | 0.0946 | 0.8789 |
| Block | 02.06.2017 | 0.9385 | 0.3459 | 0.8483 | 0.7242 | 0.3276 | 0.1200 | 0.9685 | 0.5409 | 0.6911 | 0.0951 | 0.7337 | 0.8473 | 0.0864 | 0.0665 | 0.6535 | 0.0485 | 0.5508 | 0.2414 | 0.0781 | 0.6586 | 0.1550 | 0.1650 | 0.5905 | 0.2357 | 0.9048 | 0.3298 | 0.2973 | 0.9548 |
| BlockChain | 04.02.2017 | 0.9361 | 0.2733 | 0.8602 | 0.7758 | 0.1615 | 0.8335 | 0.7198 | 0.1738 | 0.9853 | 0.7442 | 0.2763 | 0.8913 | 0.8507 | 0.6280 | 0.9624 | 0.6885 | 0.5895 | 0.3790 | 0.4768 | 0.8151 | 0.0060 | 0.8929 | 0.8341 | 0.0036 | 0.3841 | 0.2194 | 0.0099 | 0.5950 |
| Cardano | 30.12.2017 | 0.1060 | 0.9211 | 0.4082 | 0.1063 | 0.3268 | 0.6851 | 0.0941 | 0.3319 | 0.3952 | 0.3148 | 0.3658 | 0.0066 | 0.1151 | 0.3513 | 0.0655 | 0.3064 | 0.2674 | 0.0059 | 0.3365 | 0.0032 | 0.7213 | 0.3658 | 0.0037 | 0.4045 | 0.0604 | 0.0020 | 0.3802 | |
| Chain Link | 28.09.2017 | 0.3229 | 0.8729 | 0.1560 | 0.5867 | 0.3433 | 0.3771 | 0.2588 | 0.2215 | 0.3101 | 0.0496 | 0.1853 | 0.2363 | 0.7505 | 0.7332 | 0.2591 | 0.6910 | 0.8786 | 0.9069 | 0.7078 | 0.9009 | 0.0191 | 0.7593 | 0.8536 | 0.0213 | 0.1152 | 0.5737 | 0.0218 | 0.1531 |
| Coinbase | 29.08.2017 | 0.6471 | 0.8404 | 0.4376 | 0.5731 | 0.6632 | 0.7959 | 0.5690 | 0.6050 | 0.3745 | 0.6592 | 0.8705 | 0.4238 | 0.4902 | 0.0322 | 0.1341 | 0.2529 | 0.1518 | 0.3131 | 0.8726 | 0.2171 | 0.0571 | 0.1806 | 0.1326 | 0.1477 | 0.2686 | 0.2681 | 0.3051 | 0.4662 |
| Dash | 18.04.2014 | 0.0913 | 0.6759 | 0.2156 | 0.1085 | 0.4343 | 0.3487 | 0.2570 | 0.6883 | 0.4163 | 0.0574 | 0.2666 | 0.1333 | 0.8487 | 0.1443 | 0.7042 | 0.4478 | 0.8825 | 0.1793 | 0.3810 | 0.3389 | 0.4424 | 0.5069 | 0.4702 | 0.3045 | 0.2753 | 0.2707 | 0.1598 | |
| Decred | 05.06.2015 | 0.6901 | 0.2955 | 0.8357 | 0.4449 | 0.1194 | 0.2481 | 0.2209 | 0.3171 | 0.2441 | 0.1796 | 0.6766 | 0.8673 | 0.3793 | 0.1437 | 0.4507 | 0.1816 | 0.8410 | 0.2345 | 0.0886 | 0.2598 | 0.0238 | 0.5500 | 0.2014 | 0.0032 | 0.1016 | 0.1019 | 0.7391 | 0.3886 |
| Dent | 05.01.2018 | 0.9397 | 0.1510 | 0.6154 | 0.7761 | 0.1409 | 0.6732 | 0.8570 | 0.1806 | 0.4032 | 0.3265 | 0.1897 | 0.3446 | 0.0122 | 0.6769 | 0.5129 | 0.0132 | 0.0719 | 0.9231 | 0.0124 | 0.0122 | 0.2471 | 0.0263 | 0.0040 | 0.4813 | 0.3859 | 0.8196 | 0.5449 | 0.3634 |
| Digital Coin | 30.09.2017 | 0.7974 | 0.3912 | 0.5048 | 0.7548 | 0.3924 | 0.2213 | 0.7962 | 0.3756 | 0.6768 | 0.4690 | 0.5300 | 0.7032 | 0.8155 | 0.5148 | 0.6382 | 0.8578 | 0.3855 | 0.9183 | 0.9258 | 0.5698 | 0.1788 | 0.0958 | 0.6014 | 0.1971 | 0.5824 | 0.9103 | 0.1886 | 0.5901 |
| DigiByte | 06.02.2014 | 0.5136 | 0.9698 | 0.4637 | 0.5168 | 0.5243 | 0.8481 | 0.4978 | 0.5981 | 0.7995 | 0.5603 | 0.5523 | 0.8508 | 0.7041 | 0.4227 | 0.7747 | 0.7787 | 0.3073 | 0.0244 | 0.0567 | 0.4354 | 0.8512 | 0.6546 | 0.4799 | 0.8029 | 0.4734 | 0.8524 | 0.7802 | 0.4576 |
| Digitalocean | 29.01.2015 | 0.9471 | 0.0619 | 0.8132 | 0.7379 | 0.3068 | 0.7102 | 0.6905 | 0.3469 | 0.4654 | 0.3501 | 0.3122 | 0.9931 | 0.9620 | 0.5304 | 0.7495 | 0.8341 | 0.4059 | 0.4286 | 0.6528 | 0.3779 | 0.1793 | 0.7098 | 0.3645 | 0.1408 | 0.6237 | 0.1968 | 0.0864 | 0.8525 |
| Dogecoin | 01.07.2016 | 0.0650 | 0.9589 | 0.4571 | 0.0631 | 0.8557 | 0.6820 | 0.0987 | 0.9756 | 0.8519 | 0.1156 | 0.4241 | 0.7620 | 0.5007 | 0.1221 | 0.5485 | 0.7345 | 0.8191 | 0.4676 | 0.9555 | 0.8391 | 0.6331 | 0.3299 | 0.5131 | 0.9843 | 0.2838 | 0.2929 | 0.7185 | 0.4385 |

