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Für Angewandte Wissenschaften

School of
Management and Law

Crypto Currencies.
An Analysis of Market Liquidity

A Study by the Department of Banking, Finance, Insurance

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Abstract

In recent years, crypto currencies have gained in importance and, due to their popularity, many new crypto currencies have emerged. An essential function of every crypto currency is its ability to be exchanged for fiat currencies such as the US dollar. The quality of this exchange market crucially depends on the liquidity of the crypto currency markets. This study examines how the market liquidity of the most important crypto coins has developed against the US dollar, compared to each other and over time. The crypto currencies reviewed were Bitcoin, XRP (Ripple), Ether, Bitcoin Cash, and LiteCoin. Developments in the period December 2015 to August 2018 were analyzed based on data collected by CoinMarketCap, and the market liquidity of the crypto currencies was measured using common key indicators. In the period under review, the market liquidity of all crypto currencies was shown to have improved, which suggests that larger volumes can be traded without having a major impact on prices. The correlation of the returns between the individual currencies was found to increase. Finally, the examination of the volatility of the crypto currencies reviewed revealed that the volatility of crypto currencies in general is still very high compared to traditional asset classes such as equities, bonds or precious metals.

Keywords: Bitcoin, market liquidity, Ether, Ripple, LiteCoin, crypto currencies, crypto coins

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1 Introduction

1.1 BACKGROUND

Bitcoin, still the best-known crypto currency, was first mentioned in a white paper by an unknown author with the pseudonym of Sathoshi Nakamoto, who described it as a “peer-to-peer electronic cash system” which would not require a financial institution for financial transactions (2008, p. 1). This disintermediation would make transactions simpler, cheaper, and faster (Drescher, 2017, p. 22). In recent years, many new crypto currencies have emerged, including Ripple, Ether and LiteCoin, all virtual currencies traded against normal currencies such as the US dollar via online exchanges and trading platforms. For market participants, an important aspect of trading crypto currencies via these platforms is market liquidity.

1.2 PROBLEM STATEMENT

When talking about crypto currencies, the Bitcoin is usually mentioned as an example. In fact, all crypto currencies that are not Bitcoin are referred to as "altcoins", which stands for alternative coins. Bitcoin accounts for more than 65% of the total market capitalization of the entire crypto currency market. The total market capitalization of all crypto currencies together is around USD 243 billion. In comparison, as of year-end 2019 the market capitalization of the world’s largest food producer, Nestle, was about USD 314 billion (Ernst & Young, 2019).

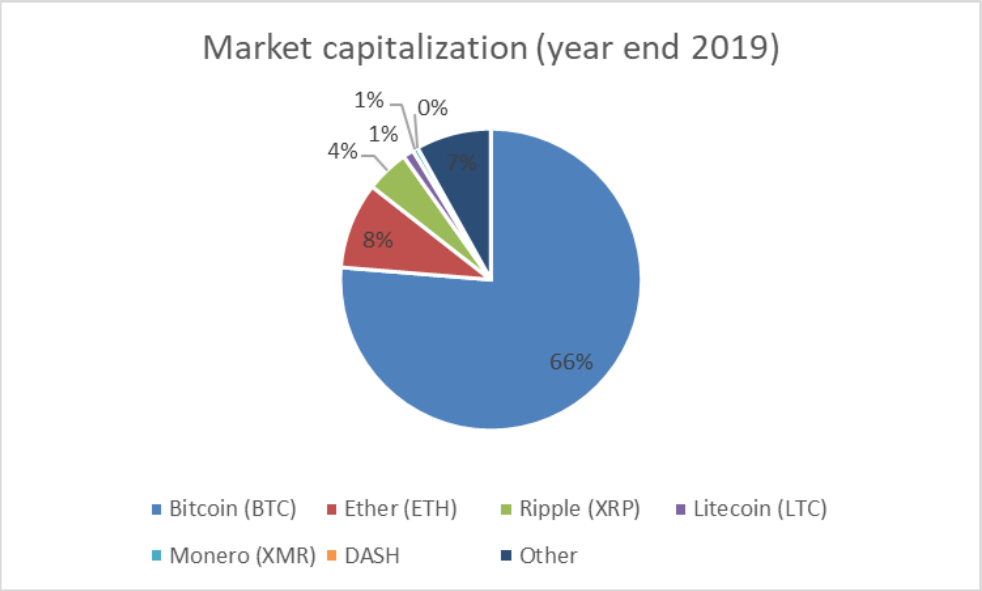

Figure 1: Bitcoin Dominance in Terms of Market Capitalization (Statista 2020 based on data from www.tradingview.com)

1.3 OBJECTIVES

This paper analyzes some of the most widely-known crypto coins with regard to their market liquidity (exchange against the US dollar). The crypto currencies were examined using common indicators and compared to each other and across time.

1.4 DATA AND CHOICE OF METHODS

For the purpose of this study, daily data from the period 1 December 2015 to 31 August 2018 was sourced using the website CoinMarketCap, which tracks and collects market data from crypto currency exchanges and makes it

available to retail users. While the data it provides does not include all trading places, the largest and most important trading places supply their data to the website (CoinMarketCap 2020).

Chapter 3 contains a more detailed discussion of the methodology.

1.5 STRUCTURE

This paper is organized as follows: After the introduction in Chapter 1, Chapter 2 explains basic terms and definitions. Chapter 3 describes the data, showing how the various liquidity measures were calculated and explaining the basic pattern of the analysis. Chapter 4 presents the results of the analysis. Firstly, the background of each crypto currency is explained, followed by the analysis and evaluation of the development of prices and volumes. Also, different liquidity indicators are shown and evaluated against Bitcoin as well as across time. The chapter ends with a comparison of correlations between returns and 30-day volatility over time. Finally, Chapter 5 summarizes and discusses the results.

2 Concepts and Definitions

2.1 RELEVANT CRYPTO CURRENCIES

With two exceptions, this paper discusses the five most capitalized crypto currencies. The first exception is Tether, which was found to be unsuitable for the purpose of this study because it is a so-called "stablecoin"[1]. This means that its price would always be around USD 1.00, and volume would not be a reliable indicator because supply is based on demand. The second exception is Bitcoin SV, also known by its full name: Bitcoin Satoshi's Vision. It is a split of of the Bitcoin Cash that was only carried out in November 2018 (Bitcoin Suisse, 2020), which is why the data file used does not yet contain any market data for this crypto currency.

NAME	SYMBOL	PRICE USD	CIRCULATING IN 1,000	MAX SUPPLY IN 1,000	MARKET CAP IN 1,000 USD	MINEABLE
Bitcoin	BTC	$8,896.39	18,363	21,000	$163,364,705	Yes
Ether	ETH	$205.22	110,801	No max.	$22,738,908	Yes
Ripple	XRP	$0.21619	44,112,853	100,000,000	$9,536,766	No
Tether	USDT	$1.00	6,361,033	No max.	$6,385,611	No
Bitcoin Cash	BCH	$243.29	18,399	21,000	$4,476,137	Yes
Bitcoin SV	BSV	$206.64	18,398	21,000	$3,801,612	Yes
LiteCoin	LTC	$46.76	64,662	84,000	$3,023,540	Yes
Binance Coin	BNB	$16.92	155,537	187,537	$2,631,018	No
EOS	EOS	$2.77	922,365	No max.	$2,550,661	No
Tezos	XTZ	$2.74	709,388	No max.	$1,946,646	No

Table 1: Crypto Currencies with the Highest Market Capitalization (5 May 2020; CoinMarketCap 2020)

[1] Stablecoins are crypto currencies linked to the rate of commodities, fiat money or other crypto currencies (Schiller, 2019). Compared to other crypto currencies, they are less volatile. The best-known example is Tether. Tether is based on the US dollar, and the exchange rate should, therefore, always be USD 1.00, at least theoretically. As a company, Tether generates new coins when it sells them for money and redeems repurchased coins for money (Tether, 2020). Thus, the supply is theoretically unlimited, and there is no maximum quantity of coins.

2.2 MARKET LIQUIDITY

2.2.1 Definition

A liquid market is usually understood as a market where purchases and sales can be made immediately with a minimal price impact (Ranaldo, 2001, p. 5). Liquidity is difficult to measure, firstly, because it is multidimensional and, secondly, because it is strongly linked to market efficiency. It must be possible to execute an order immediately, regardless of the volume and without price impact while, on the other hand, efficiency requires that the price be constantly adjusted to the latest market information (Ranaldo, 2001, p. 3).

2.2.2 Dimensions

According to Von Wyss (2004, p. 5), liquidity cannot be quantified with a one-dimensional variable. Rather, it is made up of several dimensions as the subsequent chart illustrates:

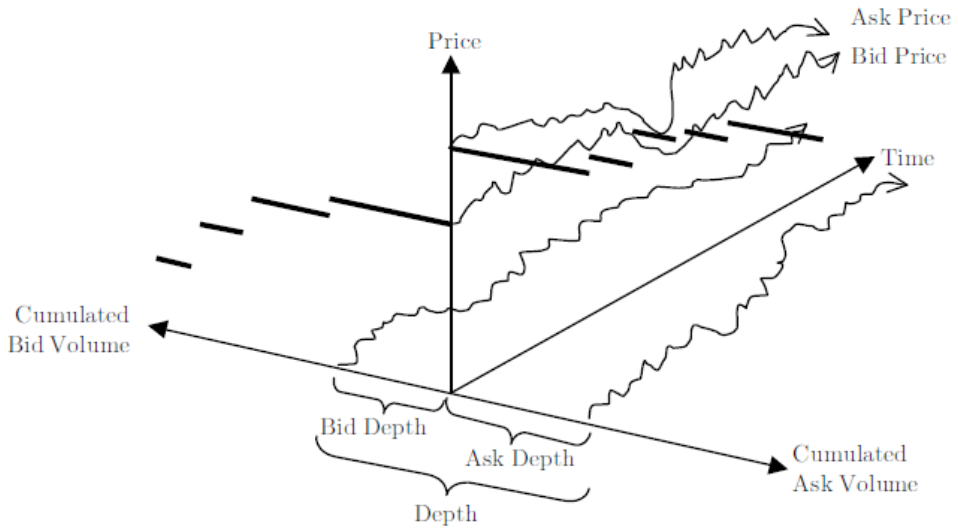

Figure 2: Development of Order Book over Time to Illustrate the Multi-Dimensional Nature of Liquidity (von Wyss, 2004, p.8)

Von Wyss (2004, p. 5 et seqq.) differentiated between the following dimensions:

- Trading time: Can a transaction be executed immediately at the prevailing price?
- Tightness: The market has high tightness if one can buy and sell at very similar price (bid-ask spread).
- Depth: The market is called deep when large quantities can be bought or sold without the price changing significantly.
- Resiliency: The market is described as resilient if any imbalances may be corrected in a short time.

2.2.3 Measurement Concepts

Due to the multi-dimensional nature of liquidity, it is advisable to use several liquidity measures. Typically used ratios include:

- Transaction cost ratios

Transaction cost ratios primarily measure the direct costs of trading of an asset. They are usually calculated using the bid-ask spread. This is one of the most frequently used key figures in connection with liquidity (Gabrielsen, Marzo, & Zagalia, 2011, p. 19). Unfortunately, this key figure cannot be used for this study because the bid and ask prices are not available in our data set.

– Volume-based ratios

The simplest ratio is the turnover ratio:

– **Turnover ratio**: The turnover ratio can only be calculated for assets for which the total amount in circulation is known. Since this information is also available for crypto currencies, the turnover ratio can be calculated based on our data set. The traded volume is put in relation to the total volume in circulation: the higher the ratio, the better the market liquidity (Bünzli, Eichenberger, Gantenbein, & Kley, 2013, p. 10).

