Portfolio optimization in the digital financialization era using cryptocurrencies

(การเพิ่มประสิทธิภาพการลงทุนแบบกลุ่มหลักทรัพย์ในยุคการเงินดิจิทัลโดยใช้สกุลเงินดิจิทัล)

Pongsutti Phuensane [1]

Yotaek Chaiyarit [2]

[1] Lecturer of finance

[2] Graduate student

Khonkaen Business School, KKU

Outline

- Background
- Challenges[GAP]
- Objective
- Methodology
- Result
- Conclude
- Reference

Background

- **Development of investment portfolio theory**
  - **TPT, MPT and PMPT** *(Lekovic, 2021)*
- **Modern Portfolio Theory** *(Markowitz, 1952)*
  - **Rational investor**
  - **Multiple Assets**
  - **Overall risk**
- **The minimum return an investor can expect on any asset is usually the same risk-free rate of return combined with a margin of return to compensate for the risk** *(Murphy, 1990)*

Background(Cont.)

- **Cryptocurrency** *(Bhatt, 2014)*
  - **Can be used to purchase goods or services**
  - **High security features**
  - **Decentralized finance**
- **High potential and Second Life or Maybe equivalent to the social network Web 2.0** *(Guadamuz and Marsden, 2015; Nian and Chuen (2015); Gafar et al., 2021)*

Background(Cont.)

- **Support combine Cryptocurrency to Portfolio**
  - **Low correlation with traditional assets***(Krückeberg and Scholz, 2019)*
  - **Improve risk and returns***(Brière et al., 2015;Brauneis and Mestel, 2019; Symitsi and Chalvatzis, 2019; Kajtazi and Moro; 2019; Borri, 2019;Trimborn et al., 2020; Bialkowski, 2020;Petukhina et al., 2021; Kaya and Mostowfi, 2021)*

Background(Cont.)

- **Moving average**
  - **Suitable for risks and returns***(Skintzi and Xanthopoulossisinis, 2007; Metghalchi et al., 2021)*
  - **Price prediction***(Khorram and Sheshmani, 2015;Ren et al., 2018; CALISKAN et al., 2020)*
- **Naive Portfolio**
  - **Minimizes risk without sacrificing expected returns***(Tang, 2003)*
  - **Optimal strategy***(Bock, 2018;Brown et al., 2013;li, 2018)*

Background(Cont.)

- **Mean variance portfolio**
  - **There was no significant difference in performance between MinVar. Vs MaxSarpe.** *(Vinzelberg and Auer, 2021)*

GAPs

- lack of integration
  - G1 : Efficiency by mean variance in Cryptocurrency Add a traditional asset portfolio with transaction costs using moving averages.
  - G2 : Efficiency point in the efficient frontier.
- Identify key points of interest

"Portfolio optimization in the digital financialization era using cryptocurrencies"

Objective

1. To create a portfolio with equal weight distribution using digital assets (The Naïve portfolio).

2. To test the strategy of buying, selling, buying and holding, buying and selling over time Buy and sell following the moving average trend following.

3. To test the level of return and risk according to the Mean-Variance model.

Related Literature

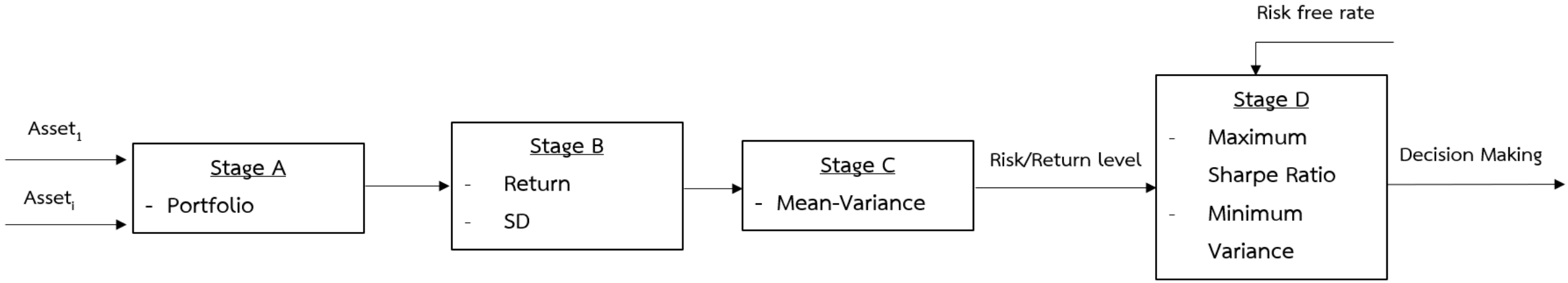
1. **Naïve portfolio** $W_i = \frac{1}{N}$ *(Tang, 2004)*

2. **Mean-Variance** $E(R_p) = \sum_{i=1}^{N} w_i E(R_i)$, $w^T \sum w$ *(Markowitz, 1952)*

3. **Sharpe ratio** $\frac{E(R) - R_f}{\sigma}$ *(Sharpe., 1994)*

4. **MA** $SMA = \frac{(P_1 + P_2 .... + P_n)}{n}$ *(Metghalchi et al., 2021)*

Conceptual framework



DATA

5 Most/Major value Periods 2016 to 2021 [From yahoofinance confirm by Coinbase, investing, Nasdaq and bloomberg]

I. Cryptocurrency
II. Technology Stocks U.S. Market
III. Currency
IV. Commodity

Methodology

1.st Build an investment portfolio by the Naïve portfolio $W_i = \frac{1}{N}$ *(Tang, 2004)*