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|------------------|------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Dragon Chain | 18.12.2017 | 0.9945 | 0.9773 | 0.2118 | 0.9788 | 0.1234 | 0.9791 | 0.8660 | 0.1069 | 0.3757 | 0.7491 | 0.1407 | 0.9386 | 0.0664 | 0.3962 | 0.5507 | 0.0764 | 0.1764 | 0.0610 | 0.0144 | 0.2134 | 0.1914 | 0.4277 | 0.1750 | 0.2558 | 0.2992 | 0.4922 | 0.3683 | 0.2089 | | |
| Electrosum | 03.11.2017 | 0.6469 | 0.9319 | 0.3896 | 0.8573 | 0.0628 | 0.6987 | 0.8153 | 0.0625 | 0.6149 | 0.2912 | 0.1829 | 0.4461 | 0.9125 | 0.8865 | 0.4053 | 0.9598 | 0.5122 | 0.7313 | 0.0859 | 0.4218 | 0.1602 | 0.4789 | 0.9409 | 0.2162 | 0.5570 | 0.9398 | 0.2833 | 0.3765 | | |
| Enigma | 14.10.2017 | 0.8623 | 0.7417 | 0.6234 | 0.9160 | 0.4656 | 0.6766 | 0.8713 | 0.5156 | 0.2735 | 0.2278 | 0.8170 | 0.4443 | 0.4512 | 0.9407 | 0.4018 | 0.3996 | 0.8886 | 0.6759 | 0.4552 | 0.9258 | 0.1784 | 0.8953 | 0.8626 | 0.2017 | 0.9409 | 0.4763 | 0.5486 | 0.6543 | | |
| Fox | 29.06.2017 | 0.4896 | 0.9038 | 0.8803 | 0.4841 | 0.9490 | 0.1466 | 0.4917 | 0.9359 | 0.4382 | 0.8931 | 0.9537 | 0.4390 | 0.1285 | 0.4117 | 0.4285 | 0.1302 | 1.0000 | 0.4761 | 0.1278 | 0.9962 | 0.0692 | 0.9267 | 0.9996 | 0.0690 | 0.8657 | 0.0786 | 0.0725 | 0.8762 | | |
| Filigrum | 07.08.2015 | 0.5426 | 0.4947 | 0.9113 | 0.5571 | 0.9503 | 0.5637 | 0.5429 | 0.9432 | 0.9906 | 0.6256 | 0.9612 | 0.9778 | 0.4666 | 0.8778 | 0.9933 | 0.4573 | 0.6466 | 0.5743 | 0.4466 | 0.6204 | 0.8792 | 0.7068 | 0.6754 | 0.9217 | 0.9054 | 0.5526 | 0.9356 | 0.8901 | | |
| Filigrum Classic | 27.07.2016 | 0.2357 | 0.9445 | 0.4205 | 0.3211 | 0.7954 | 0.0740 | 0.3564 | 0.8087 | 0.5722 | 0.5558 | 0.7506 | 0.5753 | 0.9662 | 0.3122 | 0.4093 | 0.4996 | 0.3865 | 0.8007 | 0.5301 | 0.3858 | 0.6045 | 0.6439 | 0.5744 | 0.5787 | 0.4535 | 0.8168 | 0.5378 | 0.4551 | | |
| Fiscom | 05.10.2015 | 0.6532 | 0.5015 | 0.1414 | 0.1440 | 0.0623 | 0.3774 | 0.6568 | 0.6726 | 0.9869 | 0.7544 | 0.6974 | 0.7333 | 0.7375 | 0.6969 | 0.1418 | 0.5263 | 0.6156 | 0.8927 | 0.8179 | 0.4361 | 0.0889 | 0.9489 | 0.6045 | 0.6712 | 0.6960 | 0.0533 | 0.3397 | 0.2511 | 0.0822 | 0.2110 |
| Fuhrer | 08.05.2016 | 0.6532 | 0.5015 | 0.1414 | 0.1440 | 0.0623 | 0.3774 | 0.6568 | 0.6726 | 0.9869 | 0.7544 | 0.6974 | 0.7333 | 0.7375 | 0.6969 | 0.1418 | 0.5263 | 0.6156 | 0.8927 | 0.8179 | 0.4361 | 0.0889 | 0.9489 | 0.6045 | 0.6712 | 0.6960 | 0.0533 | 0.3397 | 0.2511 | 0.0822 | 0.2110 |
| Game Credits | 19.11.2015 | 0.7503 | 0.9336 | 0.1510 | 0.9592 | 0.4503 | 0.4993 | 0.8729 | 0.1096 | 0.6227 | 0.4895 | 0.3120 | 0.6591 | 0.0217 | 0.5860 | 0.7741 | 0.1016 | 0.1293 | 0.4048 | 0.0056 | 0.2316 | 0.0782 | 0.6469 | 0.9642 | 0.0974 | 0.4106 | 0.3373 | 0.1708 | 0.2620 | | |
| Gas | 07.09.2017 | 0.7042 | 0.9636 | 0.8662 | 0.8072 | 0.3838 | 0.2247 | 0.8757 | 0.5894 | 0.2748 | 0.3882 | 0.7575 | 0.1946 | 0.1610 | 0.0966 | 0.1116 | 0.2914 | 0.3499 | 0.7775 | 0.7399 | 0.3838 | 0.0764 | 0.4928 | 0.3566 | 0.1158 | 0.6779 | 0.4299 | 0.2671 | 0.5281 | | |