Other volume-based ratios contrast the traded volumes with the price change and thus measure the market depth (Gerharter, 2014, p. 7).

– **Conventional liquidity ratio:** According to Gerharter (2014, p. 7), the conventional liquidity ratio is one of the most frequently used indicators in empirical analysis. It shows how much volume is necessary to achieve a price change of one percent in the asset under analysis. A high ratio means that even large trading volumes have a small influence on the price, which indicates high liquidity.

– **Amihud illiquidity ratio**: The Amihud illiquidity ratio can be assigned to volume-based ratios and price-based ratios and is, therefore, a multidimensional measure. A high value indicates that a security is illiquid. Large trading volumes cause the value to fall, while large price changes cause it to rise. This measure shows the price change for a one US dollar trading volume. Amihud (2002) found that there are better figures for determining liquidity, but only easily available data are needed for the calculation.

– **Hui-Heubel liquidity ratio**: By relating the price changes over a period to the turnover, two dimensions are covered, which are width and resilience (Bünzli et. al., 2013, p. 11). The measure could also use the bid-ask spread instead of the highest and lowest price, but this would distort the measure.

– Price-based ratios

Price-based ratios examine price changes and can thus show the resiliency dimension of liquidity for an asset. The most commonly used price-based ratios are the liquidity ratio of Marsh and Rock and the variance ratio (Gabrielsen et al., 2011, p.13). These measures were not used in this study as more data would be required than is available.

3 Data and Methodology

3.1 DATA SOURCES

The data set used in this study contains the historical data of several hundred different crypto currencies collected by CoinMarketCap from different trading platforms. The data file was downloaded from Kaggle, a platform owned by Google. Kaggle is an online community aimed at data scientists who share data sets and models and seek solutions to data science challenges. The data file was provided by user “wayward artisan” and is a compilation of downloads from CoinMarketCap covering 1 December 2015 – 31 August 2018.

In order to compare the volatility of asset classes with other asset classes, the historical price data for the gold ounce rate in USD, the SMI, and the CHF/USD exchange rate were extracted from Bloomberg.

3.2 ELEMENTS OF THE DATA SET

The file contains the following data:

- Date: Trading Day x.
- Symbol: Each crypto currency has a unique identifier assigned to it.
- Open: This is the opening price on Day x.
- High: The highest price reached on Day x.
- Low: The daily low that was reached on Day x.
- Close: The rate at which the crypto currency closed on Day x.
- Volume: The daily turnover as traded coins per day times the opening price.
- Market cap: The market capitalization in USD as the number of coins in circulation times the opening price. With this data, the volume was calculated as number of coins and the outstanding coins, which are also needed for the calculation of the selected key figures.

3.3 CALCULATION METHODOLOGY

The following describes the methodology that was employed to analyze the individual crypto currencies. Each crypto currency is given its own sub chapter, in which the following points are analyzed in the same order:

- Basic analysis of the crypto currency
  First, each individual crypto currency is examined. It is analyzed how the coins inflate over time, whether they are centralized or decentralized and whether they can be mined.

- Price
  For each of the currencies, a chart is created with the spot rates. This is then examined for special events. The price development over the period, the highs, and the lows are also briefly reviewed, and any conspicuous features are discussed.

- Volume
  The volume provides an overview of how many coins were traded at one time. This is shown by means of a bar chart. The number of coins in circulation are visualized by means of a line chart. This is particularly interesting because, unlike in other asset classes, the amount of coins in circulation is constantly changing. The number of coins traded per day is calculated in such a way that the daily volume in USD is calculated by the opening rate. For the calculation of the coins in circulation, the market capitalization is calculated by the opening rate.

– Turnover ratio

The formula of the turnover ratio has already been described. The calculation is performed in such a way that the ratio is displayed for each individual day in the observed period. The amount of outstanding coins is divided by the number of coins traded on a given day. This is then displayed in a bar chart. The ratios of the other coins are compared with the ratio of Bitcoin. The formula is as follows (Bünzli et al., 2013, p. 10):

$$TR_t^i = \frac{Sh_t^i}{NSh_t^i}$$

h_t^i = Number of Shares (coins) *i* traded on Day *t*
NSh_t^i = Number of Shares (coins) *i* in circulation on Day *t*
TR_t^i = Turnover ratio of the Asset *i* on Day *t*

– Conventional liquidity ratio

The conventional liquidity ratio indicates how much trading volume must be traded in US dollars for a price change of one percent to occur. Data from the last 30 days was used for the calculations. The calculated data was visualized with the help of a bar chart and compared and discussed with the data from Bitcoin (Gerharter, 2014, p. 7).

$$LR_{it} = \frac{\sum_{t=1}^{T} P_{it} V_{it}}{\sum_{t=1}^{T} |PC_{it}|}$$

P_{it} = Price of the Asset *i* on Day *t*
V_{it} = Volume of the Asset *i* on Day *t*
$|PC_{it}|$ = Absolute percentage of price change of the Asset *i* on Day *t*
LR_{it} = Liquidity ratio of the Asset *i* on Day *t*

– Amihud illiquidity ratio

The Amihud illiquidity ratio indicates the price change for each USD trading volume (Gerharter, 2014, p. 9). High values indicate low liquidity. A high trading volume therefore should have as little influence on the price as possible. The ratio is calculated over the last 30 days and the resulting figures are visualized in a chart.

$$ILLIQ_T^i = \frac{1}{D_t} \sum_{t=1}^{D_T} \frac{\left|R_{t,T}^i\right|}{V_{t,T}^i}$$

D_t = Number of trading days
$|R_{t,T}^i|$ = Absolute daily return of Asset *i* on Day *t*
$V_{t,T}^i$ = Daily volume of Asset *i* on Day *t*
$ILLIQ_T^i$ = Illiquidity ratio of Asset *i* over Observed Period *T*

One disadvantage of the Amihud illiquidity ratio is related to the denominator, which can – in our example – become very large. This results in very small figures which cannot easily be compared to other markets.

– Hui-Heubel ratio

For the purpose of this study, the Hui-Heubel ratio is calculated using the highest and lowest prices. In theory, bid and ask prices could have been used, but this data was not available. The ratio is calculated for a period of seven days and the data together with the Bitcoin data is displayed in a bar chart.

The formula is as follows (Bünzli et. al., 2013, p. 11):

$$LR_{HH} = \frac{\frac{(P_{max} - P_{min})}{P_{min}}}{\frac{V}{(S * \bar{P})}}$$

P_{max} = Highest price over observed period
P_{min} = Lowest price over observed period
V = Trading volume of the asset over observed period
S = Number of shares in circulation in the observed period
$\overline{P}$ = Average price over observed period

LR_{HH} = Hui-Heubel liquidity ratio

– Volatility
The volatilities of the individual currencies are compared in an additional section based on the volatility of the last 30 days and using the Excel standard deviation formula. The aim is to determine how strongly the rates of the crypto currencies fluctuate. The same is calculated using data from the SMI, the gold ounce rate, and the CHF/USD exchange rate in order to compare the volatilities with those of other asset classes.

– Correlation matrix
To create the correlation matrix, the logarithmic rates of return were calculated. The correlation was then calculated for each year. It should be noted that the correlations calculated for the year 2018 were only available for the first eight months.

4 Results

This chapter evaluates the data described in the previous chapter. In the first part, Bitcoin is examined using the calculated key figures. In the following parts, this is done with each of the selected crypto currencies. This is followed by a comparison with Bitcoin.

4.1 BITCOIN (BTC)

As already mentioned above, Bitcoin was forked several times. The main chain is, therefore, called Bitcoin Core (BTC). In mining, those who succeed in finding a new block will be rewarded with new Bitcoin. In the beginning, there were 50 coins per new block. However, the reward is halved every 210,000 blocks (Hosp, 2019, p. 90). This process is called "halving". The maximum number of Bitcoins will be 21 million, and as of May 2020 there were already more than 18 million (CoinMarketCap, 2020).

4.1.1 Price

Figure 3: Bitcoin Price

The highest closing price paid in the observed period was USD 19,497.40 on 16 December 2017. This is an increase of 5,252% from the low of USD 364.33 on 15 January 2016. In other words, the price of Bitcoin has increased more than fifty-two times in less than two years.

4.1.2 Volume

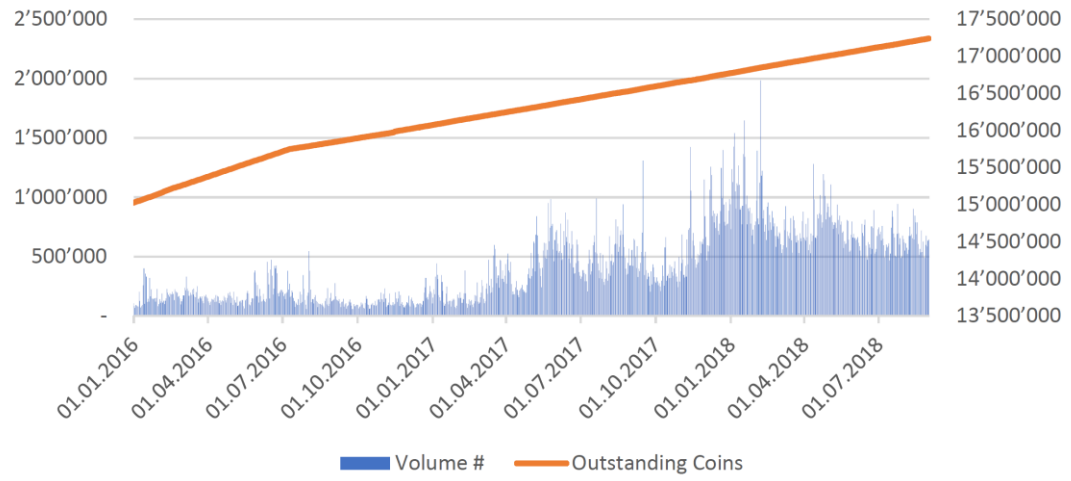

Figure 4: Bitcoin Volume

As one can see in this chart, the outstanding coins were constantly increasing. Until July 2016, however, the total number of coins increased more strongly. This is due to the Bitcoin halving that took place at that time. As already described above, the reward was halved from 25 to 12.5. As a result, the supply and the inflation rate were drastically reduced in one stroke. For smaller or less efficient mining companies, the mining was no longer financially profitable, so they had to shut down their servers until the price reaches a level at which the mining will be financially profitable again (Young, 2020).