Port.1	**5 Most value cryptocurrency [BTC, ETH, Tether, XRP and Dogecoin]**
Port.2	**5 Major currency [EUR, JPY, GBP, AUD and CNY]**
Port.3	**5 Most value tech stocks [AAPL,MSFT,GOOG,AMZN and FB]**
Port.4	**5 Major commodity [Crude Oil, Gold, Coffee, Natural Gas and Silver]**
Port.5	**No.1 + No.2**
Port.6	**No.1 + No.3**
Port.7	**No.1 + No.4**

Methodology (Cont.)

2.nd Trading strategy

- **Buy and Hold**
- **Holding Periods (calendar)**
  - **1, 3, 6, 12, 36, 48 months**
- **MA(50,200 Day)**
  - $$SMA = \frac{(P_1 + P_2 .... + P_n)}{n}$$
    - **BUY MA(50) > MA(200)**
    - **Sell MA(50) < MA(200)**

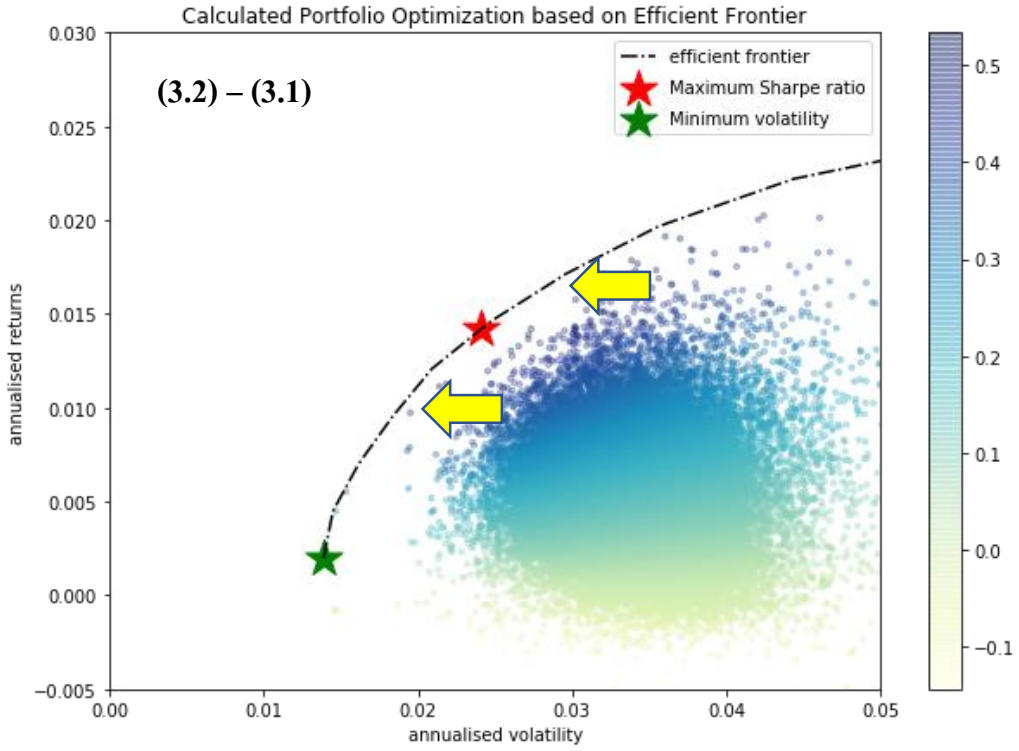
(Skintzi and Xanthopoulossisinis, 2007)

Methodology (cont.)

3.1 rd Mean-Variance from 2nd

- $$E(R_P) = \sum_{i=1}^{N} w_i E(R_i) \qquad (3.1)$$
  - $\sum_{i=1}^{N}$ is sum of asset i to N
- $$w^T \sum w \qquad (3.2)$$
  - w is weight
  - $\sum$ is the variance-covariance matrix

(Markowitz, 1952)



Methodology (cont.)

3.1.1 Optimized Sharpe ratio from 3.rd

$$\max \frac{E(R) - R_f}{\sigma}$$

R_f is risk free rate

SD is standard deviation

(Sharpe, 1994)

3.1.2 Minimum Variance 3.rd

$$VAR(R_{p_{\min}}) = a^2\sigma_x^2 + (1-a)^2\sigma_y^2 + .. + 2a(1-a)r_{xy}\sigma_x\sigma_y + ..$$

or

$$\sigma_{p\,\min}^2 = Min w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + ... + 2w_1w_2\sigma_1\sigma_2\rho_{12} + ...$$

