THE DEPENDENCE BETWEEN THE RETURN RATE VOLATILITY AND THE TRADING VOLUME OF THE MOST IMPORTANT CRYPTOCURRENCIES – A CORRELATION ANALYSIS

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Abstract

The aim of the article is to identify the dependence between the return rate volatility and the trading volume of the most significant cryptocurrencies. An attempt was made to answer the question: is an increase in the volume of transactions accompanied by a rise in the level of risk, emerging from a more unstable return rate, or does an upsurge in the trading volume possibly ease fluctuations in cryptocurrency prices (and vice versa)? To achieve the aim, the analysis of the correlation coefficient was utilised. The study allowed to observe – as a rule – a positive dependence between the variables. It is not equally strong for all examined currencies and its relevance changes depending on whether the trading volume is measured in dollars or in currency's units. Additionally, a positive correlation between the level of expected income and investment risk, prevailing on most financial markets, was noticed. The results of the study indicate that the stabilisation of the exchange rate does not result in fact in the spread of cryptocurrencies, an increase in their popularity or the intensification of buy and sell orders, but it is the speculation which is much more important for the growth of the trading volume.

Key words: return rate, trading volume, cryptocurrencies

JEL Code: F31, G12, G15

Introduction

Cryptocurrencies are becoming an increasingly popular asset, serving not only investments but also speculation or payment. Their role in international finances is solidifying steadily and the trading volume in their markets is subject to a long-term upward trend. As a result, more and more often they are treated as standard financial instruments and put under the fundamental and technical analysis – consequently, the significance of forecasting their prices and identifying the determinants of their return rates is growing continuingly. On the other hand, trading in cryptocurrencies is encumbered with substantial risk due to major fluctuations in their exchange

rates. However, this does not deter a large number of investors who, despite (or may be actually because of) the considerable volatility of the prices, are trading on cryptocurrency exchanges hoping to make profits.

The aim of the article is to identify the relationship between the return rate volatility – determining the scale of risk – and the trading volume of the most significant cryptocurrencies. An attempt was made to answer the question: is an increase in the volume of transactions accompanied by a rise in the level of risk, emerging from a more unstable return rate (growth of volatility), or does an upsurge in the trading volume possibly ease fluctuations in cryptocurrency prices (and vice versa)? It also seems that the stabilisation of the exchange rate should result in the spread of cryptocurrencies and in the expansion of their popularity and the trading volume (Michalczyk, 2018). The identification of this dependence's nature is important both from the applicative point of view – in order to facilitate forecasting cryptocurrencies' exchange rates – and from the cognitive one – for explaining phenomena and relationships taking place on virtual currency exchanges. To achieve the aim, the analysis of the correlation coefficient, one of the simplest statistical methods, was utilised. Nevertheless, it allowed to observe the most important interactions. In the examined variables, in addition to the return rate volatility, the rate value itself was also included, with the intention of slightly widening the context of the studied dependencies.

1 Theoretical background

The dependence between return rates (including their volatility) and trading volumes regarding instruments of financial markets has been investigated for a very long time and described in the economic literature relatively thoroughly. For example, J. M. Karpoff presented a detailed overview of the early theoretical-empirical output in this area (Karpoff, 1987). Most studies indicate the existence of positive correlation between volumes and prices at various approaches – i. e. measured by levels, changes (return rates, both per se and absolute), volatility etc. – in cases of many financial instruments, different in their essence, type and origin. This also applies to currency markets including foreign exchange ones (Mougoue, Aggarwal, 2011). Various theoretical models were developed to explain this connection: distribution, asymmetric information or differences in opinion ones – although there is still no consensus on what is its actual root (Chan, Fong, 2000). It is worth noting that from the perspective of the article's aim, the positive relations between trading volumes and absolute values of the price change and between volumes and the return rate volatility, often mentioned in literature, are particularly

significant – J. M. Karpoff recalled in this context an old Wall Street saying: "It takes volume to make prices move".