4.1.3 Turnover Ratio

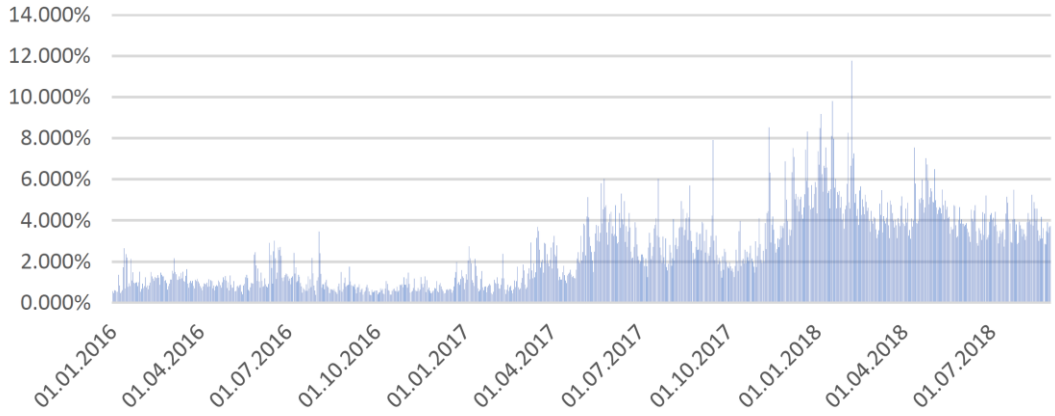

Figure 5: Bitcoin Turnover Ratio

The chart showing the turnover ratio is very similar to that showing the volume. Although the number of coins in circulation was slowly increasing, this only had a very slight influence on the turnover ratio. Over the observed period, the key figure fluctuated between 0.35% and 11.78%; the average was about 2.48%. In comparison, the average turnover ratios of Nestle, Roche, and Novartis over the same period were between 0.17% and 0.21%, which is, of course, a different investment category. It is noticeable that the turnover ratio also increased with rising

prices in 2017. While prices fell sharply in 2018, the turnover ratio remained more or less stable. This shows that despite falling prices there was brisk trading in Bitcoins.

4.1.4 Conventional Liquidity Ratio

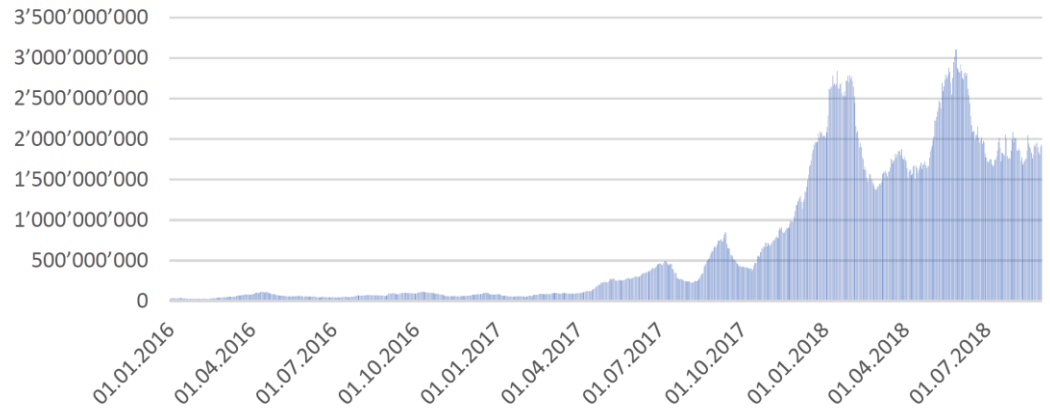

Figure 6: Bitcoin Conventional Liquidity Ratio (30 days rolling)

It is clear from the graph that the conventional liquidity ratio rose sharply in the period under observation, which can be regarded as positive for the liquidity in Bitcoin. It shows that the price does not fluctuate too much with large trading volumes. In 2017, the year in which there was a real crypto boom, the conventional liquidity ratio also began to rise. In 2016, an average of USD 78 million in trading volume was required for a one-percent price change, and this value more than doubled to an average of USD 737 million in 2017. Although prices declined in 2018, which had an impact on trading volume, the ratio remained at high levels. Thus, the highest values were also measured in 2018.

4.1.5 Amihud Illiquidity Ratio

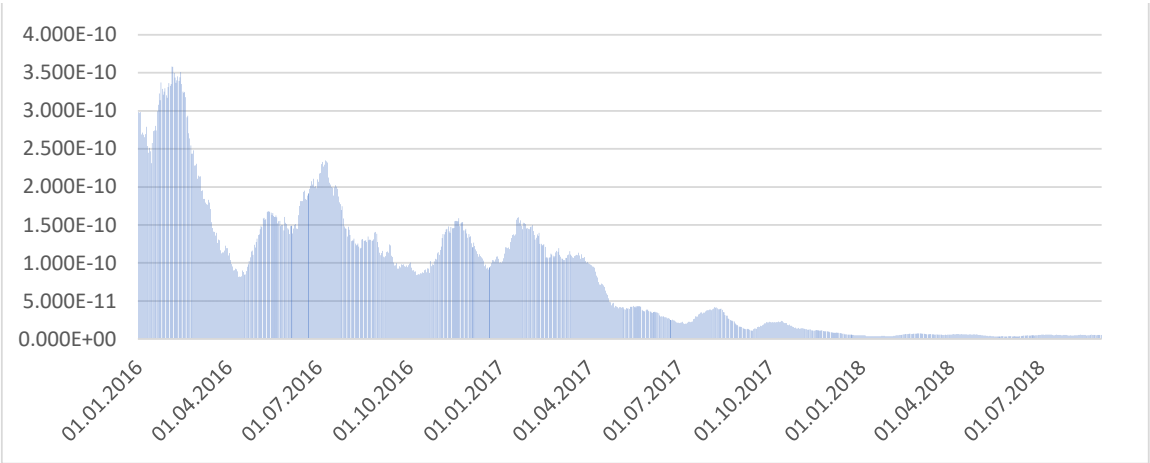

Figure 7: Bitcoin Amihud Illiquidity Ratio (30 days rolling)

The Amihud Illiquidity ratio noticeably improved over the observed period. In 2016, one USD in trading volume had more influence on the price than in later years. Even before the boom, the liquidity was improving.

4.1.6 Hui-Heubel Liquidity Ratio

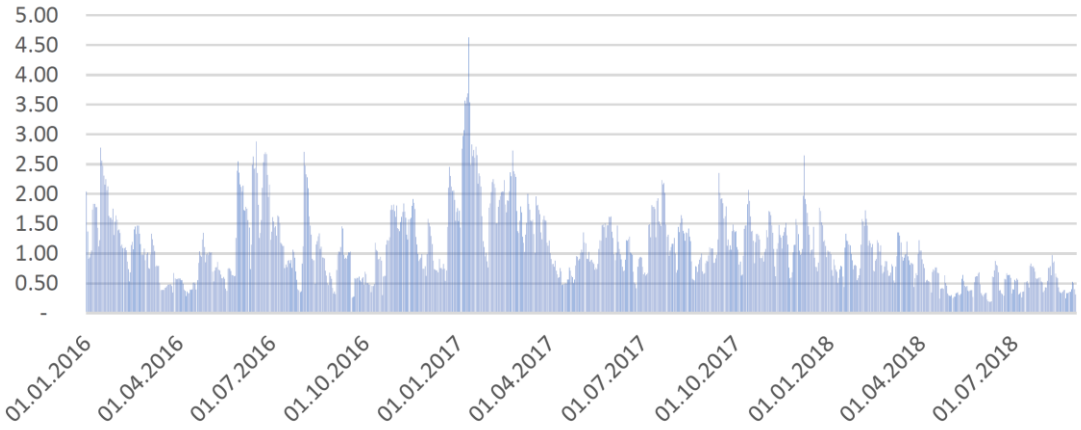

Figure 8: Bitcoin Hui-Heubel Liquidity Ratio (7 days rolling)

4.2 ETHER (ETH)

In 2013, Vitalik Buterin published a white paper describing his idea of a decentralized system that uses the technology of Bitcoin and extends its capabilities (Cointelegraph, 2020a). This network has its own internet browser, coding language, and payment system, allowing users to create their own applications on the Ethereum Blockchain. The virtual currency used is Ether (ETH), and it is used to pay for the execution of the decentralized applications (dapps), therefore serving as a kind of fuel. Ether can either be bought or mined. Ether does not have a hard limit like Bitcoin and the number of coins can increase indefinitely. Currently, Ether is the second largest crypto currency in terms of market capitalization and awareness and is therefore always compared to Bitcoin. The block mining time of a Bitcoin, on average, is about 10 minutes while Ether tries not to take longer than 12 seconds. Bitcoin can now only be mined by professional mining farms, while Ethereum's algorithm also encourages individuals to mine (Cointelegraph, 2020a).

4.2.1 Price

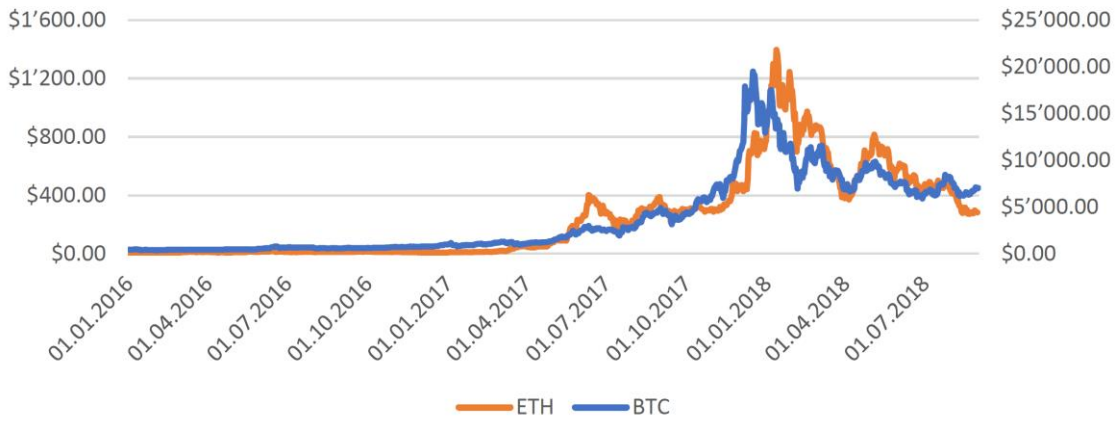

Figure 9: Ether Price

When looking at the Ether price, it can be seen that this currency went through an extreme price increase. In fact, over whole time span under observation, it was more than 30,000%. The price development was similar to that of Bitcoin, although the price seems to have been a little bit more volatile than Bitcoin over the entire period.

4.2.2 Volume

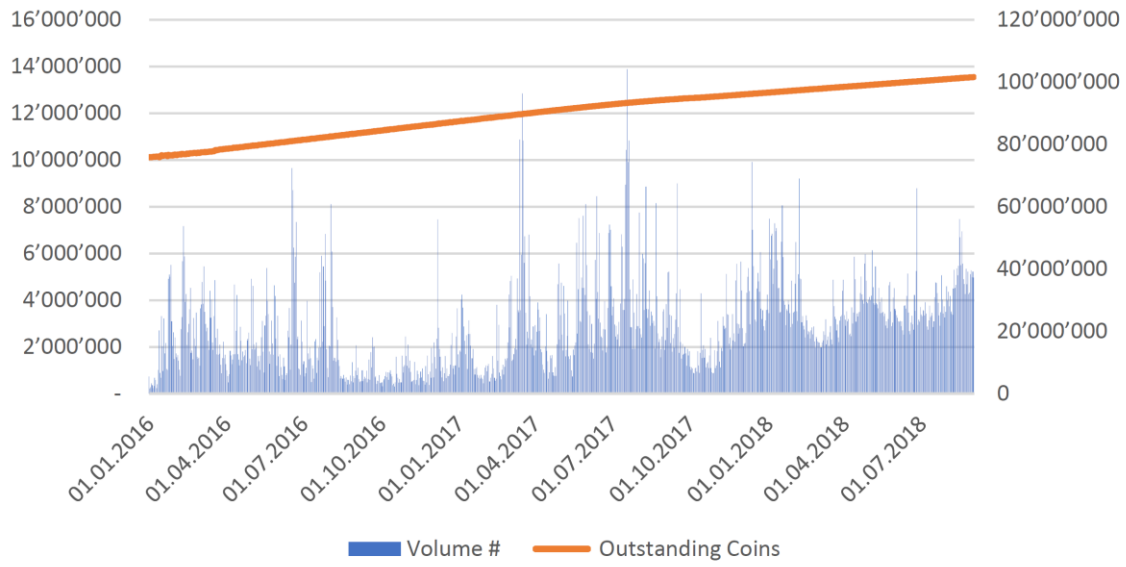

Figure 10: Ether Volume

The number of coins in circulation increased by around 34% over the period under review. This is due to the fact that the supply was constantly increasing as a result of mining. Bitcoin increased by 16% over the same period. However, the increase in coins in circulation could continue to rise for Ether as the currency, unlike Bitcoin, has no cap.

