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Tema:Portfolio optimization in the era of digital financialization using cryptocurrencies

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Fichamento

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| Pagina | Texto | Comentário |
| 1 - 2 | Schwab (2017) defines the Fourth industrial revolution as a sociotechnical process that is affecting the digital, physical, and biological domains. This change is based on the effective and innovative exploitation of new and emerging digital technologies, through their fusion and interaction with each other.  It is safe to say that these currencies and blockchains are challenging as well as changing the traditional financial system, that too rapidly. Klaus Schwab, in a piece of recent news,1 coined in that the concept and practice of blockchain, is at the heart of the fourth industrial revolution. His article further indicated that in order for the fourth industrial revolution to be successful, Bitcoin – which is the most famous, and disruptive digital currency - must be given its due credit and importance, as it provides an open and borderless payment protocol to be exercised.  The investment into, or the allocation of money to benefit from a financial initiative in the future is a common trait in human behavior, as an attempt to secure oneself against any uncertainty that one might face. To many, investing and managing an investment portfolio is a profession. To some, however, it is a hobby, and to many, these investments provide financial security after retirement. Most often, employees in different companies are allowed to invest in retirement or provident funds |  |
| 2 | The cryptocurrencies and the blockchain technology, which make the digital currencies, are disrupting and challenging the traditional financial systems in many ways. The high costs of financial intermediaries, transactional delays, and paperwork, act as an added burden on the consumers. The technological advancements, that the currencies offer, not only do not require an intermediary to verify the transactions or identities of individuals, but also reduce the time required for these transactions, hence providing a transparent system for recording the data and information. In the same stride, the blockchain technologies are changing the banking system by possessing the capacity to facilitate smart contracts, electronic banking ledgers, and money remittances, that too on a global level (Peters and Panayi, 2016). Effective electronic business models are now being proposed using blockchain's peer to peer transaction mode (Su et al., 2020b; Zhang and Wen, 2017).  In addition to this, the blockchain technology also allows firms, of any size, to raise funds through peer-to-peer, globally distributed share offerings, or the initial coin offerings. The initial coin offerings not only brings the global investors together but also removes the requirement of any intermediaries, investment bankers, or auditors, which automatically reduces the costs incurred to the relevant companies. In the year 2018 alone, a staggering amount of 550 million USD was raised through initial coin offerings (ICO), a figure that was higher than the amount raised through any traditional channels (Perez et al., 2020).  Cryptocurrencies, Bitcoin, and blockchain are also considered to be a significant part of the evolving FinTech.  Cryptocurrencies and blockchain technologies are shaping the financial systems, and are a significant part of the ongoing global financial innovation. Khraisha and Arthur (2018) defined financial innovation as a process that is carried out by any institution involving the creation and adoption of new products and platforms. The latest products and platforms enable technologies to introduce innovative ways in which financial activities can be carried out. They further suggested that blockchain and PayPal are financial innovations that have been introduced by non-financial institutions  In addition to financial innovation, blockchain technologies and cryptocurrencies also help in developing financial inclusion. Financial inclusion is a process that guarantees availability, ease of access, and usage of formal financial systems, for all the members of a particular economy, Moreover, it also entails the use of financial services (Allen et al., 2016).  Rodima-Taylor and Grimes (Rodima-Taylor and Grimes, 2018) argued that remittances through cryptocurrencies and mobile transfers could facilitate a shift in paradigm in financial inclusion and locally innovative ecosystems. They also suggest that digital financial inclusion would be likely to provide solutions to a significant chunk of the unbanked people so that they can effectively communicate with the formal financial systems. It may, therefore, be argued that the digitalization of financial systems, through financial innovation in the form of blockchain and cryptocurrencies, provides financial inclusiveness to the marginal components of the society.  In the extant literature, various authors have discussed the effects of financial innovation on the portfolio risk diversification. The financial innovations have not only brought down the costs associated with the traditional financial systems, but have also provided a broader range of technologically sophisticated, and innovative products into the market. |  |