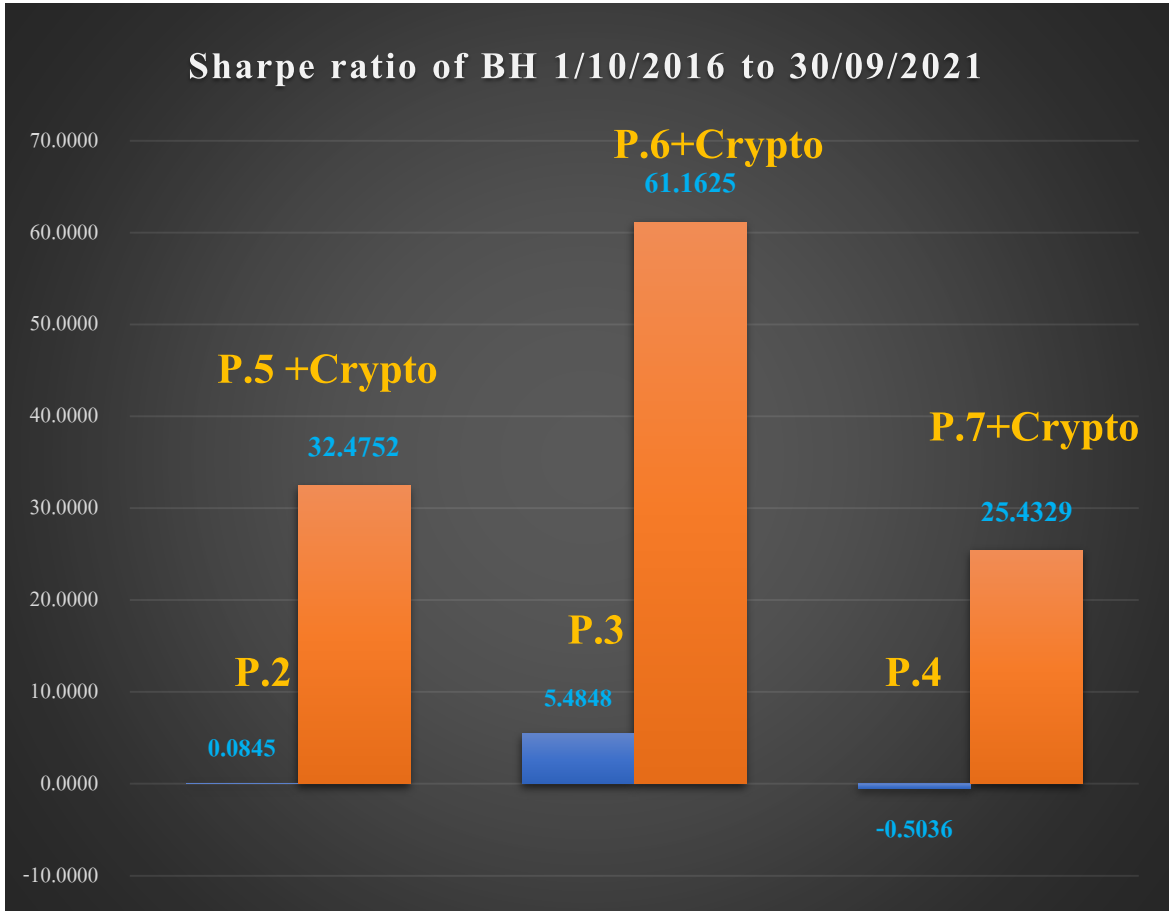
w is weight of asset

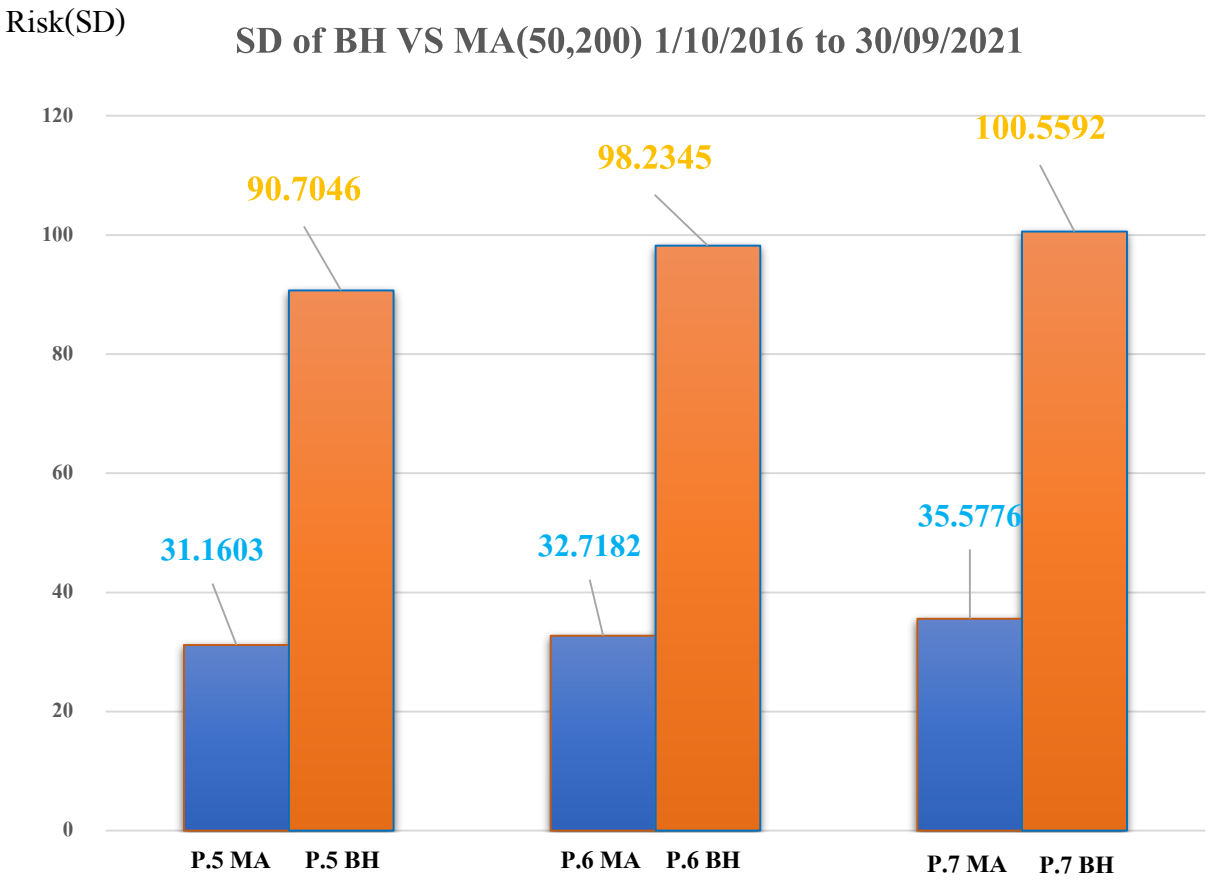
σ is volatility

ρ is correlation coefficient

(Markowitz, 1952)

Result


Sharpe ratio of BH 1/10/2016 to 30/09/2021
70.0000
60.0000
50.0000
40.0000
30.0000
20.0000
10.0000
0.0000
-10.0000
P.2
0.0845
32.4752