4.2.3 Turnover Ratio

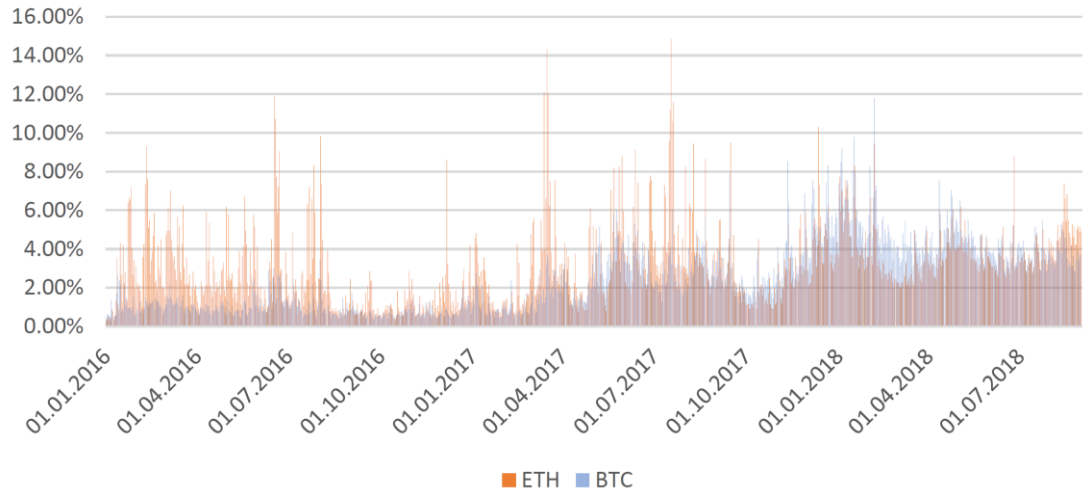

Figure 11: Ether Turnover Ratio

The turnover ratio was always higher at the beginning of the observed period than at the end. This also applied compared to Bitcoin. However, there were always a few days on which very large turnovers occurred, such as two

days on which more than 14% of the coins in circulation were traded. Basically, a high turnover ratio is positive because there is a lot of trading, but it is possible that such a high turnover leads to high volatility.

4.2.4 Conventional Liquidity Ratio

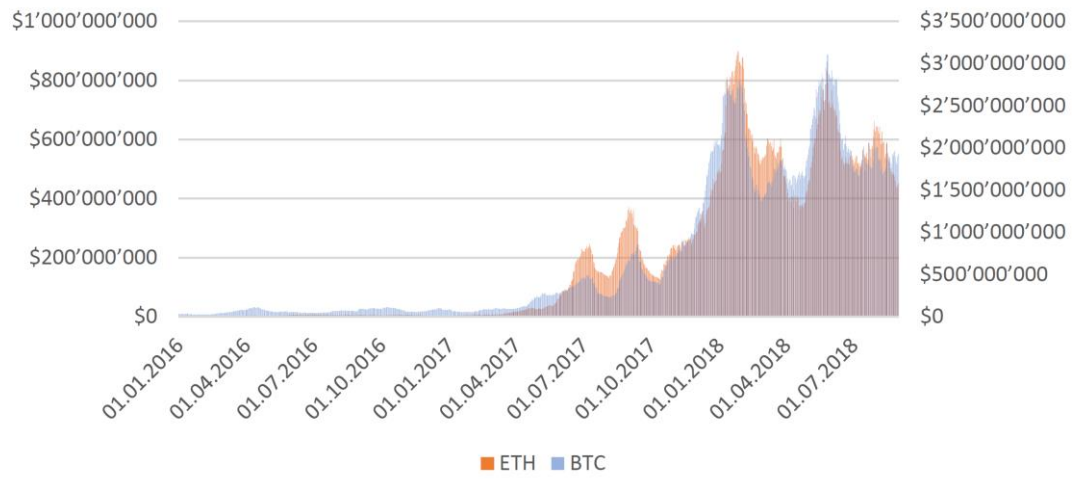

Figure 12: Ether Conventional Liquidity Ratio (30 days rolling)

The conventional liquidity ratio shows that the large trading volume has an increasingly smaller influence on the price. In 2016, an average of around USD 4 million was still required for a one-percent price change, whereas in 2017 it was already USD 140 million and in 2018 more than 500 USD million. In addition to the higher price, the higher volumes are likely to have contributed to this improvement.

4.2.5 Amihud Illiquidity Ratio

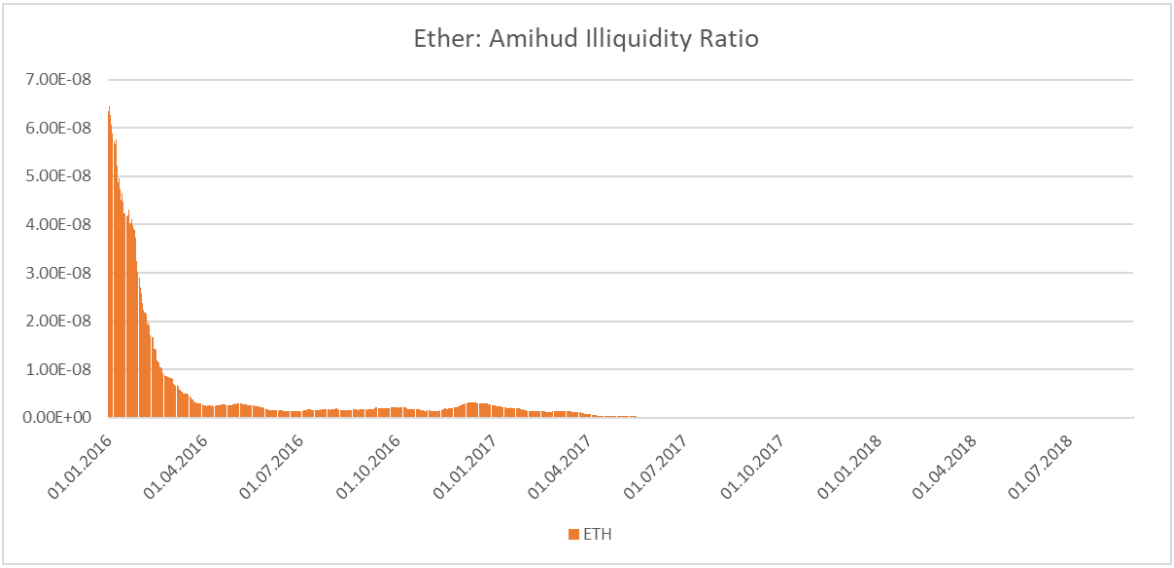

Figure 13: Ether Amihud Illiquidity Ratio (30 days rolling)

With the Amihud illiquidity ratio of Ether, it can be seen that it fell sharply over the observed period. Liquidity, therefore, increased.

4.2.6 Hui-Heubel Liquidity Ratio

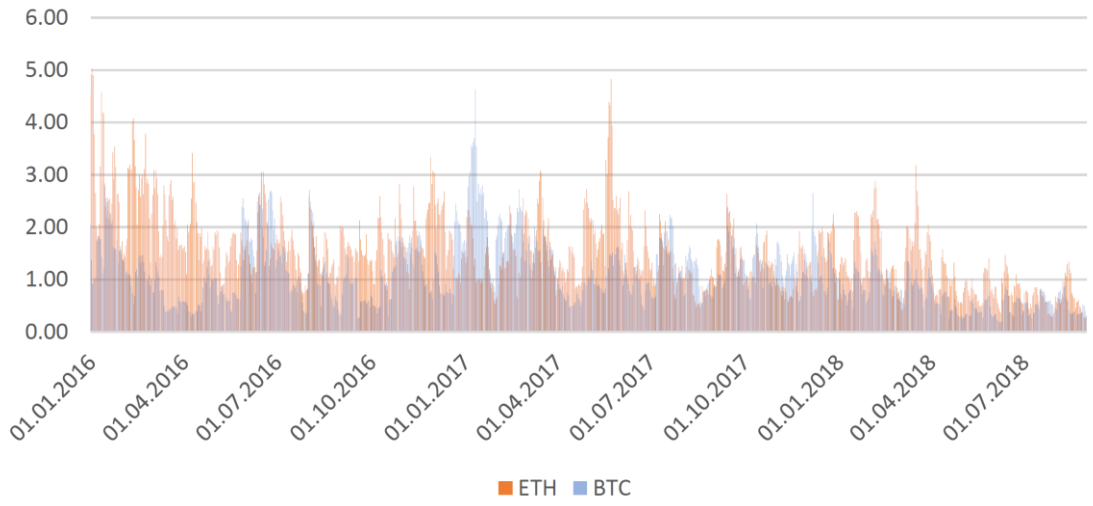

Figure 14: Ether Hui-Heubel Liquidity Ratio (7 days rolling)

The Hui-Heubel ratio was shown to have improved over time. In 2016, the average value was still 1.91, and in 2018 it dropped to an average of 1.04. The reason for this is probably that volatility and the turnover ratio improved, which both have a positive effect on the ratio. In mid-2017, there was still an isolated spike, which may be due to the very low turnover ratio at that time (see turnover ratio chart).

4.3 RIPPLE (XRP)

XRP is the crypto currency of the Ripple Network (Cointelegraph, 2020c). The goal of this network is to make international payment transactions more efficient and cost-effective for banks. The network is not based on block-chain technology. To be able to verify the transactions, Ripple has its own patented technology: the Ripple protocol consensus algorithm (RPCA). Since XRP is not based on blockchain technology, the tokens cannot be mined. Therefore, the entirety of the 100 billion XRP exist from the beginning, of which 44 billion are currently in circulation. The rest is controlled by Ripple Labs, the company behind Ripple. The company uses the retained tokens to finance itself. Tokens can be exchanged on the platform for any currency or digital asset. The transaction fee is approxi-mately 0.00001 XRP, which are destroyed (Cointelegraph, 2020c).

4.3.1 Price

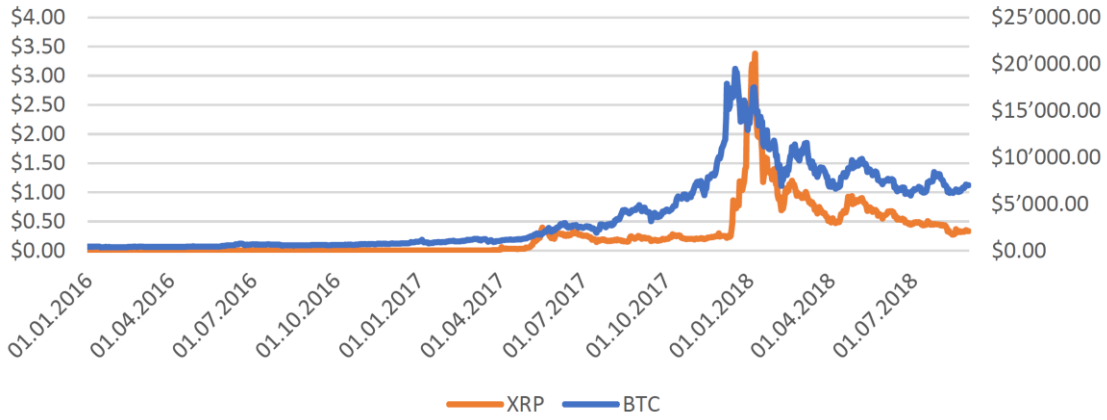

Figure 15: XRP Price

As the graph shows, the price of XRP increased more than 54 times since the beginning of 2016. At one time, the price even rose to USD 3.38, which corresponds to an increase in value of more than 55,860%. This peak was reached during the boom at the end of 2017. Compared to Bitcoin, XRP took off a little later and started to fade again earlier. The price fell even more drastically after the peak and is now back at a relatively low level. In the past, there were a number of accusations, which in some cases led to litigation, that Ripple was secretly manipulating prices (Coindesk, 2020).