| Genesis | 01.05.2017 | 0.7523 | 0.9392 | 0.6196 | 0.5197 | 0.5870 | 0.5061 | 0.4218 | 0.7724 | 0.6640 | 0.8312 | 0.9702 | 0.6941 | 0.1192 | 0.6227 | 0.6799 | 0.0720 | 0.2428 | 0.6238 | 0.0692 | 0.1300 | 0.0677 | 0.7195 | 0.1412 | 0.0777 | 0.7847 | 0.2019 | 0.2890 | 0.8380 | | |
| Golem | 03.02.2017 | 0.8453 | 0.1870 | 0.3349 | 0.4667 | 0.8109 | 0.7837 | 0.4493 | 0.7154 | 0.8991 | 0.9177 | 0.7281 | 0.8673 | 0.2555 | 0.6998 | 0.9927 | 0.1866 | 0.9745 | 0.2385 | 0.0960 | 0.7124 | 0.2725 | 0.9556 | 0.6774 | 0.2370 | 0.8041 | 0.4069 | 0.3694 | 0.6042 | | |
| Goshales | 14.12.2017 | 0.202 | 0.2834 | 0.9271 | 0.1674 | 0.3057 | 0.9219 | 0.1744 | 0.2755 | 0.9061 | 0.3739 | 0.3916 | 0.8104 | 0.1209 | 0.3253 | 0.6456 | 0.2148 | 0.0969 | 0.4474 | 0.3327 | 0.1327 | 0.6057 | 0.2612 | 0.0851 | 0.0999 | 0.9294 | 0.4204 | 0.0201 | 0.7716 | | |
| Hilanes | 08.11.2017 | 0.0610 | 0.6550 | 0.8978 | 0.0304 | 0.8359 | 0.7766 | 0.0641 | 0.7465 | 0.4345 | 0.3118 | 0.5794 | 0.6497 | 0.1733 | 0.0551 | 0.8899 | 0.3450 | 0.0579 | 0.9863 | 0.3470 | 0.6476 | 0.0928 | 0.4538 | 0.6227 | 0.1363 | 0.5483 | 0.6776 | 0.1082 | 0.6500 | | |
| Icon | 23.09.2017 | 0.0247 | 0.9052 | 0.0152 | 0.0210 | 0.3271 | 0.6981 | 0.0571 | 0.4198 | 0.5892 | 0.2934 | 0.5640 | 0.7902 | 0.0965 | 0.3189 | 0.7342 | 0.1301 | 0.8912 | 0.4071 | 0.2590 | 0.9043 | 0.1480 | 0.1655 | 0.8065 | 0.2403 | 0.0777 | 0.4854 | 0.6928 | 0.0106 | | |
| Iconomi | 25.10.2016 | 0.5418 | 0.2502 | 0.9266 | 0.3896 | 0.3625 | 0.8180 | 0.3129 | 0.3704 | 0.9695 | 0.7818 | 0.1934 | 0.9668 | 0.6903 | 0.9747 | 0.8899 | 0.0885 | 0.5937 | 0.3787 | 0.0030 | 0.3403 | 0.1645 | 0.9112 | 0.4441 | 0.1726 | 0.6520 | 0.2534 | 0.4174 | 0.4226 | | |
| Insosten | 18.01.2018 | 0.0743 | 0.0760 | 0.9831 | 0.0925 | 0.9724 | 0.6125 | 0.0765 | 0.9875 | 0.3252 | 0.6836 | 0.9652 | 0.3201 | 0.0301 | 0.5792 | 0.3387 | 0.6814 | 0.4738 | 0.5441 | 0.1599 | 0.4914 | 0.1515 | 0.1189 | 0.4131 | 0.2337 | 0.9989 | 0.5425 | 0.3140 | 0.8479 | | |
| Kemaboi | 16.03.2017 | 0.1679 | 0.2603 | 0.3264 | 0.6007 | 0.2776 | 0.7800 | 0.6419 | 0.3109 | 0.5058 | 0.7607 | 0.4551 | 0.4439 | 0.1945 | 0.5323 | 0.6142 | 0.0915 | 0.1543 | 0.3290 | 0.0571 | 0.0561 | 0.6070 | 0.9335 | 0.0946 | 0.0935 | 0.9946 | 0.3118 | 0.0150 | 0.5685 | | |
| Kucoin | 13.12.2017 | 0.3894 | 0.1967 | 0.7995 | 0.4880 | 0.7447 | 0.8724 | 0.4853 | 0.7516 | 0.7699 | 0.6407 | 0.8085 | 0.8231 | 0.0710 | 0.1460 | 0.9331 | 0.1857 | 0.7446 | 0.3186 | 0.2154 | 0.9623 | 0.0666 | 0.1810 | 0.6534 | 0.1079 | 0.7583 | 0.9446 | 0.1393 | 0.6311 | | |
| Kyber Network | 20.06.2017 | 0.3880 | 0.3704 | 0.8447 | 0.3742 | 0.6476 | 0.2899 | 0.1584 | 0.9556 | 0.3513 | 0.3866 | 0.7999 | 0.6880 | 0.3666 | 0.6260 | 0.3088 | 0.2897 | 0.0672 | 0.7532 | 0.3395 | 0.0849 | 0.1304 | 0.7042 | 0.0821 | 0.1692 | 0.9248 | 0.1248 | 0.3317 | 0.9292 | | |