P.3
5.4848
61.1625
P.4
-0.5036
25.4329
P.5 +Crypto
P.6+Crypto
P.7+Crypto

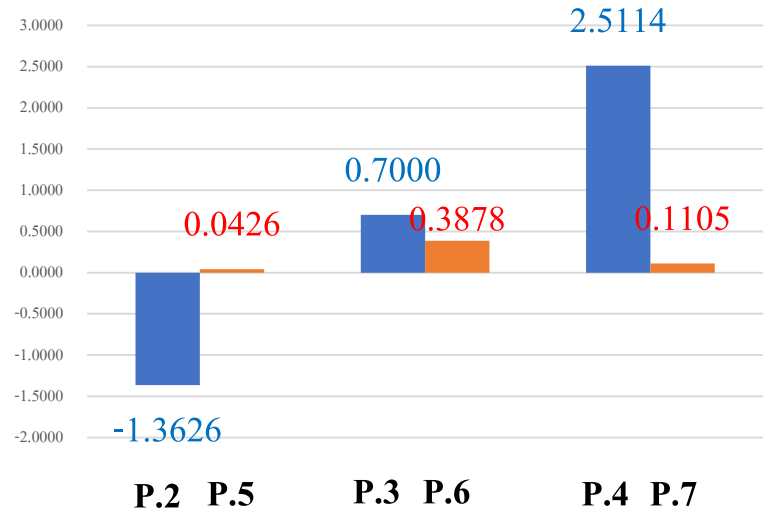

Risk(SD)
SD of BH VS MA(50,200) 1/10/2016 to 30/09/2021
120
100
80
60
40
20
0
31.1603
90.7046
32.7182
98.2345
35.5776
100.5592
P.5 MA
P.5 BH
P.6 MA
P.6 BH
P.7 MA
P.7 BH

Result [Out of sample]