4.3.2 Volume

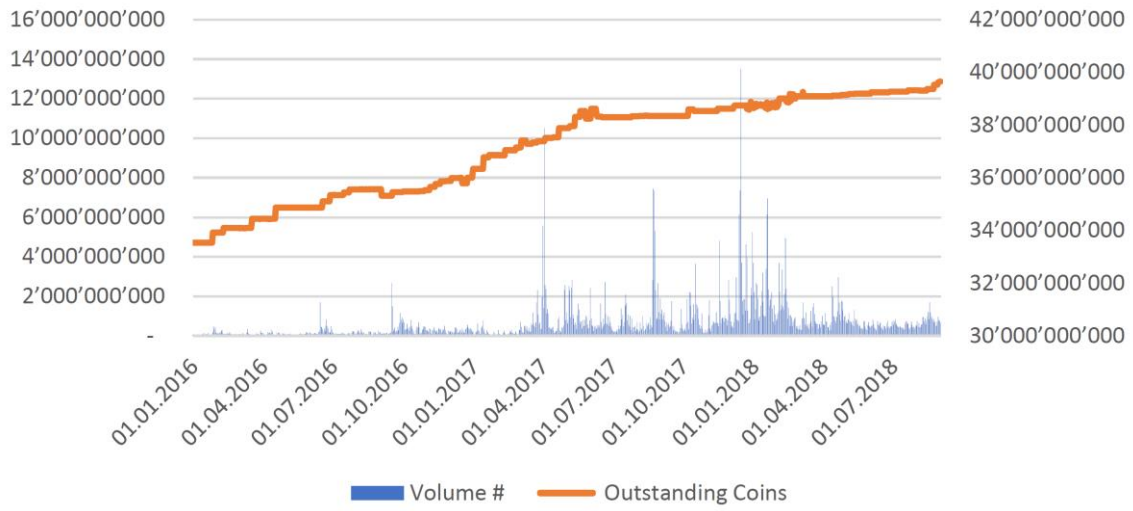

Figure 16: XRP Volume

This graph shows how the number of currencies in circulation constantly increased by about 18% over the observed period. While the increase was relatively constant for the other currencies, it is noticeable that the curve for XRP is very irregular. This is due to the fact that with XRP the currency is deleted in the transactions and the currency cannot be mined. The only supply represents the stock of the company, Ripple Lab, which brings new XRP tokens on the market. The way they do this changed over time: While at the beginning, the development was rather unstable, it became more constant from mid-2017 on, except for during the boom at the end of 2017, when some large volumes were traded.

4.3.3 Turnover Ratio

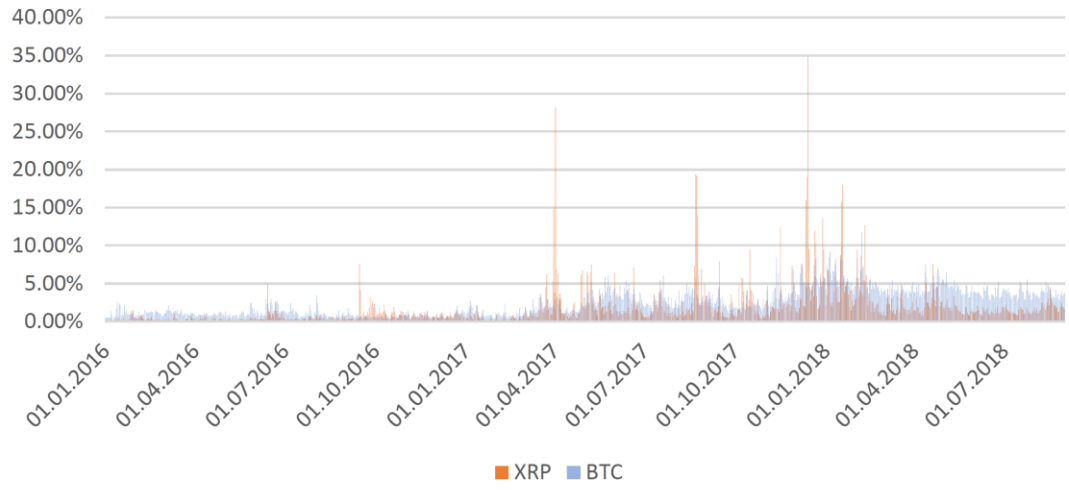

Figure 17: XRP Turnover Ratio

With regard to the turnover ratio, it is noticeable that Bitcoin shows a higher turnover ratio overall. On average, there was a turnover ratio of 1.72% over the entire term. However, there were some peak days on which a turnover ratio of up to 35% was achieved. While Bitcoin also had some outliers, these were less extreme.

4.3.4 Conventional Liquidity Ratio

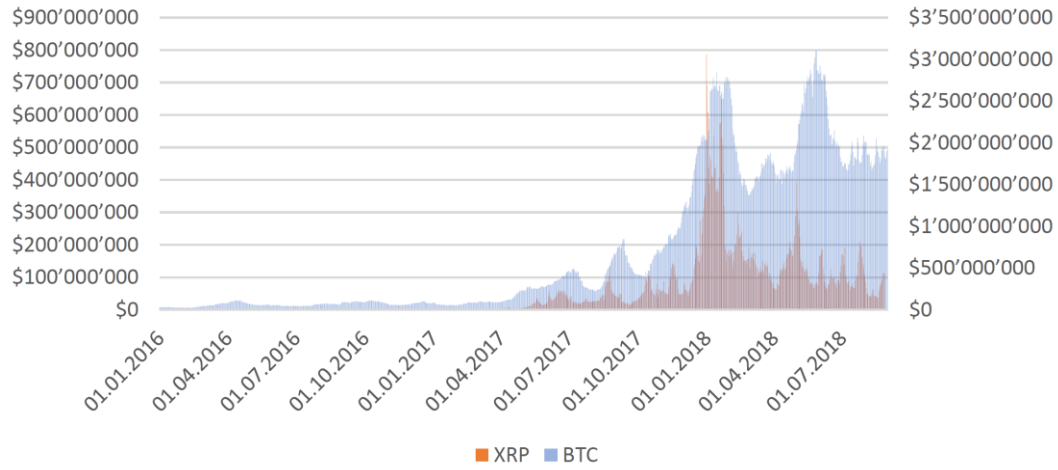

Figure 18: XRP Conventional Liquidity Ratio (30 days rolling)

As can be seen, the traditional liquidity ratio improved. While the ratio for Bitcoin remained more or less constant at the higher level at the beginning of 2018, the ratio for XRP corrected downwards in the meantime. In 2017, an average trading volume of USD 35 million led to a price change of one percent, while the following year, on average, it was already more than 4.5 times as much.

4.3.5 Amihud Illiquidity Ratio

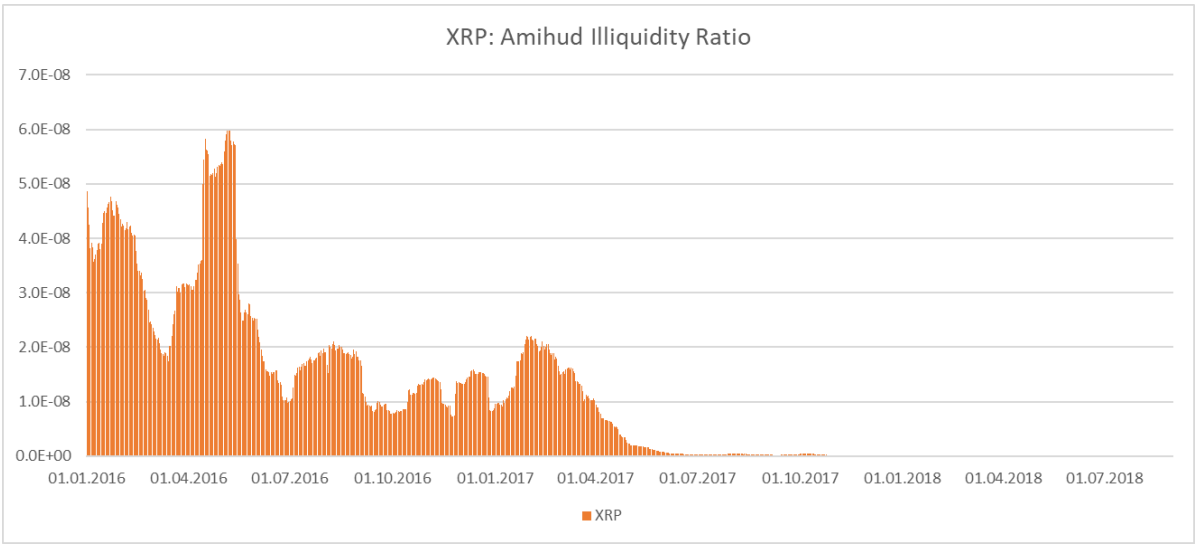

Figure 19: XRP Amihud Illiquidity Ratio (30 days rolling)

The Amihud illiquidity ratio decreased sharply over the observed period, which is a very positive sign for liquidity. At the end of 2017, there was not really a massive increase in the ratio, which shows that XRP did not have as large a change in volume as the other currencies during the boom.

4.3.6 Hui-Heubel Liquidity Ratio

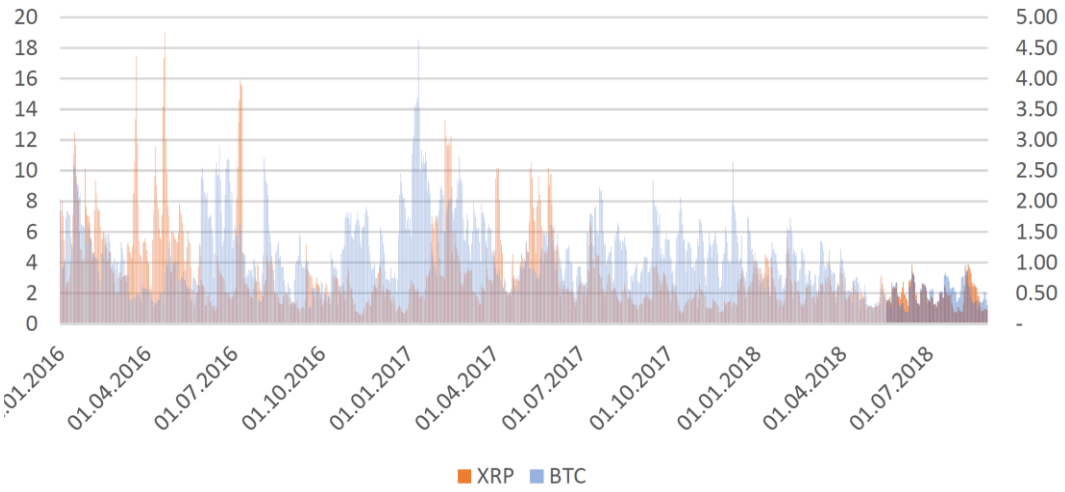

Figure 20: XRP Hui-Heubel Liquidity Ratio (7 days rolling)

The Hui-Heubel ratio was very high at the beginning of the observed period. This seems to be mainly due to the very low turnover ratio. At the beginning of 2017, it was probably also the turnover ratio again that was to blame, while in mid-2017 it was the high volatility. Viewed over the entire period, it is evident that the ratio also fell. However, this was, on average, the highest value of all the currencies examined in all three years.