| Lib | 22.02.2017 | 0.1767 | 0.5241 | 0.3012 | 0.1163 | 0.5238 | 0.7287 | 0.1213 | 0.5153 | 0.9134 | 0.1714 | 0.4405 | 0.7952 | 0.5393 | 0.8625 | 0.7814 | 0.3450 | 0.3616 | 0.9123 | 0.3388 | 0.3512 | 0.9539 | 0.2576 | 0.1846 | 0.9459 | 0.3319 | 0.5519 | 0.9937 | 0.3628 | | |
| Litecoin | 24.10.2013 | 0.6314 | 0.6334 | 0.9250 | 0.6934 | 0.4901 | 0.7594 | 0.6821 | 0.4856 | 0.8314 | 0.7137 | 0.4911 | 0.8234 | 0.2108 | 0.3344 | 0.7893 | 0.1927 | 0.8041 | 0.9317 | 0.1895 | 0.8000 | 0.6760 | 0.7575 | 0.7655 | 0.6975 | 0.9639 | 0.8415 | 0.6858 | 0.9480 | | |
| Loaning | 23.09.2017 | 0.1387 | 0.9925 | 0.8674 | 0.1424 | 0.5294 | 0.3165 | 0.0933 | 0.7315 | 0.4883 | 0.2284 | 0.9904 | 0.163 | 0.6623 | 0.8168 | 0.4245 | 0.6241 | 0.1929 | 0.9835 | 0.6384 | 0.1648 | 0.0155 | 0.9462 | 0.1452 | 0.0725 | 0.7138 | 0.3710 | 0.0340 | 0.8812 | | |
| Minskafcom | 29.01.2015 | 0.1840 | 0.1744 | 0.1835 | 0.4275 | 0.3822 | 0.5888 | 0.6068 | 0.5134 | 0.5436 | 0.3292 | 0.3145 | 0.2312 | 0.2843 | 0.3073 | 0.1657 | 0.1010 | 0.7570 | 0.8591 | 0.0949 | 0.8076 | 0.9831 | 0.7752 | 0.9544 | 0.8987 | 0.8539 | 0.2248 | 0.5528 | 0.4666 | | |
| Milner | 23.11.2017 | 0.2257 | 0.9502 | 0.3230 | 0.2135 | 0.5566 | 0.7025 | 0.3645 | 0.6684 | 0.2291 | 0.9301 | 0.6748 | 0.3077 | 0.2326 | 0.3096 | 0.0766 | 0.6961 | 0.2818 | 0.8594 | 0.6667 | 0.2039 | 0.7187 | 0.2847 | 0.1197 | 0.8597 | 0.5304 | 0.0855 | 0.5948 | 0.3157 | | |
| Miliblic | 03.12.2014 | 0.7499 | 0.0631 | 0.8861 | 0.5889 | 0.7455 | 0.4156 | 0.3483 | 0.3880 | 0.5873 | 0.4995 | 0.6002 | 0.4003 | 0.9019 | 0.8997 | 0.6554 | 0.5823 | 0.4826 | 0.9543 | 0.6564 | 0.4398 | 0.0470 | 0.5763 | 0.5603 | 0.0554 | 0.3853 | 0.2454 | 0.2361 | 0.1397 | | |
| Monacoin | 02.02.2015 | 0.3825 | 0.0718 | 0.9991 | 0.8756 | 0.8153 | 0.9035 | 0.9738 | 0.7797 | 0.4696 | 0.4896 | 0.9886 | 0.3461 | 0.7860 | 0.4019 | 0.2367 | 0.5396 | 0.6838 | 0.8602 | 0.6346 | 0.6413 | 0.8832 | 0.4990 | 0.4603 | 0.7428 | 0.2113 | 0.4110 | 0.9247 | 0.4031 | | |
| Neblio | 11.09.2017 | 0.6623 | 0.5339 | 0.8932 | 0.5862 | 0.8425 | 0.4563 | 0.2200 | 0.9713 | 0.7218 | 0.5098 | 0.9970 | 0.8513 | 0.1083 | 0.5764 | 0.7800 | 0.1809 | 0.6680 | 0.6743 | 0.4210 | 0.7021 | 0.1541 | 0.5612 | 0.8086 | 0.2165 | 0.4437 | 0.2893 | 0.2079 | 0.6672 | | |
| Nebula | 08.01.2018 | 0.1571 | 0.0697 | 0.1758 | 0.2261 | 0.2682 | 0.6349 | 0.1344 | 0.2737 | 0.3571 | 0.8118 | 0.2501 | 0.3294 | 0.1704 | 0.3700 | 0.2774 | 0.2692 | 0.1761 | 0.2516 | 0.3065 | 0.2328 | 0.0246 | 0.0535 | 0.1083 | 0.0521 | 0.1515 | 0.5432 | 0.0517 | 0.1121 | | |
| Nexo | 05.08.2017 | 0.5995 | 0.3501 | 0.1574 | 0.5866 | 0.5839 | 0.8783 | 0.4655 | 0.5866 | 0.8895 | 0.2576 | 0.8533 | 0.9107 | 0.0805 | 0.3483 | 0.8308 | 0.0846 | 0.8327 | 0.3928 | 0.0715 | 0.8133 | 0.0327 | 0.8842 | 0.0236 | 0.1746 | 0.4488 | 0.0288 | 0.1669 | | | |