1/11/2018 to 31/10/2019

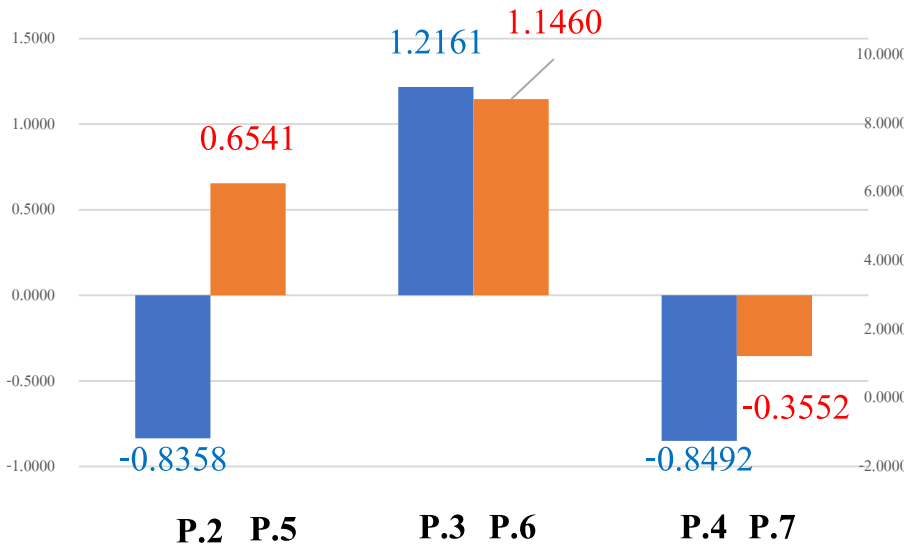
Sharpe ratio

Pre-Covid



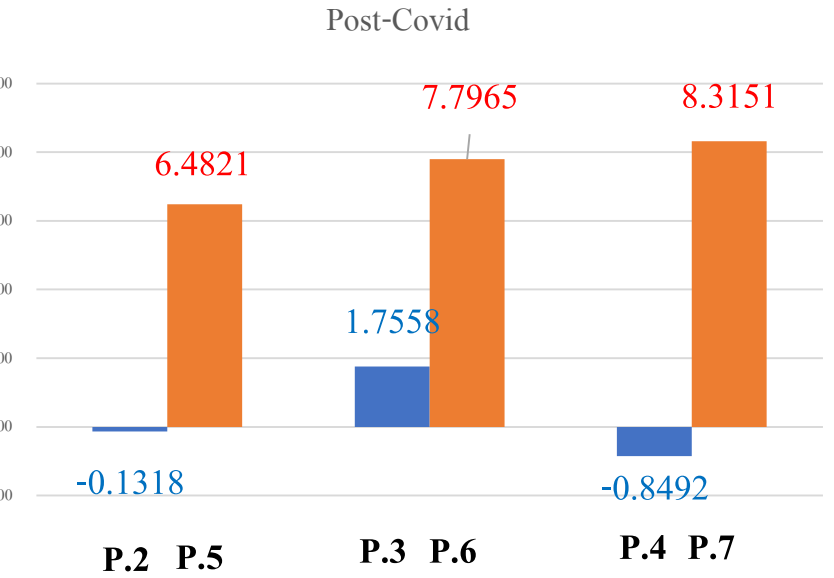
1/11/2019 to 31/10/2020

During-Covid



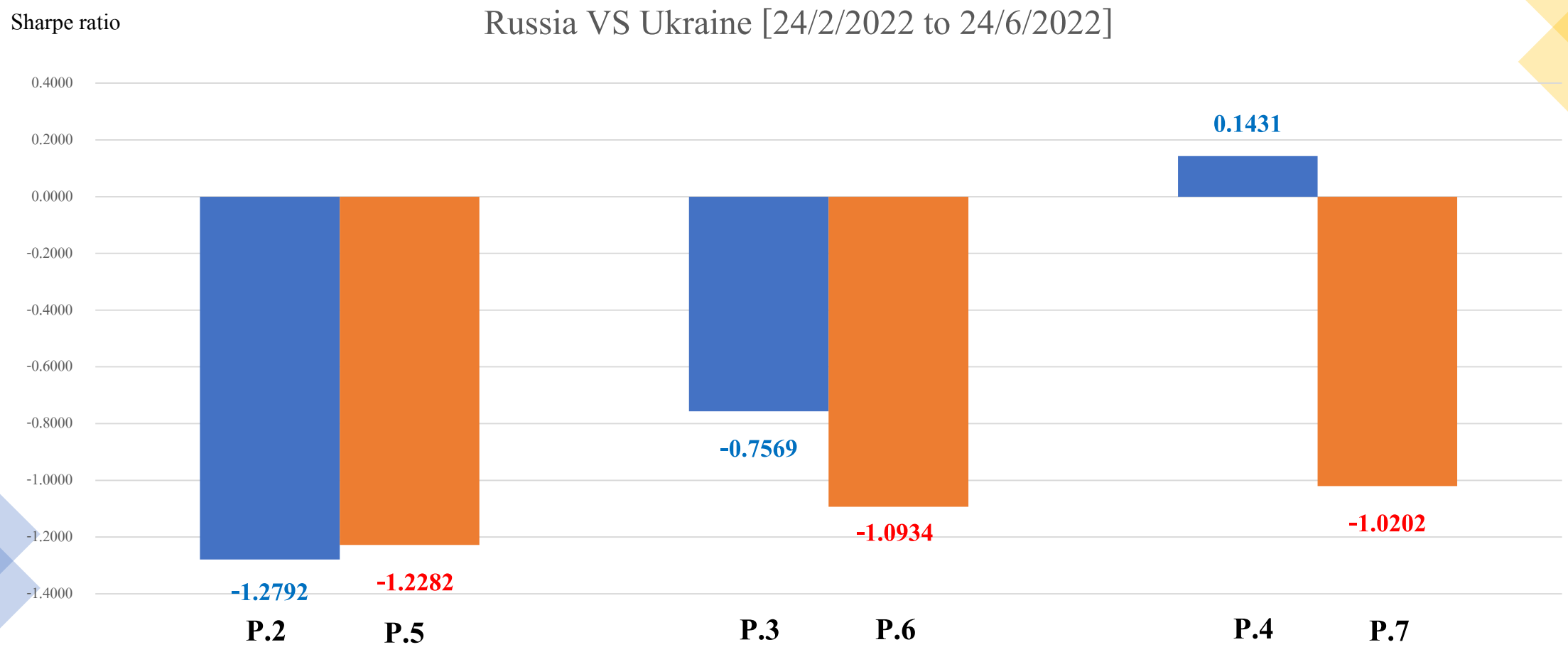
1/11/2020 to 31/10/2021

Post-Covid



(Fu and Mishra , 2021)