There are relatively few publications on statistical analyses of virtual currencies' exchange rates, and most of them focus on the bitcoin as the most important and the oldest cryptocurrency of the global range (Chan, Chu, Nadarajah, Osterrieder, 2017; Conrad, Custovic, Ghysels, 2018; Chaim, Laurini 2018; Silva, Maganini, Almeida, 2018). The number of available studies investigating the relation between their return rates and trading volumes is very limited at all (Koutmos, 2018; Balcilar, Bouri, Gupta, Roubaud, 2017; Blau, 2018). Their dominant observation is the existence of a dependence between these two variables also in the virtual currencies market. Nevertheless, this field can be treated as researched still inadequately and due to the increasingly influential role of cryptocurrencies in international finances, worth further exploration.

2 The method

The analysis concerned nine cryptocurrencies: bitcoin (BTC), ripple (XRP), ether (ETH), lumen (XLM), tether (USDT), litecoin (LTC), monero (XMR), dash (DASH) and xem (XEM). The selection of the sample was determined both by the size of market capitalisation and by the time the given currency had been present on exchanges (tab. 1). It was assumed that the capitalisation should not be less than 0.5 billion USD, which guaranteed the appropriate scale of transactions and the effective operation of market mechanisms, and the particular cryptocurrency – at least three years subject to the organised trade. This should ensure that its market was at the suitable level of maturity and solidified properly and there was a sufficiently large number of data concerning its price and trading volume.

The examined cryptocurrencies differ in many parameters, e. g. the type of the transaction confirmation algorithm used, the category of the encryption mechanism or the level of anonymity. However, in the face of mainly speculative nature of trading in virtual currencies, it can be generally assumed that these attributes may have small impact on adjustments of their return rates. It is worth emphasizing only that one of the nine cryptocurrencies, i. e. the tether, is a so-called stablecoin, which has close influence on the very small scale of fluctuation in its exchange rate. According to declarations made by the creators of the tether, its issuance has full coverage in the reserve of dollars, in a ratio of 1:1. This is to assure its stable value and facilitate the organised exchange of cryptocurrencies – the tether is supposed to be a digital representation of the dollar, guaranteed by its trouble-free exchange to American money at an unchangeable

rate. And indeed, until April 2017, the tether price was constant. Later, some fluctuations occurred, which had their source not only in a significant increase in the volume of transactions, but also in the unconfirmed size of dollar reserves and difficulties in conducting external audits. Nevertheless, the deviations from the parity (1 USDT = 1 USD) higher than 2% was rare and did not exceed approx. 8-9%.

Tab. 1: Cryptocurrencies with market capitalisation higher than 0.5 billion USD, as on 31.12.2018

	System	Currency	Symbol	Capitalisation (USD million)	First year of quotations
1	Bitcoin	bitcoin	BTC	66 811.4	2009
2	Ripple	ripple	XRP	14 818.8	2013
3	Ethereum	ether	ETH	14 273.6	2015
4	Bitcoin Cash	bitcoin cash	BCH	2 809.5	2017
5	EOS	eos	EOS	2 373.2	2017
6	Stellar	lumen	XLM	2 233.1	2014
7	Tether	tether	USDT	1 895.1	2015
8	Litecoin	litecoin	LTC	1 879.9	2011
9	Bitcoin Satoshi Vision	bitcoin sv	BSV	1 531.9	2018
10	TRON	tronix	TRX	1 314.0	2017
11	Cardano	ada	ADA	1 099.4	2017
12	IOTA	mega iota	MIOTA	986.9	2017
13	Binance Coin	binance coin	BNB	805.2	2017
14	Monero	monero	XMR	803.2	2014
15	Dash	dash	DASH	697.8	2014
16	NEM	xem	XEM	599.2	2015
17	Ethereum Classic	ether classic	ETC	559.5	2016
18	NEO	neo	NEO	512.5	2016

Shaded are the currencies introduced to exchanges later than in 2015 (less than 3 years of quotations).

Source: own elaboration based on the data provided by (Cryptocurrency, 2019).

When making analyses, the natural logarithm of the chain index of the closing exchange rate of a given cryptocurrency against the dollar was accepted as the daily return rate measure:

$$R_t = \ln \frac{E_t}{E_{t-1}},$$

where R_t is the daily return rate and E_t stands for the closing exchange rate of a cryptocurrency in USD. Then the average rate in a given period (monthly and semi-annual) was an indicator of the expected income, while the measure of risk, instability of the return rate and its volatility was its standard deviation in a given time interval.