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|-----------------|------------|--------|---------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Nexas | 22.09.2016 | 0.1502 | 0.23389 | 0.7513 | 0.0486 | 0.4888 | 0.7955 | 0.0880 | 0.5184 | 0.6977 | 0.4591 | 0.7280 | 0.5588 | 0.9936 | 0.7317 | 0.5907 | 0.5972 | 0.4615 | 0.4444 | 0.4137 | 0.3939 | 0.9746 | 0.4567 | 0.3974 | 0.6300 | 0.1724 | 0.6380 | 0.9109 | |
| Nxt | 29.10.2014 | 0.7369 | 0.7165 | 0.8870 | 0.6245 | 0.2738 | 0.4583 | 0.4138 | 0.0893 | 0.1939 | 0.2657 | 0.4897 | 0.0949 | 0.0152 | 0.3520 | 0.0812 | 0.8425 | 0.7633 | 0.1300 | 0.9798 | 0.0057 | 0.2904 | 0.4198 | 0.0105 | 0.9979 | 0.9529 | 0.0222 | 0.9645 | |
| OmnicGo | 14.07.2017 | 0.7335 | 0.2867 | 0.9707 | 0.7976 | 0.7099 | 0.8154 | 0.7793 | 0.7119 | 0.7207 | 0.7251 | 0.7268 | 0.8200 | 0.2307 | 0.5232 | 0.4224 | 0.7204 | 0.6588 | 0.7330 | 0.7098 | 0.6421 | 0.1042 | 0.7583 | 0.5781 | 0.1022 | 0.9261 | 0.8670 | 0.1071 | 0.9282 |
| Particl | 21.07.2017 | 0.2774 | 0.5128 | 0.4201 | 0.1877 | 0.0499 | 0.2954 | 0.1214 | 0.0977 | 0.3344 | 0.5445 | 0.7032 | 0.4412 | 0.3444 | 0.8790 | 0.4449 | 0.3736 | 0.8045 | 0.5054 | 0.5038 | 0.9762 | 0.0097 | 0.5161 | 0.9292 | 0.0067 | 0.8771 | 0.1643 | 0.0166 | 0.5657 |
| Prvx | 13.02.2017 | 0.1813 | 0.8278 | 0.8150 | 0.1243 | 0.4262 | 0.4925 | 0.0998 | 0.2909 | 0.5042 | 0.4711 | 0.2238 | 0.2677 | 0.7758 | 0.4428 | 0.5408 | 0.9641 | 0.1412 | 0.2578 | 0.6380 | 0.2540 | 0.0269 | 0.8507 | 0.2348 | 0.0195 | 0.8539 | 0.8983 | 0.0222 | 0.8669 |
| Popul8us | 24.10.2017 | 0.9887 | 0.3753 | 0.2172 | 0.7075 | 0.8235 | 0.2478 | 0.7511 | 0.8797 | 0.2166 | 0.7083 | 0.8544 | 0.0063 | 0.0063 | 0.8822 | 0.8647 | 0.0101 | 0.1390 | 0.9178 | 0.0125 | 0.1391 | 0.0078 | 0.8572 | 0.1128 | 0.0089 | 0.5975 | 0.3902 | 0.0234 | 0.4344 |
| PowerLedger | 02.11.2017 | 0.6444 | 0.8027 | 0.7612 | 0.6994 | 0.9880 | 0.7803 | 0.6309 | 0.9467 | 0.9964 | 0.5644 | 0.7890 | 0.8241 | 0.0311 | 0.7101 | 0.7113 | 0.0676 | 0.5966 | 0.8654 | 0.1369 | 0.5536 | 0.0023 | 0.7838 | 0.8931 | 0.0027 | 0.8017 | 0.6521 | 0.0077 | 0.6846 |
| Qash | 21.11.2017 | 0.1231 | 0.3965 | 0.6798 | 0.0357 | 0.7609 | 0.4822 | 0.0227 | 0.7930 | 0.4566 | 0.6403 | 0.8228 | 0.4757 | 0.8104 | 0.3339 | 0.4016 | 0.5766 | 0.6010 | 0.9112 | 0.5594 | 0.5952 | 0.0024 | 0.7949 | 0.6109 | 0.0022 | 0.3994 | 0.3736 | 0.0029 | 0.4442 |
| Qium | 25.11.2017 | 0.8300 | 0.5590 | 0.6140 | 0.7933 | 0.9905 | 0.9091 | 0.8576 | 0.9843 | 0.4120 | 0.1739 | 0.8694 | 0.5313 | 0.0230 | 0.3411 | 0.4432 | 0.0162 | 0.1996 | 0.2742 | 0.0259 | 0.2466 | 0.3353 | 0.7026 | 0.8499 | 0.0956 | 0.6793 | 0.5636 | 0.3170 | 0.7207 |
| Quantstamp | 29.11.2017 | 0.6555 | 0.7374 | 0.0945 | 0.7106 | 0.2152 | 0.8089 | 0.6920 | 0.2549 | 0.1543 | 0.4919 | 0.3574 | 0.1309 | 0.1661 | 0.9888 | 0.0877 | 0.1962 | 0.8722 | 0.6237 | 0.2817 | 0.9770 | 0.0034 | 0.7454 | 0.8270 | 0.0045 | 0.1774 | 0.3100 | 0.0096 | 0.0958 |
| Rechain | 05.01.2018 | 0.0159 | 0.1810 | 0.0733 | 0.0347 | 0.7945 | 0.8846 | 0.0369 | 0.8134 | 0.7417 | 0.1881 | 0.9330 | 0.6565 | 0.9664 | 0.4585 | 0.7161 | 0.8930 | 0.6070 | 0.0496 | 0.9918 | 0.4982 | 0.0046 | 0.0553 | 0.6431 | 0.0089 | 0.0112 | 0.4473 | 0.0126 | 0.0089 |
| ReddCoin | 01.11.2017 | 0.0511 | 0.5808 | 0.6394 | 0.0350 | 0.3347 | 0.4414 | 0.0230 | 0.3961 | 0.3240 | 0.0941 | 0.3189 | 0.2568 | 0.8576 | 0.3874 | 0.1804 | 0.9502 | 0.0506 | 0.2487 | 0.8946 | 0.0739 | 0.0050 | 0.1236 | 0.0117 | 0.7033 | 0.9094 | 0.0126 | 0.7117 | |
| Request Network | 21.10.2017 | 0.5751 | 0.5053 | 0.2317 | 0.6241 | 0.0789 | 0.6522 | 0.7391 | 0.0949 | 0.8316 | 0.1826 | 0.2603 | 0.6029 | 0.1850 | 0.9481 | 0.6116 | 0.1836 | 0.7191 | 0.9969 | 0.2047 | 0.7179 | 0.0277 | 0.6448 | 0.8384 | 0.0516 | 0.2489 | 0.5290 | 0.1234 | 0.1634 |