| 3 | The classification of cryptocurrencies as currencies, financial assets, commodities, or other forms of a financial product, has raised a considerable amount of discussion, as well as criticism with researchers, who have varied opinions on this matter. Empirical studies in the past have shown that uninformed users have approached the cryptocurrencies as an alternative form of an investment vehicle, instead of an alternative transactional vehicle (Glaser et al., 2014). Studies show that Bitcoin does not correlate with traditional assets, such as stock and bonds, and is primarily used as a speculative investment, rather than a medium of exchange (Baur et al., 2018). Some researchers argue that Bitcoin does not behave like a conventional currency, asset, or security. However, it somewhat resembles a technology-driven product, a bubble event, or even an emerging asset class (White et al., 2020). They argued that the magnitude of the long-term appreciation of Bitcoin is much higher than the paper currencies. They further discussed that the characteristics of the risk and return, and the inverse correlation with other currencies could make Bitcoin, a potentially viable portfolio investment. Researchers undertook further research, on the efficiency of the cryptocurrencies (Tran and Leirvik, 2020; Urquhart, 2016; Hu et al., 2019), the price discovery (Kapar and Olmo, 2019), volatility (Ardia et al., 2019; Baur and Dimpfl, 2018) and the conditional tail-risk (Borri, 2019), are some of the contributions of the digital currencies, towards market efficiency, pricing, and risk behavior  The inclusion of Bitcoin, in a traditional hedging portfolio of gold, oil, and equities, reduces the risk of the portfolio by a considerable level.  Whether cryptocurrency is considered to be a financial or speculative investment asset, or as an innovative technological product, the endowment fund managers have also shown interest in the investments made in cryptocurrency, primarily to diversify their portfolios. In October 2018, several articles were published stating that a fund manager at Yale University, USA, had invested in a cryptocurrency fund2 . In April 2019, Bloomberg published that one of the largest endowment funds at Harvard University (USA) took part in a crypto token sale. Furthermore, in April 2019, CCN3 also published a survey, quoting that 94% (141 out of 150) endowment funds had invested in cryptocurrencies in the last 12 months. Moreover, Virginia's police department not only invested in the endowment fund, but in the year 2019, it also became the first institution in America to invest their pension funds in the blockchain-based technology4 . |  |
| 4 | Furthermore, our results also show that including cryptocurrencies in an existing portfolio, significantly reduces the risk, and also increases the Sharpe ratio. In some cases, the returns provided by the diversified portfolios have been higher, while simultaneously reducing the risk. We also observed that when the short sales of assets are allowed, the results for diversification improve significantly. |  |
| 5 - 6 | we have calculated the log-returns by using the formula,  ri t = log [Pi t/pi t-1]  where Pi, t is the price of i th asset in the data at time t. Pi t, 1 is the price of the same asset at time t- 1 (that is on the previous day), ri, t is the return on asset i, at time t. Using the data, we have calculated the expected return μi and standard deviation σi for asset i by using the following formulae.  where t is the number of observations for asset i. Once the returns and the standard deviations are calculated, we annualize the values for both. The performance of each portfolio is recorded for its expected return, standard deviation, and optimal portfolio using the Markowitz Mean-Variance analysis and the Sharpe ratio. The expected returns and the standard deviations, as calculated above, provide the return and risk characteristics for individual assets daily. Moreover, these are the basis of calculating the portfolio returns, and the variance that is required in the Markowitz Mean-Variance optimization, and also in calculating the Sharpe ratios for each portfolio. Markowitz Mean-Variance optimization In 1952, Markowitz (1952) established the theoretical contributions that played a critical role in various aspects of corporate finance and global financial economics. These contributions eventually won him a Nobel Prize later on and also helped establish the modern portfolio theory (MPT). Markowitz also provided a conceptual framework to find the optimal weights of the assets in an investment portfolio. These assets were those that provided a maximum expected portfolio return for a given level of risk in the portfolio. The dual problem is to find the optimal weights of the assets that provide a minimum level of risk for a given expected portfolio return. Before formally identifying the concerns regarding the optimization for the Markowitz Mean-Variance analysis, we calculated the return on a portfolio, E(R), that consisted of m assets, as mentioned below:  where μj is the return on the asset j, and wj is the weight of the asset j in the portfolio. The variance of the portfolio is calculated as,  where w = ( w1,w2, ..., wn) is the vector of weights, and Σ denotes the variance-covariance matrix of the assets in the portfolio. Hence, in this study, we have formulated the following version of the Markowitz Mean-Variance analysis Max E(R) subject to wT∑w = α  where α is the given level of risk, as measured by the variance. The second condition constrains the sum of the weights to be equal to 1, while the last condition enforces the long positions in all the assets  Sharpe ratio The Sharpe ratio is defined as a measure of the excessive returns, over a risk-free rate of return per unit of the risk in the portfolio. It is calculated as,  where Rf is the annualized risk-free rate, and the standard deviation is the square root of the variance. The formula is a measure