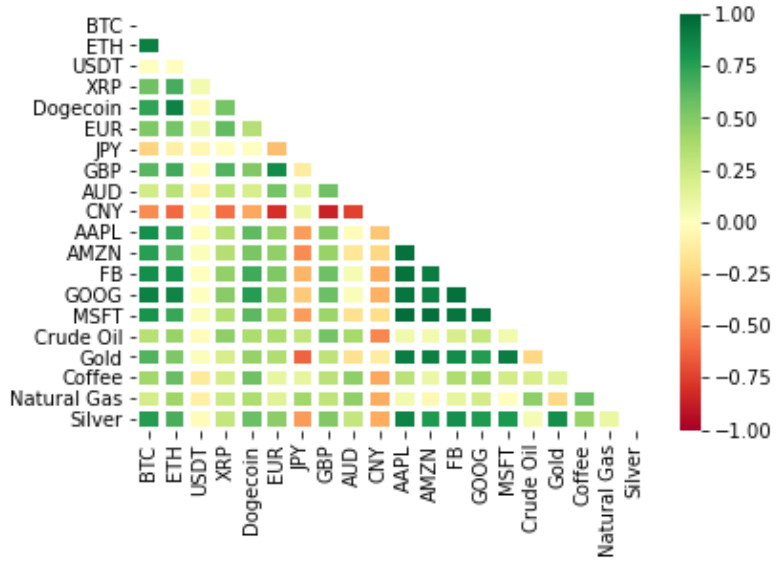
Result [Out of sample]

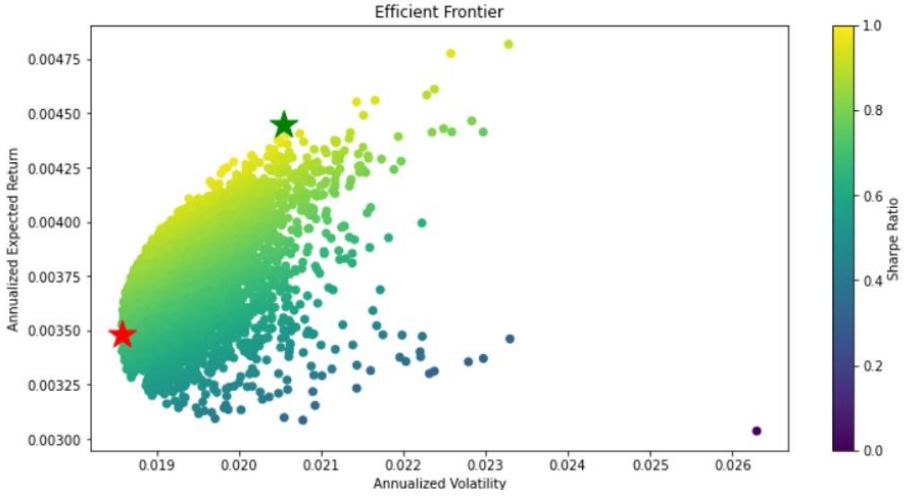


(Bbc , 2022)

Conclude

- Correlation Coefficient
- Returns and risks level
  - MinVar
  - MaxSharpe





Reference

Aljinović, Z., Marasović, B. and Šestanović, T. (2021). Cryptocurrency portfolio selection—a multicriteria approach. **Mathematics, 9,** 1677.

Atta Mills, E.F.E., Zeng, K., Fangbiao, L. and Fangyan, L. (2021). Modeling innovation efficiency, its micro-level drivers, and its impact on stock returns. **Chaos, Solitons and Fractals, 152,** 111303.

Barillas, F., Kan, R., Robotti, C. and Shanken, J. (2020). Model comparison with sharpe ratios. **Journal of Financial and Quantitative Analysis, 55,** 1840-1874.

Bhatt, P.C.P. (2014). What's new in computers: Cryptocurrencies: An introduction. **Resonance, 19,** 549 – 569.

Bock, J. (2018). An updated review of (sub-)optimal diversification models. Retrieved June 1, 2022, from https://arxiv.org/ftp/arxiv/papers/1811/1811.08255.pdf

Boda, M. and Kanderová, M. (2018). What is the true effect of rebalancing-a higher return or a lower risk? **Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis, 66,** 1417-1430.

Borri, N. (2019). Conditional tail-risk in cryptocurrency markets. **Journal of Empirical Finance, 50,** 1-19.

Brauneis, A. and Mestel, R. (2019). Cryptocurrency-portfolios in a mean-variance framework. **Finance Research Letters, 28,** 259-264.

Brown, S. Hwang, I. and In, F. (2013). Why optimal diversification cannot outperform naive diversification: Evidence from tail risk exposure. Retrieved June 1, 2022, from https://www.researchgate.net/publication/273084879_Why_Optimal_Diversification_Cannot_Outperform_Naive_Diversification_Evidence_from_Tail_Risk_Exposure.

Brière, M., Oosterlinck, K. and Szafarz, A. (2015). Virtual currency, tangible return: Portfolio diversification with bitcoin. **Journal of Asset Management, 16,** 365-373.

Białkowski, J. (2020). Cryptocurrencies in institutional investors' portfolios: Evidence from industry stop-loss rules. **Economics Letters, 191,** 108834.

CALISKAN CAVDAR, S. and Dilek AYDIN, A. (2020). Hybrid Model Approach to the Complexity of Stock Trading Decisions in Turkey. **Journal of Asian Finance, Economics and Business, 7,** 9-21.

Chakrabarti, D. (2021). Parameter-free robust optimization for the maximum-Sharpe portfolio Problem. **European Journal of Operational Research, 293,** 388-399.