In order to quantify another of the analysed variables, i. e. the trading volume, the average value of transactions on cryptocurrency exchanges in a given period was utilised. It is

mainly determined by speculative demand and supply, but somewhat constitutes an indicator of the expansion and the popularity of a currency, too. Although directly omitting other spheres: payments, savings etc., the scale of transactions on exchanges is also a derivative of the use of a given cryptocurrency in settlements and thesaurisation. An additional problem was making a decision whether to measure the trading volume in USD or in cryptocurrency's units. It could be justified that applying each of the solutions might encumber the data with the level of the currency's exchange rate against the dollar. Both approaches were therefore included in the study.

The analysis covered the period of three full years of 2016-2018, appointed on the one hand by the availability of figures, on the other – by the necessity to collect their sufficient amount. The calculation of correlation coefficients was made for daily data as well as for monthly and semi-annual intervals.

3 The results

The analysis of the coefficient of correlation between daily return rates and trading volumes, whether expressed in dollars or in currency's units, indicated a total lack of dependence for all nine researched cryptocurrencies. The values of the coefficient, both for non-delayed data and after introducing a one-day delay – either in the volume or in the return rate, did not exceed the range from -0.10 to 0.39. Even taking as a measure of the volume its daily change instead of the value per se, did not bring significant adjustments in the coefficient's levels. A noteworthy rise in the strength of correlation occurred only when replacing the return rates with their absolute values (which in a sense are also a measure of volatility), and this confirmed that price changes in both directions require an appropriate scale of trade. In this approach, the correlation coefficient for the volume in units and non-delayed data reached in the cases of XRP, XLM, LTC and XMR the ceilings of as much as 0.50-0.66.

Much more promising results were acquired when analysing data on a monthly basis, which additionally allowed to include the standard deviation of the return rate (the measure of risk and volatility) as a variable. The values of the correlation coefficient were calculated in five arrangements, i. e. for the relationships between:

(1) the average daily return rate in months (expected income) and its standard deviation (volatility) in the same intervals,
(2) the average return rates and trading volumes in USD,
(3) the average return rates and trading volumes in the cryptocurrency's units,

(4) the standard deviation of the return rate and the average trading volumes in USD,
(5) the standard deviation of the return rate and the average trading volumes in the cryptocurrency's units.

Tab. 2: Correlation coefficients between the average daily logarithmic return rate, its standard deviation and the average daily trading volume on exchanges of the most important cryptocurrencies for monthly data of years 2016-2018

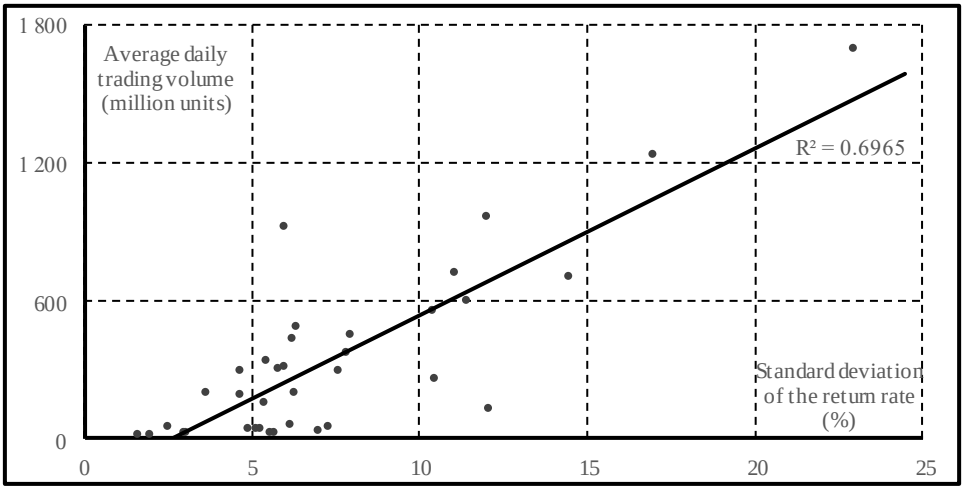
Currency	Pair of variables for which the coefficient is calculated				
	(1)	(2)	(3)	(4)	(5)
	A & B	A & C	A & D	B & C	B & D
BTC	-0.06	-0.23	-0.26	0.61	0.55
XRP	0.66	0.03	0.29	0.41	0.59
ETH	0.45	-0.21	-0.15	0.02	0.14
XLM	0.69	0.20	0.64	0.35	**0.83**
USDT	0.03	0.00	0.00	0.29	0.28
LTC	0.46	0.16	0.17	0.67	0.62
XMR	0.57	0.03	0.49	0.27	**0.70**
DASH	0.37	-0.25	-0.25	0.32	0.20
XEM	0.66	-0.04	0.27	0.48	0.47