of risk-adjusted returns and had been developed by Sharpe (1966). The formula is used to calculate the performance of an individual asset, as well as of a portfolio. It further helps in comparing the performance of two or more investments or portfolios. A Sharpe ratio that is greater than one is considered to be acceptable. Additionally, the higher the value of the Sharpe ratio, the more excessive returns on the risk-free rate, the portfolio, or the assets provide. In addition to providing an efficient frontier for different portfolios, we solve the optimization problem of maximizing the Sharpe Ratio, subject to the constraint on the weights in a portfolio, that is:  subject to:  where wi are the weights of the assets in a portfolio. The second condition, = = w 1, i m i 1 in the above formula, says that the sum of all weights in the assets is equal to 1. |  |
| 6 – 7 | It can be observed that the cryptocurrencies’ portfolio tends to increase the returns when the risk is increased. By understanding this trend, a positive relationship between the return and risk has been observed in the case of the cryptocurrency portfolio. This observation regarding the cryptocurrency portfolio also allows us to explore the diversification of the existing portfolios of different assets, by including cryptocurrencies. Brière et al. (2015) observed a similar relationship between Bitcoin returns and volatility and concluded that the addition of Bitcoin in the asset portfolio might help investors to achieve the diversification benefits. When dividing the returns into high and low price volatility regimes, Koutmos (2019) observed that a higher volatility regime is associated with higher mean returns. However, he also observed that the returns in the high volatility regime do not always reward the investors for the higher levels of volatility, and are prone to tail risks when compared with the low volatility regimes. Hence, we have analyzed the diversification of the existing portfolios using multiple cryptocurrencies next in this section.  The results for the optimized Sharpe ratio for cryptocurrencies show that the performance is considered to be good |  |
| 8 | It was observed, in all the cases presented above, that a cryptocurrency diversified portfolio provides better returns as compared to a portfolio of assets (without cryptocurrencies), for the same level of risk, as measured by the standard deviation of the portfolios. The cryptocurrency diversified portfolios outperformed the traditional portfolios of not only the technology companies but also of the other stocks in both the long and the short asset portfolios. Moreover, the diversification through cryptocurrencies also reduced the risk significantly while achieving higher returns.  Therefore, we can conclude that adding cryptocurrencies to the existing portfolios may significantly increase the returns, and provide a better diversification by reducing the risk of the portfolio |  |
| 10 -11 | Therefore, we can conclude that adding cryptocurrencies to the existing portfolios may significantly increase the returns, and provide a better diversification by reducing the risk of the portfolio the blockchain challenging the traditional financial systems but the investment opportunities in the cryptocurrencies are also changing the way investors are managing their portfolios. With the arrival of digital platforms and technology, investors are being compelled to upgrade their investment strategies for developing and managing their portfolios  This paper provides empirical evidence that validates the theory that the cryptocurrencies, in an existing portfolio of different asset classes, increases the potential gains from the portfolio. The rapid growth of cryptocurrencies makes these portfolios a promising investment asset by increasing the returns from the portfolio and diversifying the risks. Moreover, we have also provided a comparison of different portfolios with and without diversification through cryptocurrencies. Furthermore, the traditional Markowitz mean-variance framework is also applied in order to investigate the performances of the portfolios with and without diversification through the inclusion of cryptocurrencies. The results are provided in the form of the efficient frontiers of these portfolios, indicating higher returns for the same level of risk for a diversified portfolio with cryptocurrencies.  The optimized Sharpe ratio shows the potential of the cryptocurrencies in diversifying portfolios. The diversified portfolios showed a tremendous growth of as much as 80% in the returns and reducing risk by as much as 20%.  The findings of the study indicate that cryptocurrencies have a high potential of diversifying the existing portfolios of stocks, currencies, and commodities. In addition to this, we also found that the inclusion of several cryptocurrencies in a portfolio provides better portfolio diversification results with an increase in the Sharpe ratio.  If investors do not want to invest in multiple cryptocurrencies, in order to diversify their existing portfolios, it is observed that Ethereum provides better results compared to Bitcoin. This observation also implies that other cryptocurrencies may have better diversification capabilities, but due to the hype, Bitcoin has so far received more attention from both researchers and investors.  Thus, our findings suggest that cryptocurrencies provide reasonable investment avenues that most certainly require further exploration. The effects of transactional costs, liquidity, and optimal rebalancing on the performance of the portfolio and its diversification could interest future researchers in the field. | Conclusão |