Das, S. R., Kazachkov, D., and Goyal, M. (2014). Computing optimal rebalance frequency for Log-optimal portfolios. **Quantitative Finance,** 14, 1489-1502.

Demcenko, D. (2021). Word portfolio optimization in the environment of zero interest rate. **Ekonomika, 100,** 156-174.

DeMiguel, V., Garlappi, L. and Uppal, R. (2011). Optimal versus Naive Diversification: How Inefficient Is the 1/N Portfolio Strategy. **Oxford University Press, 9780199744282,** 1915–1953.

De Paula, J.S. and Iquiapaza, R.A. (2022). Investment fund selection techniques from the perspective of Brazilian pension funds. **Revista Contabilidade e Finanças, 33,** 167-182.

Dichtl, H., Drobetz, W. and Wambach, M. (2016). Testing rebalancing strategies for stock-bond portfolios across different asset allocations. **Applied Economics, 48,** 772-788.

Ding, Y. and Lu, Z. (2020). HOW'S THE PERFORMANCE OF THE OPTIMIZED PORTFOLIOS BY SAFETY-FIRST RULES: THEORY WITH EMPIRICAL COMPARISONS. **Journal of Industrial and Management Optimization, 16,** 2703-2721.

Du Sart, C.F. and van Vuuren, G. (2021). Comparing the performance and composition of tracking error constrained and unconstrained portfolios. **Quarterly Review of Economics and Finance, 81,** 276-287.

Fahmy, H. (2020). Mean-variance-time: An extension of Markowitz's mean-variance portfolio Theory. **Journal of Economics and Business, 109,** 105888.

Feng, Y., Medo, M., Zhang L, and Zhang, Y.C. (2011). **Transaction fees and optimal rebalancing in the growth-optimal portfolio. Physica A: Statistics and its Applications,** 390(9), 1635-1645.

Gafar, A. Abenoh, N.B. and Ahmed, E.M. (2021). Generations y and X Perception towards Bitcoin in Malaysia. **Journal of Information and Knowledge Management, 20,** 2150007.

Guadamuz, A. and Marsden, C. (2015). Blockchains and Bitcoin: Regulatory responses to Cryptocurrencies. **First Monday, 20,** 1-47.

Guesmi, K., Saadi, S., Abid, I. and Ftiti, Z. (2019). Portfolio diversification with virtual currency: Evidence from bitcoin. **International Review of Financial Analysis, 63,** 431-437.

Hagiwara, D. and Harada, T. (2017). Portfolio Rebalancing with a Consideration of Market Conditions Changes Using Instance-Based Policy Optimization. **Electronics and Communications in Japan, 100,** 66-75.

Hoe, L.W. and Siew, L.W. (2016). Portfolio optimization with mean-variance model. **AIP Conference Proceedings, 1739,** 020046.

Kajtazi, A. and Moro, A. (2019). The role of bitcoin in well diversified portfolios: A comparative global study. **International Review of Financial Analysis, 61,** 143-157.

Kaya, O. and Mostowfi, M. (2021). Low-volatility strategies for highly liquid cryptocurrencies. **Finance Research Letters,** 102422.

Khorram, M. and Sheshmani, M. (2015). What period of time is better to use for moving average to predict stock price in Tehran stock exchange? **Indian Journal of Science and Technology,** 8, IPL0570.

Koutsouri, A., Poli, F., Alfieri, E., Petch M., Distaso, W., and Knottenbelt, W.J. (2020). Balancing Cryptoassets and Gold: A Weighted-Risk-Contribution Index for the Alternative Asset Space. **Springer Proceedings in Business and Economics,** 217-232.

Krückeberg, S. and Scholz, P. (2019). Cryptocurrencies as an asset class. **Contributions to Management Science,** 1-28.

Koutsouri, A., Petch, M. and Knottenbelt, W.J. (2021, May). **Diversification benefits of commodities for cryptoasset portfolios.** Paper present at the 3rd IEEE International Conference on Blockchain and Cryptocurrency, ICBC, Virtual, Sydney, AUS.

Kozat, S.S. and Singer, A.C. (2011). Universal Semiconstant Rebalanced Portfolios. **Mathematical Finance, 21,** 293-311.

Kuhn, D. and Luenberger, D.G. (2010). Analysis of the rebalancing frequency in log-optimal portfolio selection. **Quantitative Finance, 10,** 221-234.

Reference cont.

Lekovic, M. (2021). Historical Development of Portfolio Theory. **Tehnika, 76,** 220-227.

Li, B. (2018). **Essays on Naive Diversification.** Ph.D. Dissertation, Department of Finance, The University of Melbourne, AUS.

Li, B., Wang, J., Huang, D., Hoi, and Hoi Steven C.H. (2018). **Transaction cost optimization for online portfolio selection. Quantitative Finance,** 18, 1411-1424.

Li, H., Huang, Q. and Wu, B. (2021). Improving the naive diversification: An enhanced indexation Approach. **Finance Research Letters, 39,** 101661.

Lin, T. T., Lee C. C, and Chiu, T. F. (2009). **Application of DEA in analyzing a bank's operating Performance. Expert Systems with Applications,** 36, 8883-8891.