| Salt | 29.09.2017 | 0.6319 | 0.8243 | 0.1774 | 0.6720 | 0.3801 | 0.4335 | 0.6663 | 0.5170 | 0.4154 | 0.4716 | 0.3933 | 0.4701 | 0.6723 | 0.5008 | 0.4249 | 0.4464 | 0.9188 | 0.5534 | 0.4462 | 0.0031 | 0.6885 | 0.2276 | 0.0027 | 0.2535 | 0.5030 | 0.0034 | 0.1722 | |
| StarCoin | 26.08.2015 | 0.0761 | 0.6225 | 0.0742 | 0.0875 | 0.6954 | 0.8979 | 0.1144 | 0.6508 | 0.9639 | 0.4188 | 0.8057 | 0.7260 | 0.9159 | 0.3337 | 0.5125 | 0.6782 | 0.4531 | 0.5139 | 0.5579 | 0.4507 | 0.2453 | 0.6574 | 0.2866 | 0.0531 | 0.9716 | 0.2742 | 0.4605 | |
| SmartCash | 01.11.2017 | 0.3813 | 0.7708 | 0.0899 | 0.3897 | 0.7113 | 0.8904 | 0.3983 | 0.7046 | 0.4618 | 0.9952 | 0.7057 | 0.4591 | 0.8334 | 0.5839 | 0.4621 | 0.3716 | 0.1426 | 0.4417 | 0.8199 | 0.1333 | 0.9642 | 0.0105 | 0.1208 | 0.9830 | 0.0422 | 0.3452 | 0.9921 | 0.0389 |
| Status | 22.11.2017 | 0.3051 | 0.8576 | 0.2634 | 0.1639 | 0.4067 | 0.2859 | 0.3009 | 0.2939 | 0.3965 | 0.9145 | 0.3266 | 0.3839 | 0.0451 | 0.7282 | 0.7376 | 0.1243 | 0.8924 | 0.4795 | 0.2228 | 0.9581 | 0.4310 | 0.0580 | 0.5149 | 0.1114 | 0.1665 | 0.2441 | 0.0997 | 0.3747 |
| Stream | 17.04.2016 | 0.5304 | 0.2382 | 0.9990 | 0.3467 | 0.4064 | 0.6160 | 0.3091 | 0.4598 | 0.3806 | 0.9932 | 0.4935 | 0.3716 | 0.8616 | 0.7741 | 0.3134 | 0.4592 | 0.1819 | 0.7202 | 0.4010 | 0.2178 | 0.0002 | 0.7168 | 0.2599 | 0.0002 | 0.3582 | 0.2340 | 0.0017 | 0.5826 |
| Stratis | 15.07.2017 | 0.4345 | 0.1457 | 0.3430 | 0.3114 | 0.7611 | 0.1105 | 0.1751 | 0.9964 | 0.7420 | 0.5670 | 0.9470 | 0.7950 | 0.0013 | 0.0470 | 0.7655 | 0.0839 | 0.9166 | 0.4684 | 0.0783 | 0.8874 | 0.0012 | 0.7340 | 0.8388 | 0.0012 | 0.4184 | 0.3993 | 0.0006 | 0.4472 |
| SysCoin | 02.12.2014 | 0.2726 | 0.0781 | 0.6532 | 0.0863 | 0.8931 | 0.4706 | 0.0689 | 0.7390 | 0.2379 | 0.2653 | 0.9895 | 0.4370 | 0.2481 | 0.2626 | 0.6494 | 0.0872 | 0.6928 | 0.7748 | 0.1150 | 0.7497 | 0.0004 | 0.7865 | 0.8293 | 0.0002 | 0.7060 | 0.3511 | 0.0008 | 0.9166 |
| Terra | 26.05.2017 | 0.2393 | 0.4637 | 0.8157 | 0.1780 | 0.4147 | 0.4355 | 0.1466 | 0.4988 | 0.6937 | 0.7166 | 0.6281 | 0.0525 | 0.1204 | 0.6292 | 0.0212 | 0.0888 | 0.2909 | 0.8527 | 0.0907 | 0.3786 | 0.1501 | 0.8229 | 0.3990 | 0.1899 | 0.8877 | 0.2368 | 0.1717 | 0.9478 |
| Teher | 05.05.2017 | 0.5470 | 0.1390 | 0.1875 | 0.4408 | 0.6528 | 0.2195 | 0.4680 | 0.5408 | 0.2383 | 0.8867 | 0.4598 | 0.2381 | 0.8038 | 0.2810 | 0.6284 | 0.0043 | 0.8320 | 0.7352 | 0.0894 | 0.8692 | 0.5777 | 0.1536 | 0.5230 | 0.0239 | 0.6624 | 0.4499 | 0.0229 | |
| Trom | 10.10.2017 | 0.9340 | 0.4419 | 0.3255 | 0.3777 | 0.8124 | 0.6542 | 0.3363 | 0.7909 | 0.4008 | 0.2009 | 0.6764 | 0.3476 | 0.0726 | 0.7882 | 0.3665 | 0.0731 | 0.5664 | 0.6964 | 0.0625 | 0.5449 | 0.1054 | 0.9836 | 0.8875 | 0.1037 | 0.2469 | 0.8419 | 0.1164 | 0.2504 |
| TrueUSD | 06.12.2017 | 0.8719 | 0.6100 | 0.5762 | 0.8358 | 0.9950 | 0.2510 | 0.9386 | 0.9184 | 0.0951 | 0.8053 | 0.9288 | 0.1001 | 0.6048 | 0.8192 | 0.0927 | 0.0133 | 0.7293 | 0.2939 | 0.0175 | 0.7984 | 0.4474 | 0.2397 | 0.9322 | 0.3404 | 0.5015 | 0.9769 | 0.3237 | 0.5050 |
| Walton | 04.09.2017 | 0.6398 | 0.4269 | 0.7910 | 0.4781 | 0.6549 | 0.7745 | 0.5633 | 0.5908 | 0.2342 | 0.8001 | 0.5799 | 0.2484 | 0.1984 | 0.0173 | 0.0640 | 0.5189 | 0.5076 | 0.3742 | 0.7381 | 0.7107 | 0.0003 | 0.1603 | 0.4914 | 0.0006 | 0.7311 | 0.2268 | 0.0036 | 0.9851 |
| Waves | 04.08.2017 | 0.6382 | 0.8433 | 0.8375 | 0.6612 | 0.4920 | 0.9157 | 0.6402 | 0.4946 | 0.4611 | 0.5692 | 0.5110 | 0.5055 | 0.0474 | 0.9250 | 0.4876 | 0.0483 | 0.1360 | 0.2906 | 0.0384 | 0.1751 | 0.0026 | 0.3225 | 0.2429 | 0.0045 | 0.9973 | 0.3676 | 0.0063 | 0.8981 |
| Wave | 08.01.2018 | 0.1814 | 0.2362 | 0.6510 | 0.0971 | 0.8352 | 0.7080 | 0.1414 | 0.4901 | 0.4666 | 0.2196 | 0.7985 | 0.0998 | 0.7365 | 0.5596 | 0.0892 | 0.6198 | 0.1327 | 0.3230 | 0.8948 | 0.2487 | 0.1148 | 0.6884 | 0.3573 | 0.4087 | 0.4674 | 0.4374 | 0.4483 | |