A – the average daily logarithmic return rate in a given month
B – the standard deviation of the daily logarithmic return rate in a given month
C – the average daily trading volume in USD in a given month
D – the average daily trading volume in the cryptocurrency's units in a given month
Shaded are the coefficients with the absolute value equal at least 0.5.

Source: own calculations based on the data provided by (Cryptocurrency, 2019).

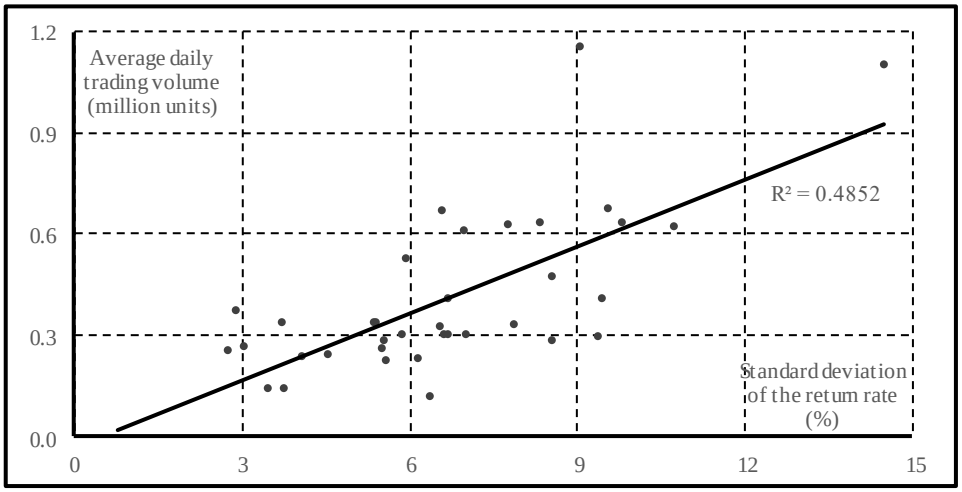
The highest values of the coefficient were obtained regarding dependence (1) and (5), and cryptocurrencies: XRP, XLM, XMR and XEM (tab. 2). This corroborated, firstly, that also in the case of cryptocurrencies there exists a positive connection between levels of expected income and of investment risk, which is ubiquitous on financial markets, and secondly, that the nature of the relationship between the return rate volatility and the trading volume of major cryptocurrencies is essentially positive, too. Slightly weaker correlation occurred concerning BTC and LTC, as well as the arrangement (4). At the same time, it seems that the link between the average return rate and the trading volume is of low significance – the absolute value of the coefficient for dependences (2) and (3) did not exceed 0.5, except for XLM, where for the trading volume in units it equalled to 0.64.

Fig. 1: The scatter diagram of the standard deviation of the daily logarithmic return rate and the average daily trading volume on exchanges of the lumen (XLM) in months of years 2016-2018



Source: own elaboration based on the data provided by (Cryptocurrency, 2019).

Fig. 2: The scatter diagram of the standard deviation of the daily logarithmic return rate and the average daily trading volume on exchanges of the monero (XMR) in months of years 2016-2018



Source: own elaboration based on the data provided by (Cryptocurrency, 2019).

The correlation coefficient reached particularly high levels for the relation between the standard deviation of the return rate (its volatility) and the trading volume in the cryptocurrency's units in the cases of the lumen (0.83) and the monero (0.70). The representation of these variables on a scatter diagram (fig. 1 and 2) also showed a clear positive dependence.