Liu, M., Jotaki, H. and Takahashi, H. (2021). A Study of the Impact of Crypto Assets on Portfolio Risk-Return Characteristics Before and After COVID-19 Outbreak (2014–2020). **Smart Innovation, Systems and Technologies, 241,** 243-254.

Ma, Y., Ahmad, F., Liu, M. and Wang, Z. (2020). Portfolio optimization in the era of digital financialization using cryptocurrencies. **Technological Forecasting and Social Change, 161,** 120265.

Maciel, L. (2021). A new approach to portfolio management in the Brazilian equity market: Does assets efficiency level improve performance? **Quarterly Review of Economics and Finance, 81,** 38-56.

Markowitz, H. (1952). Portfolio Selection. **The Journal of Finance, 7,** 77-99.

Mattei, M.D. and Mattei, N. (2016). Analysis of fixed and biased asset allocation rebalancing **Strategies. Managerial Finance, 42,** 42-50.

Metehalchi, M., Durmaz, N., Cloninger, P. and Farahbod, K. (2021). Trading rules and excess returns: evidence from Turkey. **International Journal of Islamic and Middle Eastern Finance and Management,** 14, 713-731.

Mills, E.F.E.A. and Zeng, K. (2021). Portfolio management strategies of cryptocurrencies. **International Journal of Applied Decision Sciences, 14,** 43-54.

Monga, R., Aggrawal, D. and Singh, J. (2021). Exploring new frontiers in indexing strategies: an optimization-based risk-efficient solution. **International Journal of Systems Assurance Engineering and Management.**

Murphy, J.A. (1990). USING BAYESIAN BETAS TO ESTIMATE RISK RETURN PARAMETERS: AN EMPIRICAL INVESTIGATION. **Journal of Business Finance & Accounting, 17,** 471-477.

Nian, L.P. and Chuen, D.L.K. (2015). **Introduction to Bitcoin.** (Handbook of Digital Currency: Bitcoin, Innovation, Financial Instruments, and Big Data). 5-30.

Petukhina, A., Trimborn, S., Härdle, W.K. and Elendner, H. (2021). Investing with cryptocurrencies–evaluating their potential for portfolio allocation strategies. **Quantitative Finance, 21,** 1825-1853.

Platanakis, E. and Urquhart, A. (2019). Portfolio management with cryptocurrencies: The role of estimation risk. **Economics Letters, 177,** 76-80.

Plaxco, L.M. and Arnott, R.D. (2002). Rebalancing a global policy benchmark. **Journal of Portfolio Management, 28,** 9-22.

Rasiah, D. (2012). Post-modern portfolio theory supports diversification in an investment Portfolio to measure investment's performance. **Journal of Finance and Investment Analysis, 1,** 69-91.

Ren, L., Ren, P. and Glasure, Y. (2018). On the different forms of returns from moving average buy-sell trading rule in the stock market. **Benchmarking,** 25, 253-258.

Ren, T., Zhou, Z. and Xiao, H. (2021). Estimation of portfolio efficiency considering social responsibility: Evidence from the multi-horizon diversification DEA. **RAIRO - Operations Research, 55,** 611-637.

Symitsi, E. and Chalvatzis, K.J. (2019). The economic value of Bitcoin: A portfolio analysis of currencies, gold, oil and stocks. **Research in International Business and Finance, 48,** 97-110.

Schellinger, B. (2020). Optimization of special cryptocurrency portfolios. **Journal of Risk Finance, 21,** 127-157.

Sharpe, W. F. (1994). The Sharpe Ratio. **The Journal of Portfolio Management, 21,** 49-58.

Sun, X., Li, B. and Pang, H. (2021). Portfolio Construction for Pharmaceutical Industry. **E3S Web of Conferences, 275,** 03032.

Skiotzi, V.D. and Xanthopoulossisinis, S. (2007). Evaluation of correlation forecasting models for risk management. **Journal of Forecasting,** 26, 497-526.

Tang, G.Y.N. (2004). How efficient is naive portfolio diversification? An educational note. **Omega, 32,** 155-160.

Trimborn, S., Li, M. and Härdle, W.K. (2020). Investing with Cryptocurrencies - A Liquidity Constrained Investment Approach. **Journal of Financial Econometrics, 18,** 280-306.

Vinzelberg, A. and Auer, B.R. (2022). A comparison of minimum variance and maximum Sharpe ratio portfolios for mainstream investors. **Journal of Risk Finance, 23,** 55-84.

Wang, M., Li, C., Xue, H. and Xu, F. A new portfolio rebalancing model with transaction costs. **Journal of Applied Mathematics, 2014,** 942374.

Young, M.N. and Chuahay, T.J.T.N. (2019, December). **Mean-Variance Portfolio Selection Utilizing Exchange Traded Funds in Asia.** Paper present at the 6th IEEE International Conference on Engineering, Technologies and Applied Sciences, Kuala Lumpur, Malaysia.

Yu, J.-R. and Lee, W.-Y. (2011). Portfolio rebalancing model using multiple criteria. **European Journal of Operational Research, 209,** 166-175.

Zhou, Z., Gao, M., Xiao, H., Wang, R. and Liu, W. (2021). Big data and portfolio optimization: A novel approach integrating DEA with multiple data sources. **Omega (United Kingdom), 104,** 102479.

Zhu, J. (2016). **Data Envelopment Analysis.** New York: Springer.