C-C: close-Close, O-V: Overnight, O-O: Open-Open, O-C: Open-Close.

Source: own calculations.

Appendix 2. The percentage of cases for all cryptocurrencies, when the percentage of positive returns for a single cryptocurrency is higher than 60% and lower than 40%

| | Monday | | | Tuesday | | | Wednesday | | | Thursday | | | Friday | | | Saturday | | | Sunday | | | | | |
|--------|--------|--------|-------|---------|--------|--------|-----------|-------|--------|----------|-------|--------|--------|--------|--------|----------|--------|--------|--------|-------|-------|-------|--------|-------|
| | C-C | Ov | O-O | C-C | Ov | O-O | C-C | Ov | O-O | C-C | Ov | O-O | C-C | Ov | O-O | C-C | Ov | O-O | C-C | Ov | O-O | | | |
| >0.60% | 0.00% | 13.41% | 2.44% | 0.00% | 3.66% | 0.00% | 0.00% | 7.32% | 0.00% | 9.76% | 0.00% | 0.00% | 1.22% | 26.83% | 0.00% | 1.22% | 10.98% | 25.61% | 1.22% | 9.76% | 0.00% | 8.54% | 10.98% | 0.00% |
| <0.40% | 23.17% | 9.76% | 2.44% | 12.20% | 15.41% | 20.73% | 9.76% | 7.32% | 17.07% | 9.76% | 7.32% | 28.05% | 2.44% | 6.10% | 35.57% | 1.22% | 24.39% | 1.22% | 4.88% | 1.22% | 2.44% | 1.22% | 1.22% | 1.22% |

C-C: close-Close, Ov: Overnight, O-O: Open-Open, O-C: Open-Close.

Source: own calculations.