4.4 BITCOIN CASH (BCH)

Bitcoin Cash is a hard fork of Bitcoin (Cointelegraph, 2020b), which came about because there was a disagreement in the Bitcoin community about how the crypto currency should evolve. In May 2017, it was reported that some users had to wait about four days for their transactions to be confirmed. In order to speed up the process, some were willing to pay higher transaction fees. This meant that small transactions were no longer economically viable because the transaction costs were so high. At the "Future of Bitcoin" conference in Arnhem, July 2017, the Bitcoin Cash protocol Bitcoin ABC was announced. The goal was to increase the block size from 1 to 8 megabytes. With a larger block size, it is possible to perform more transactions per second. As this was a relatively large change, a hard fork occurred on 1 August 2017 (Cointelegraph, 2020b). The future visions of Bitcoin Cash and Bitcoin are also quite different. While Bitcoin would like to establish itself more as a kind of world reserve, Bitcoin Cash aims for the status of a world currency (Hosp, 2019, p. 137).

4.4.1 Price

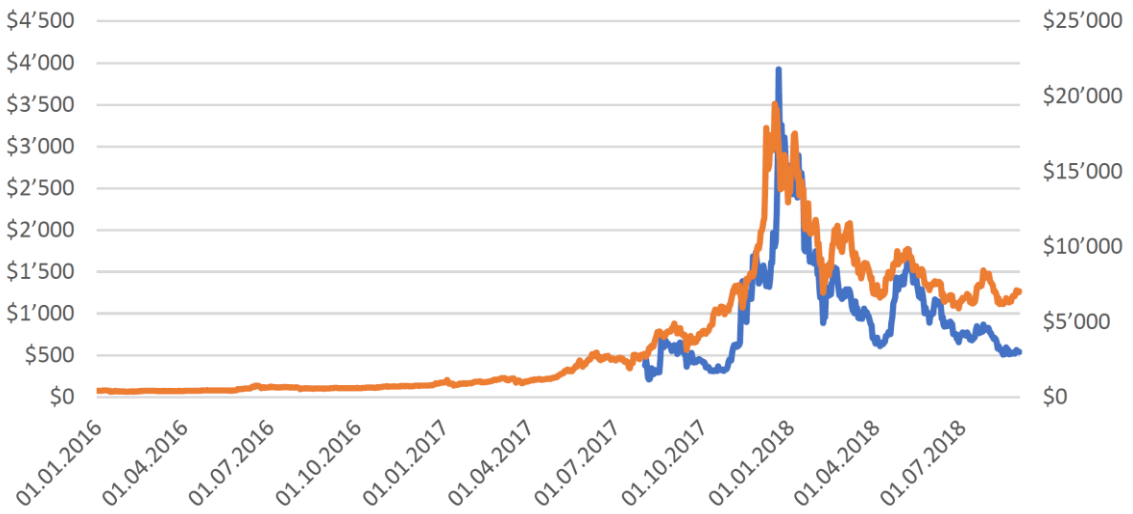

Figure 21: Bitcoin Cash Price

After the hard fork, the price of Bitcoin Cash behaved similarly to that of Bitcoin itself. In the short time the new currency had been in existence, it already generated a return of 42.91% in the period under observation. If the coins had been sold at the peak of USD 3923.07, this would have generated a return of 932.36%. It is obvious, therefore, that Bitcoin Cash had to cope with a big price drop in 2018. The coin lost 77.72% of its value in the first quarter of 2018.

4.4.2 Volume

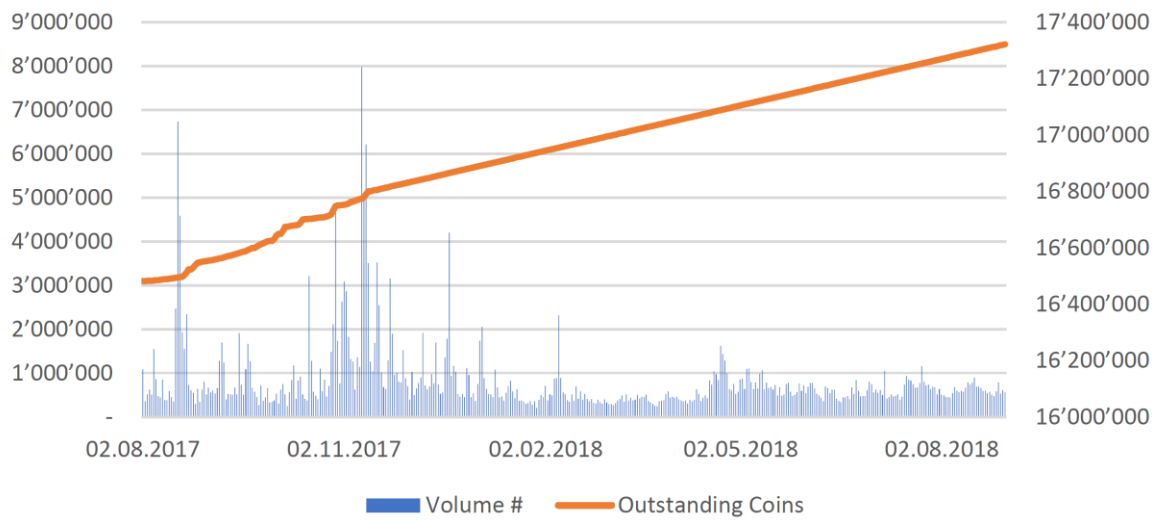

Figure 22: Bitcoin Cash Volume

In terms of coins in circulation, it is noticeable that activities were in initially not very regular. This was to be expected because after the hard fork, miners had to decide whether they wanted to continue to mine Bitcoin or Bitcoin Cash. As far as volumes are concerned, large volumes occurred from the start.

4.4.3 Turnover Ratio

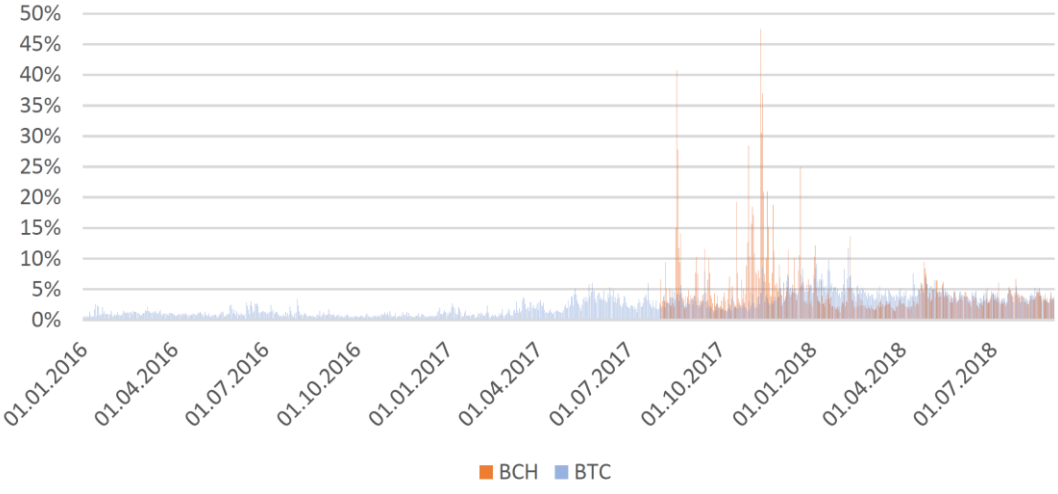

Figure 23: Bitcoin Cash Turnover Ratio

In terms of the Bitcoin Cash turnover ratio, ratios at the beginning of the term were very high. After that, the turnover ratio settled at about the same level as that of Bitcoin.

4.4.4 Conventional Liquidity Ratio

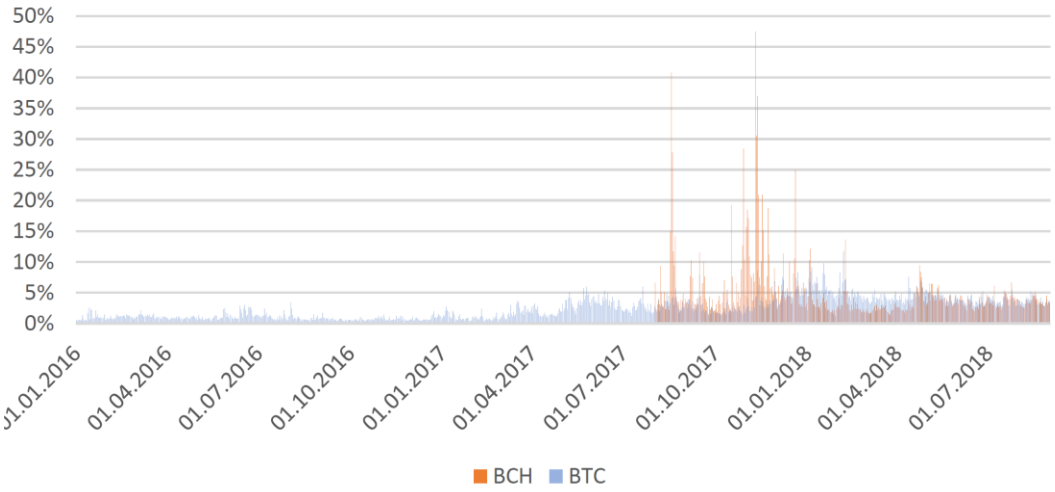

Figure 24: Bitcoin Cash Conventional Liquidity Ratio (30 days rolling)

The conventional liquidity ratio rose slightly over the period observed. It is noticeable that the curves of Bitcoin Cash and Bitcoin are relatively similar, albeit slightly offset.

4.4.5 Amihud Illiquidity Ratio

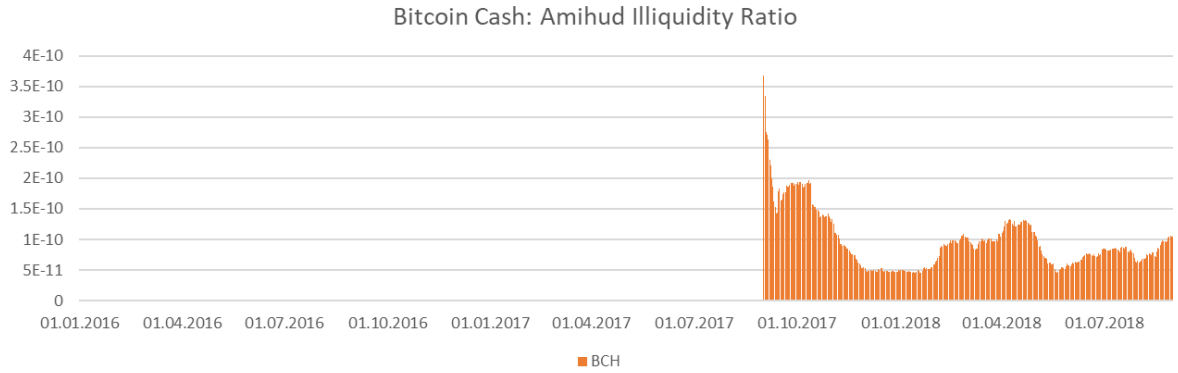

Figure 25: Bitcoin Cash Amihud Illiquidity Ratio (30 days rolling)

Over the period observed, the Amihud Illiquidity ratio fell, but not as sharply as the other coins.

