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CRYPTOCURRENCY PORTFOLIO RISK MANAGEMENT

The investment process is always risk-related. Especially high risk is associated with cryptocurrency transactions. This is due to the novelty and institutional uncertainty of these instruments. Investments in cryptocurrency can be quite risky as their price is very volatile. Therefore, making the correct decisions in investing and trading cryptocurrency in order to get the most return is a rather difficult task.

Today bitcoin remains the most widespread cryptocurrency: there is the largest market capitalization among other digital currencies (about $220 billion) [1]. The first positions of the market capitalization rating as of July 2019 are the following cryptocurrencies: Ethereum (about $33 billion), XRP (Ripple) - about $17 billion, Litecoin and Bitcoin Cash (about $7.5 billion each).

Diversification is an important risk reduction tool. Diversification is realized through the creation of a portfolio of financial assets. Markowitz model is the classic method of investment portfolio forming [2]. This model relies on the hypothesis of a normal distribution of returns. However, numerous theoretical researches in the field of finance [3] – [8] and the events in the financial market at the end of 2008 - early 2009 are doubted the hypothesis of a normal return distribution. It has been shown that the financial assets distribution contains so-called "heavy tails". It indicates a high likelihood of very large and very small return values realization.

The results of the study [9] showed that the inclusion of several cryptocurrencies in the investment portfolio allows diversifying the risks inherent in these assets. The goal of this study is evaluating the

cryptocurrencies investment risks and comparing them with the securities investment risk, in particular with the stocks investment risk.

Data and Methodology. Our analysis was done on the basis of historical data on prices of 6 cryptocurrency (Bitcoin, Bitcoin Cash, Litecoin, XRP, Ethereum, NEM) for the period from July 1, 2018 to September 30, 2019. This data are freely available from the site analytical service CoinMarketCap and site www.finance.yahoo.com. The cryptocurrency profitability was estimated by us through the corresponding normalized cryptocurrency return is performed according to

$$x_{ni} = C_{ni+1} / C_{ni} - 1, \quad (1)$$

where x_n is the daily return of the n-th asset, C_n is the daily closing price of the n-th asset, i is the observation number. The main characteristics of the investigated cryptocurrency return for the observed period are given in Table 1. For comparison, the Amazon stock returns statistical characteristics are shown in last column of the table 1. Correlation analysis showed that the return of the cryptocurrency is weakly correlated with Amazon stock return. Therefore adding Amazon stocks to the cryptocurrency portfolio can be the risk diversification good tool.

Table 1

Statistical characteristics of cryptocurrency return and AMZN return for the period 07/01/2018 to 09/30/2019

	Bitcoin	Bitcoin Cash	Litecoin	XRP	Ethereum	NEM	AMZN
Minimum	-0.141	-0.336	-0.165	-0.171	-0.187	-0.175	-0.078
Maximum	0.174	0.512	0.308	0.380	0.181	0.253	0.094
Distribution form factor γ	0.0140	0.0234	0.0252	0.0205	0.0227	0.0257	
Median, μ	0.001	-0.004	-0.003	-0.003	-0.001	-0.001	0.001
Average	0.001	-0.001	0.000	0.000	-0.001	-0.002	0.000
Standard deviation	0.036	0.066	0.051	0.050	0.048	0.051	0.021
Skewness	0.180	1.483	0.858	1.783	-0.128	0.663	0.021
Return per last 3 months	-0.002	-0.005	-0.008	-0.004	-0.004	-0.008	-0.001
The risk zone boundary per last 3 months ($\alpha = 0.95$)	-0.120	-0.135	-0.166	-0.104	-0.151	-0.169	-0.023
Risk measure per last 3 months, %	11.80	13.04	15.87	10.00	14.66	16.07	2.17

The profitability of the financial instrument and its risk are the most important criteria for choosing an investment object [2,3]. Cryptocurrency profitability we estimated as the return average over some final period of time. There are several approaches to assessing investment risk. The return variance is the risk estimate in the case of return normal distribution. Our study found that Amazon stock returns have a normal distribution, but cryptocurrency returns do not.

Under the investor risk we understand the difference between the most expected value of cryptocurrency return ($\bar{x}$) and 5% quantile of return (risk zone boundary L), which is determined using the corresponding return distribution. If the distribution is normal one, the most expected return value $\overline{p}$ is the average value of sample. If the distribution is different from the normal one and it is asymmetric, we will use the median return Me as an expected return.