Appendix 3. Cryptocurrency names and the maximum and minimum percentage of cases when the rate of return is positive with a breakdown into types of return and days of the week

| | Monday | | | Tuesday | | | Wednesday | | | Thursday | | | Friday | | | Saturday | | | Sunday | | | | | | | |
|------------------------------|-------------|--------|---------|---------|---------|---------|-----------|---------|---------|----------|---------|-----------|---------|--------|-----------|----------|---------|----------|----------|-------------|---------|----------|---------|---------|----------|----------|
| | C-C | Ov | O-O | C-C | Ov | O-O | C-C | Ov | O-O | C-C | Ov | O-O | C-C | Ov | O-O | C-C | Ov | O-O | C-C | Ov | O-O | | | | | |
| Percentage/Max | 5666% | 7000 | 61.31 | 5574 | 57.27 | 65.64 | 55.94 | 57.80 | 60.00 | 58.82 | 52.38 | 66.67 | 57.14 | 52.38 | 60.08 | 80.00 | 52.59 | 61.76 | 63.39 | 80.00 | 61.57 | 62.81 | 58.47 | 75.00 | 63.03 | 59.22 |
| Max-Name/of a cryptocurrency | Maldivicoin | EOS | Auror | Bitcoin | NEO | Bitcoin | Maker | TruUSD | OmniGo | ChainLin | TruUSD | Denacooin | Waves | TruUSD | Denacooin | Mathbook | TruUSD | Mathbook | Mathbook | PowerLedger | Tether | Mathbook | Bancor | Iconomi | Redkoin | Loopring |
| Percentage/Min | 30.39% | 12.50 | 34.58 | 31.07 | 34.58 | 33.33 | 31.07 | 34.58 | 34.58 | 25.00 | 34.58 | 34.07 | 30.19 | 25.00 | 34.58 | 30.19 | 34.58 | 31.13 | 34.58 | 34.58 | 34.58 | 34.58 | 34.58 | 27.27 | 34.58 | 34.58 |
| Min-Name/of a cryptocurrency | Relain | Tether | XShares | Alon | XShares | Tether | Relain | XShares | Denagon | Chain | Denagon | Chain | Denagon | Chain | Denagon | Chain | Denagon | Chain | XShares | Chain | XShares | XShares | XShares | XShares | ByteCoin | XShares |

C-C: close-Close, Ov: Overnight, O-O: Open-Open, O-C: Open-Close.

Source: own calculations.

THE DAY-OF-THE-WEEK EFFECT ON THE EXAMPLE OF 82 CRYPTOCURRENCIES

Summary

The problem of the effectiveness of financial markets has been the subject of interest of scientists for many years. Recently, along with the development of the cryptocurrency market, research on the effectiveness of this fragment of the financial market has begun. In the article, the occurrence of the day of the week was analyzed on the example of logarithmic rates of return of 82 cryptocurrencies vs. USD. Not only Close-Close return rates were analyzed, but also Overnight, Open-Open and Open-Close. The distribution of logarithmic rates of return was not normal for most of the cryptocurrencies analyzed. That why in the statistical analysis the Kruskal-Wallis parametric test was implemented. For individual cryptocurrencies, the occurrence of inefficiency was found for different days of the week and different types of return rates (C-C, Ov, O-C and O-O). The largest number of rejections of the null hypothesis took place for the following cryptocurrencies (the least effective cryptocurrencies): Aelf, Aeternity and Aion. No example of ineffectiveness was discovered in the case of cryptocurrencies: Ark, Basic Attention, Bitcoin, Bitcoin Gold, Cindicator, Dash, Denta Coin, Digixdao, Dogecoin, Electroneum, Enigma, EOS, Ethereum, Gas, Gnosis, Golem, Kucoin, Kyber Network, Lisk, Litecoin, Maidsafecoin, Monacoin, Neblio, OmiseGo, Tron, Wax.

WYSTĘPOWANIE EFEKTU DNIA TYGODNIA NA PRZYKŁADZIE 82 KRYPTOWALUT

Streszczenie

Problem skuteczności rynków finansowych jest przedmiotem zainteresowania naukowców od wielu lat. Ostatnio, wraz z rozwojem rynku kryptowalut, rozpoczęły się badania dotyczące efektywności tego fragmentu rynku finansowego. W artykule przeanalizowano występowanie efektu dnia tygodnia na przykładzie logarytmicznych stóp zwrotu 82 kryptowalut w stosunku do USD. Pod uwagę wzięte zostały nie tylko stopy zwrotu Close-Close, ale także Overnight, Open-Open i Open-Close. Rozkład logarytmicznych stóp zwrotu okazał się być inny niż rozkład normalny dla większości analizowanych kryptowalut. W związku z tym, w analizie statystycznej dotyczącej występowania efektu dnia tygodnia, zastosowany został test parametryczny Kruskala-Wallisa. W przypadku poszczególnych kryptowalut stwierdzono występowanie nieefektywności dla różnych dni tygodnia i różnych rodzajów stóp zwrotu (C-C, Ov, O-C i O-O). Największa liczba odrzuceń hipotezy zerowej miała miejsce w przypadku następujących kryptowalut (rynek tych kryptowalut jest najmniej efektywny): Aelf, Aeternity i Aion. Nie znaleziono natomiast żadnego przykładu nieefektywności dla następujących kryptowalut: Ark, Basic Attention, Bitcoin, Bitcoin Gold, Cindicator, Dash, Denta Coin, Digixdao, Dogecoin, Electroneum, Enigma, EOS, Ethereum, Gas, Gnosis, Golem, Kucoin, Kyber Network, Lisk, Litecoin, Maidsafecoin, Monacoin, Neblio, OmiseGo, Tron, Wax.