4.4.6 Hui-Hubel Liquidity Ratio

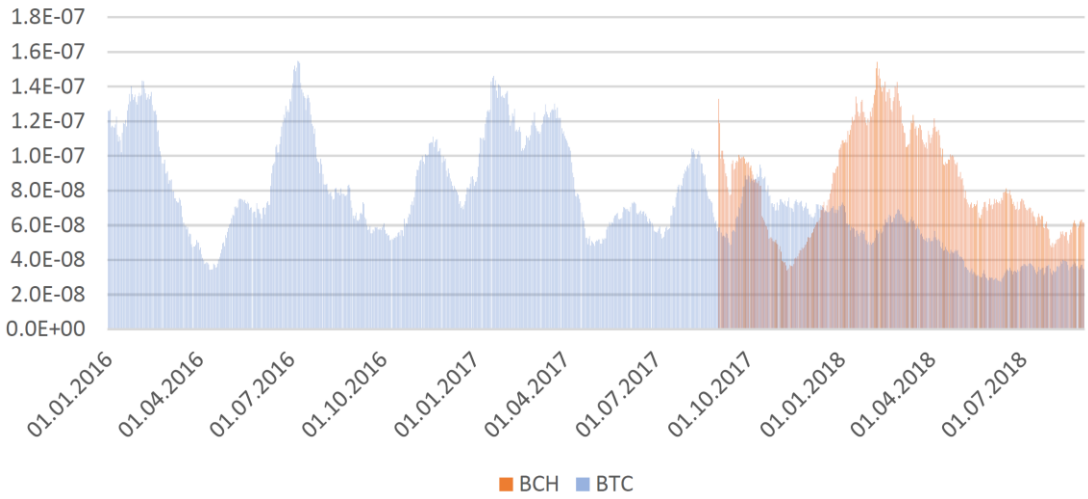

Figure 26: Bitcoin Cash Hui-Hubel Liquidity Ratio (7 days rolling)

The very high Hui-Hubel ratio at the beginning of the period under observation can be explained by the fact that in the first few days there were very large intraday differences between the high and low prices. For example, on the second trading day, the high was USD 756.93 and the low USD 309.33. In addition, at the beginning of 2018 there were large intraday fluctuations but a low turnover ratio, which led to these values.

4.5 LITECOIN (LTC)

LiteCoin is a fork of Bitcoin, which was created by Charlie Lee, a former Google employee (Vontobel, 2019). It was created in October 2011 and is considered one of the first altcoins. In contrast to Bitcoin, LiteCoin uses a different mining algorithm. As a result, it only takes about 2.5 minutes to remove a block, which is four times faster than Bitcoin. The maximum number of coins is four times higher at 84 million. The relationship between LiteCoin and Bitcoin has been compared to the relationship between silver and gold.

4.5.1 Price

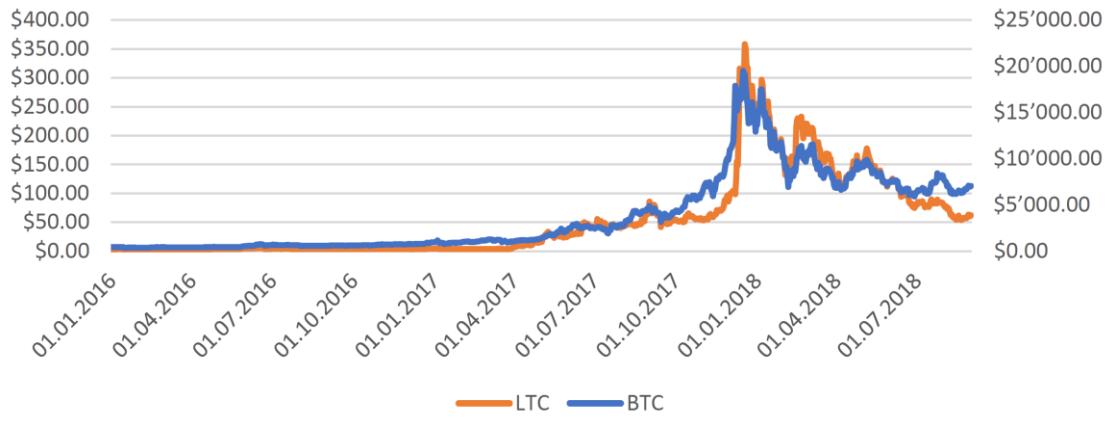

Figure 27: LiteCoin Price

Comparing the prices of LiteCoin and the original Bitcoin, it becomes immediately noticeable that they were very similar. The price rose by 1679% from the beginning of 2016 to the end of August 2018, which is the lowest return of all crypto currencies analyzed in this study.

4.5.2 Volume

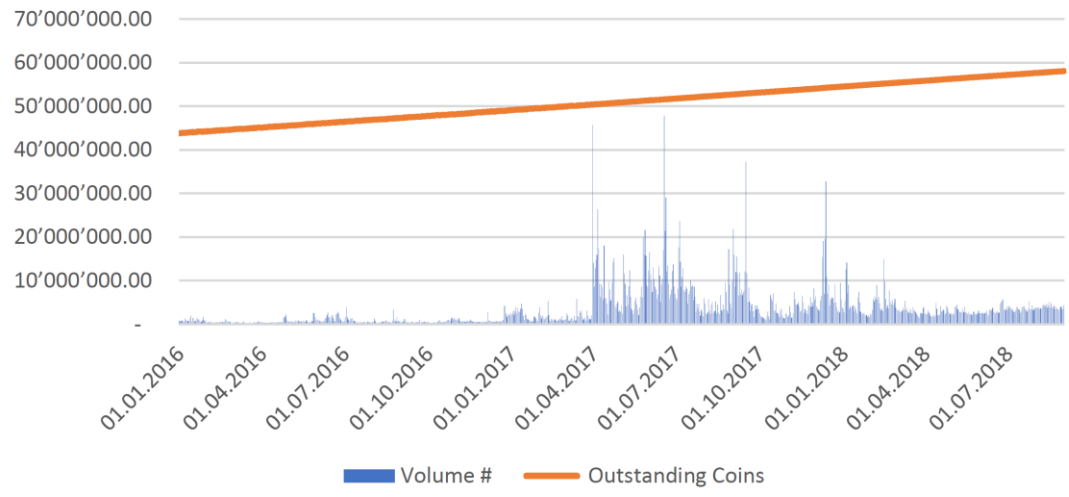

Figure 28: LiteCoin Volume

Just like Bitcoin, LiteCoin also halves every 840,000 blocks. The last halving occurred in late 2019 and the current reward for mining a block is 12.5 units of LiteCoin. The first halving took place in 2015 and the second in 2019, so the effect on the coins in circulation is not apparent. In 2017, the volumes increased significantly.

4.5.3 Turnover Ratio

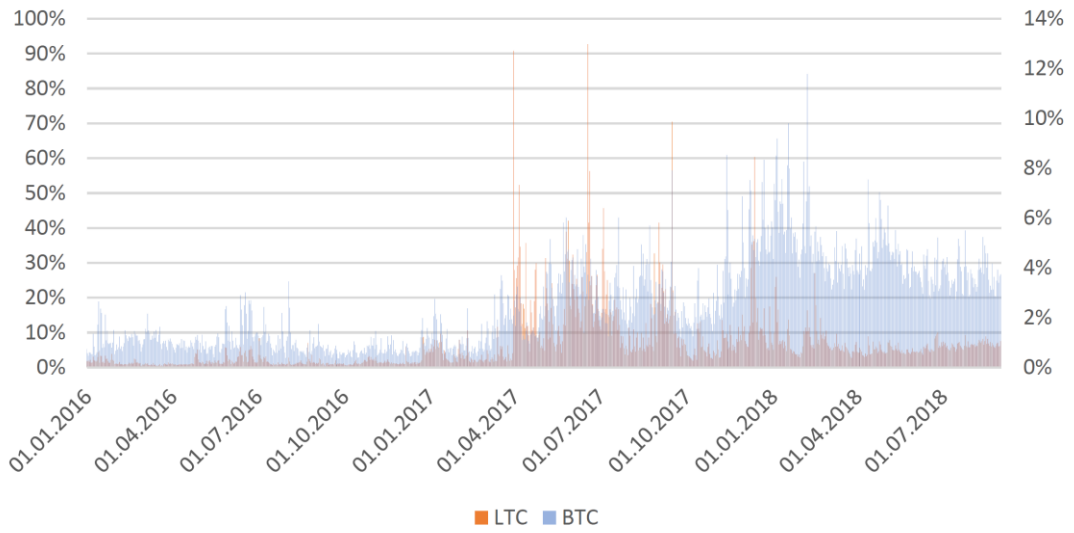

Figure 29: LiteCoin Turnover Ratio

From the turnover ratio of LiteCoin, it can be seen that there was a strong increase in volume in 2017. However, it is interesting to note that while Bitcoin saw another strong increase in turnover in 2018, LiteCoin only experienced a few spikes.

4.5.4 Conventional Liquidity Ratio

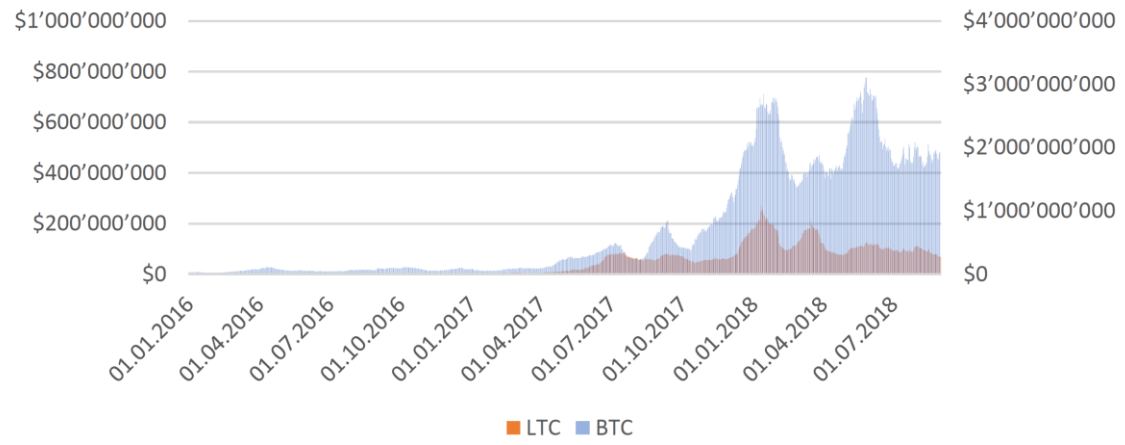

Figure 30: LiteCoin Conventional Liquidity Ratio (30 days rolling)

The conventional liquidity ratio of the LiteCoin shows a positive trend. Its movements were similar to that of Bitcoin. While at the beginning of the period under review trading turnover was around USD 1.3 million, it reached USD 69 million by the end of August 2018. This means that increasingly larger volumes could be traded without a strong impact on the price.