Consequently, the value of the asset risk, in accordance with the above definition, can be estimated by the ratio

$$V_j = Me_j - L_j . \tag{2}$$

As a result of research of the cryptocurrencies Bitcoin, Bitcoin Cash, Litecoin, XRP, Ethereum, NEM, using the Pearson and Kolmogorov-Smirnov tests, in all cases the hypothesis of normal returns was rejected. Computer experiments showed that the return of the investigated cryptocurrency with good accuracy is described by the Cauchy distribution. The Cauchy distribution function has the form

$$F(x) = \frac{1}{\pi} arctg\left(\frac{x-\mu}{\gamma}\right) + \frac{1}{2} \cdot \tag{3}$$

Here μ is the mathematical expectation (median) of return, γ is the coefficient of distribution function chosen by us for each case in accordance with the least squares method. The parameters μ , γ for the various cryptocurrencies are shown in Table 1.

Using the form of the Cauchy distribution function (3), we can find an analytic expression for risk degree at a given confidence level α

$$L_\alpha = \mu + \gamma \cdot tg\left(\pi\left(\alpha - \frac{1}{2}\right)\right). \tag{4}$$

The results of risk V calculations are shown in the last line of Ta-

ble 1. For comparison, are given at Amazon stock returns. The range of the Amazon stock return fluctuations (0.75%) is comparable to the range of the cryptocurrency's return fluctuations. The average Amazon stock return (0.1%) is small but stable positive. The average risk of Amazon stock (3.16%) is much lower (3 - 5 times) than the cryptocurrency risk.

Portfolio optimization. We will examine how the inclusion of Amazon stocks affects the cryptocurrency portfolio. A portfolio that consisting of Amazon stocks and six cryptocurrencies we've researched was built. We optimize the portfolio by applying the "modified Markowitz model" [8,9]. The mathematical description of the problem will have the form:

the problem of the maximum return

$$\begin{cases} R_p = w_i \times \mu_i \to max; \\ V_p = \sqrt{\sum_{i=1}^{7}\sum_{j=1}^{7}\left(w_i \times V_i \times w_j \times V_j \times \rho_{ij}\right)} \le V_{req}; \\ w_i \ge 0; \sum w_i = 1. \end{cases} \quad (5)$$

the problem of the maximum return

$$\begin{cases} V_p = \sqrt{\sum_{i=1}^{7}\sum_{j=1}^{7}\left(w_i \times V_i \times w_j \times V_j \times \rho_{ij}\right)} \to min, \\ R_p = w_i \times \mu_i \ge R_{req}; \\ w_i \ge 0; \sum w_i = 1. \end{cases} \quad (6)$$

An approach similar to the Markowitz one to assess portfolio risk V_p was used, but instead of a stock return standard deviation the risk measure V_i we got was used. The correctness of such approach to optimizing the portfolio substantiated in the works [6,7]. Here w_i is the i-th financial asset weight in portfolio, V_p is the general portfolio risk, V_{req} is the recommended portfolio risk, R_p is the overall portfolio return, R_{req} is the recommended portfolio return. For portfolio optimization we will use the expected cryptocurrency stock returns μ_i, previously found risk estimates V_i and a pseudo-covariance $cov\left(r_i, r_j\right) = \rho_{ij} \cdot V_i \cdot V_j$, where $\rho_{ij}, i = 1,7; j = 1,7$ is a Pearson correlation coefficient between the two time series of cryptocurrency stock return.

Using (6) without regard to second condition the minimum

possible portfolio risk level $V_p = 2.42\%$ was obtained. The return of corresponding portfolio is $R_P = 0.129\%$. This portfolio consists of 99% Amazon stocks and of 1% of XRP cryptocurrency. Using (5) without regard to second condition the portfolio with maximum possible risk level $V_p = 9.33\%$ and maximum return was obtained. The return of corresponding portfolio is $R_P = 0.235\%$. This portfolio consists of 100% Bitcoin cryptocurrency. Both marginal approaches are unacceptable when solving the problem of maximizing returns with the risk diversification requirement. By taking the average risk value $V_p = 5.88\%$ and solving the problem of portfolio's return maximizing, an «optimal portfolio» with return $R_P = 0.190\%$ was got. This portfolio consists of 44% Amazon stocks and of 56% of Bitcoin. Such portfolio can be considered as the conditionally optimal portfolio because it has a maximum return at the limited risk level. So, has been shown that the inclusion of Amazon stocks into portfolio is an effective tool for cryptocurrency portfolio risk management.

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STRATEGIC ACCOUNTING DIRECTIONS OF UKRAINIAN ENTERPRISES DEVELOPMENT IN THE CONTEXT OF EUROPEAN INTEGRATION

Achieving the goals of the progressive development of enterprises in the conditions of transformation of market relations in the globalized economic space by the concept of strategic management is projected to study information resources that fully, meaningfully and qualitatively assess both the state of the economic system and the prospects for its evolution and necessary changes. Modern strategic analysis relies on the information base as an existing content and proper responsiveness with the ability to process information on the latest information technologies.

Only the flexible, operational accounting system of strategic management accounting can solve these important tasks. Today's economic conditions provide for the division of management accounting into traditional management and much needed strategic management accounting, each of which uses a specific accounting and economic framework and has specific aspects of making effective management