The results of the analysis of the semi-annual data, although essentially based on a relatively limited number of figures (six half-years for each currency), confirmed strong, positive relationships between the average return rate and its standard deviation (1) and the return rate volatility and the trading volume in the cryptocurrency's units (5). In the case of the first dependence, the values of correlation coefficients for as many as six out of the nine analysed currencies exceeded the level of 0.5, reaching even ceilings of more than 0.8 (tab. 3). Regarding the relations (5), and also (4), the outcome was similar to the one for monthly data: moderately high values in both cases for BTC and LTC, and very high ones concerning the dependence between the return rate volatility and the trading volume in units for XLM and XMR.

Tab. 3: Correlation coefficients between the average daily logarithmic return rate, its standard deviation and the average daily trading volume on exchanges of the most important cryptocurrencies for semi-annual data of years 2016-2018

Currency	Pair of variables for which the coefficient is calculated				
	(1)	(2)	(3)	(4)	(5)
	A & B	A & C	A & D	B & C	B & D
BTC	0.25	-0.48	-0.50	0.69	0.59
XRP	**0.74**	-0.50	-0.07	0.18	0.43
ETH	**0.85**	-0.60	-0.51	-0.29	-0.28
XLM	**0.86**	-0.43	0.66	0.03	**0.79**
USDT	0.15	-0.13	-0.13	0.16	0.16
LTC	0.59	-0.18	0.16	0.64	0.65
XMR	**0.80**	-0.29	**0.73**	0.16	**0.84**
DASH	0.39	-0.56	-0.44	0.39	0.15
XEM	**0.71**	-0.51	-0.23	0.14	-0.17

A – the average daily logarithmic return rate in a given half-year
B – the standard deviation of the daily logarithmic return rate in a given half-year
C – the average daily trading volume in USD in a given half-year
D – the average daily trading volume in the cryptocurrency's units in a given half-year
Shaded are the coefficients with the absolute value equal at least 0.5.

Source: own calculations based on the data provided by (Cryptocurrency, 2019).

Interestingly, unlike in the case of monthly data, in the relations of the average return rate and the trading volume, i. e. (2) and (3), aside from significant positive values of the correlation coefficient for lumen and monero in the arrangement (3), noteworthy negative numbers (from -0.6 to -0.5) appeared here. Perhaps, they are not very high (in absolute terms) and concern rather modest data sets, but they may constitute an indication that there also exists

a dependence between an increase in the trading volume and a reduction of the return rate (and vice versa).

Conclusions

The study of the relation between the scale of turnover risk of the most significant cryptocurrencies (determined by the return rate volatility) and their trading volume on exchanges, employing the correlation coefficient analysis, allowed to observe – as a rule – a positive dependence between variables. Nevertheless, it is not equally strong for all examined currencies and its relevance changes depending on whether the trading volume is measured in dollars or in currency's units. A particularly noticeably relationship pertains to the lumen and the monero, whereas it seems to be weakly present in the cases of the ether, the tether and the dash. Additionally, a positive correlation between the level of expected income and investment risk, prevailing on most financial markets, was noticed.

Therefore, the correlation analysis can be basically assumed to confirm that, on the one hand, increasing volume of trade on exchanges contributes to fluctuations in cryptocurrencies' prices and a more unstable return rate, while its reduction is connected with lower volatility. It is based on rational premises: to make exchange rate's adjustments – both upwards and downwards – an appropriate scale of trade is necessary („It takes volume to make prices move"). On the other hand, the reverse relation seems to be justified, too: a rise in the scale of exchange rate (rate of return) variations may attract investors more risk-willing and seeking higher earnings opportunities, and boost the trading volume, while lower price volatility accompanied by limited chances to achieve extraordinary profits can discourage them and reduce the size of exchanges' turnover. The results of the study indicate then that the stabilisation of the exchange rate does not result in fact in the spread of cryptocurrencies, an increase in their popularity or the intensification of buy and sell orders, but it is the speculation – particularly realisable under circumstances of the high volatility of the return rate – which is much more important for the growth of the trading volume.

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