4.5.5 Amihud Illiquidity Ratio

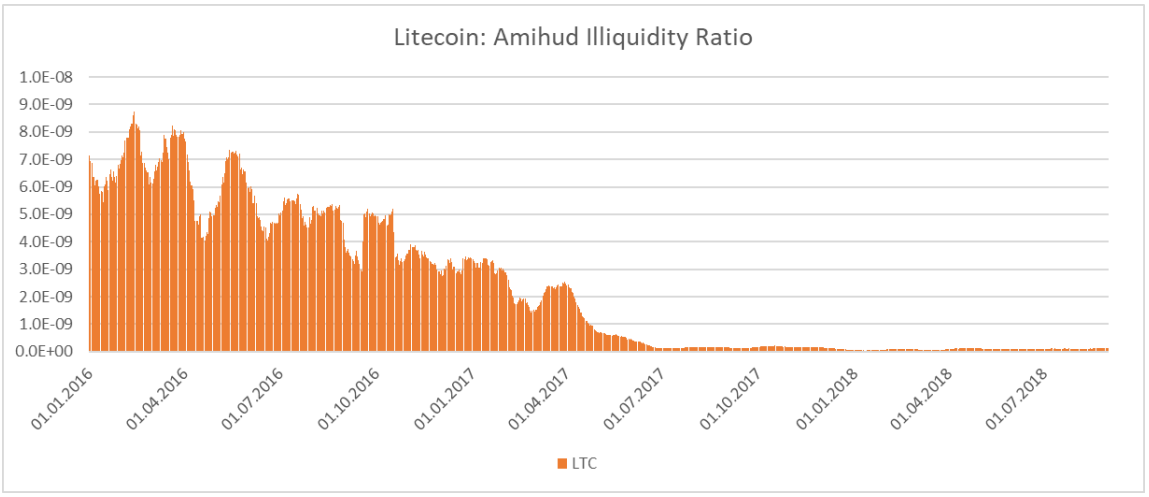

Figure 31: LiteCoin Amihud Illiquidity Ratio (30 days rolling)

The Amihud illiquidity ratio decreased over the period observed. Large volumes, therefore, seem to have had less influence on the price in 2018 than in 2016 and 2017. The decrease was much more gradual here compared to the sharp declines observed for Bitcoin and Ether.

4.5.6 Hui-Heubel Liquidity Ratio

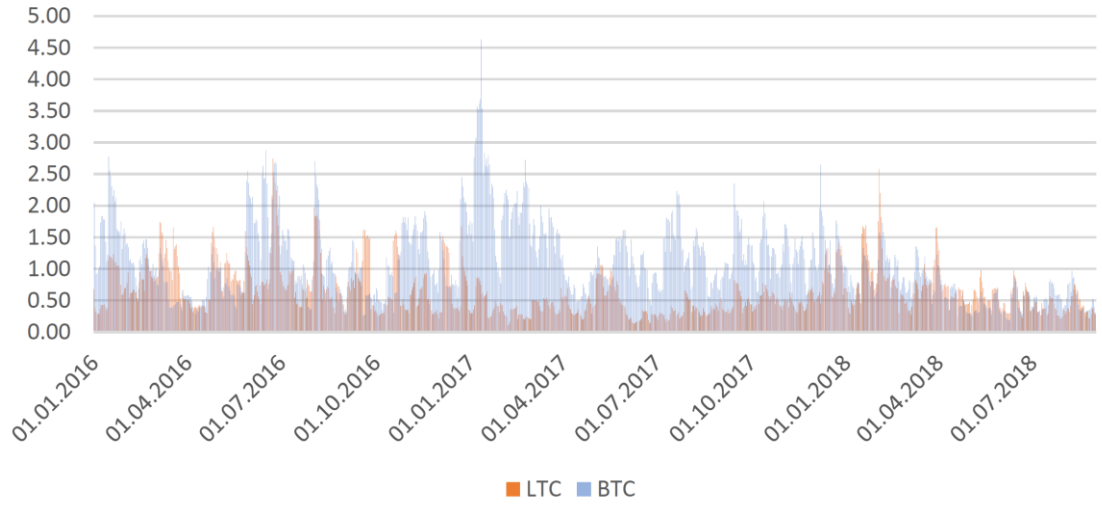

Figure 32: LiteCoin Hui-Heubel Liquidity Ratio (7 days rolling)

The Hui-Heubel ratio of the LiteCoin shows no improvement over the period under observation. The lowest values seem to have been reached in mid-2017 due to the very high turnovers. In terms of the average of the ratio in the individual years observed, LiteCoin had a better Hui-Heubel ratio in each period.

4.6 COMPARISON

4.6.1 Correlation of Returns

2016	BTC	ETH	XRP	LTC
BTC	1			
ETH	0.0350	1		
XRP	0.0793	0.0614	1	
LTC	0.7734	-0.0257	0.0757	1

Table 2: Correlation 2016

Considering the correlation of the daily log returns of all crypto currencies examined in this study in 2016, the correlation between the crypto currencies is still very low, the only exception being LiteCoin. However, this is not too unusual as the currencies are similar in structure.

2017	BTC	ETH	XRP	LTC
BTC	1			
ETH	0.3832	1		
XRP	0.1354	0.1677	1	
LTC	0.4209	0.3866	0.2375	1

Table 3: Correlation 2017

The 2017 correlation matrix shows an increase of the correlation of returns between all crypto currencies compared to the previous year. LiteCoin stands out as an exception. A explanation could be the increased interest in crypto currencies and the boom that this triggered.

2018	BTC	ETH	XRP	LTC	BCH
BTC	1				
ETH	0.8166	1			
XRP	0.7195	0.7554	1		
LTC	0.8365	0.8183	0.7346	1	
BCH	0.8255	0.7946	0.7069	0.8102	1

Table 4: Correlation 2018 (only 8 months)

In 2018, the correlations rose sharply compared with the previous year. In general, all correlations are very high. However, the figures must be put into perspective as the period observed is only 8 months. Again, the correlation between LiteCoin and Bitcoin is the highest. Rather surprising is the very high correlation between the two largest crypto currencies, Bitcoin and Ether. Bitcoin Cash was only added in 2018, but a high correlation to the other currencies is already observable. One possible explanation is that the decline of Bitcoin price after the peak seems to have uniformly flattened all coin exchange rates.

4.6.2 Volatility

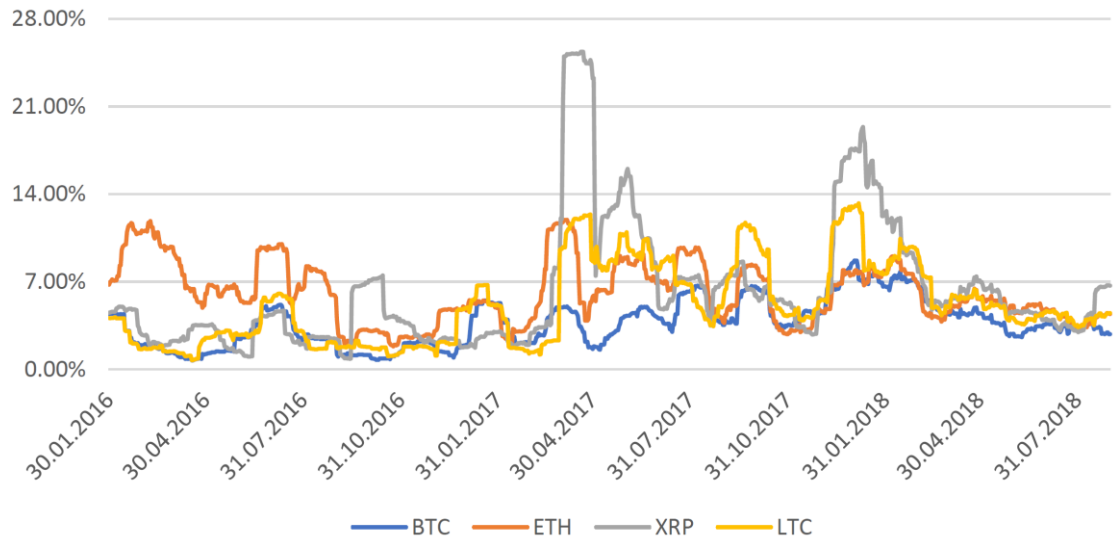

Figure 33: 30-Day Volatility

When looking at volatility, it is noticeable that the values did not only fall over the period under consideration, but even rose slightly. However, the volatilities began to correlate more strongly as the boom receded at the beginning of 2018. Surprisingly, the volatility of the crypto currencies was still extremely high in contrast to other asset classes. In comparison, the average 30-day volatility for the SMI was 1.01% in 2016 and 0.57% in 2017. For the price of a gold ounce in USD, volatility averaged 0.96% in 2016 and 0.64% in 2017. For the CHF/USD rate, volatility was 0.5% in 2016 and 0.44% in 2017. Bitcoin is seen by some investors as a hedge in times of crisis and as an alternative to gold, but an average volatility of 2.25% in 2016 and 4.42% in 2017 does not really support this assumption. The volatility of the other crypto coins was even higher. For XRP, for example, it was 8.32%, which is understandable, considering the individual breakouts.

Conclusions

The objective of this study was to measure and analyze the market liquidity of Bitcoin and the main altcoins. For this purpose, data from the best-known and most highly capitalized crypto currencies were sourced (CoinMarketCap via Kaggle) for the period 1 December 2015 to 31 August 2018. The data set contained the most common key figures such as volume, market capitalization, closing price, as well as daily high and low. These data were then used to calculate the turnover ratio, the conventional liquidity ratio, the Amihud illiquidity ratio, and the Hui-Hubel liquidity ratio. The results were then evaluated against Bitcoin and over time.

There are indications that the crypto markets are maturing and that liquidity among the major currencies under review is improving. The results show that the market liquidity of all crypto currencies improved during the above-mentioned timeframe. This means that larger volumes can be traded without having a major impact on prices.

Of the coins examined, with the exception of XRP, the technology of Bitcoin, Ether, Bitcoin Cash, and LiteCoin is based on blockchain. This has an influence on how new coins are created. In the case of blockchain-based coins, new coins are created by mining, which is why the supply is constantly increasing. This can have a long-term effect on liquidity.

According to the findings, the prices of all crypto currencies increased greatly from early 2016 to mid-2018. A peak was reached at the end of 2017, in the midst of a historic crypto boom. Various new coins and tokens were created during that time. However, the boom did not result in general lower volatility of coin prices, which in turn increased market liquidity. The analysis of volatility showed that the volatility of crypto currencies is still very high compared to traditional asset classes such as equities, bonds, or precious metals.

The results also show that the correlation of returns between the individual currencies has increased. Regarding the correlations between the crypto currencies, it is noticeable that in 2016 they were still very low except in relation to LiteCoin. From 2017 onwards, the correlations of returns between all crypto currencies increased compared to the previous year and in 2018 they rose sharply (but only measured over eight months). The impact of increasing correlations on market liquidity is ambiguous. On the one hand, it could be argued that correlated returns mean that the different markets are more closely linked, which may be advantageous for market liquidity as the impact of any trading volume may be more widely distributed (if the correlation level is maintained, of course). On the other hand, any negative effect on market liquidity may affect all crypto currencies.

One should be cautious to extend this analysis to other crypto coins. Crypto coins are exchanged on unregulated exchanges. Even worse, there have already been a number of scandals (e.g., the scandal at the Mt. Gox Bitcoin exchange in Tokyo; see Welter, 2019). As there are over 3,000 crypto coins in circulation, it is very likely that their liquidity is much less than that of the five main crypto currencies discussed here. However, this could be an interesting topic for future research.

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