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Optimizing Portfolios in the Era of Digital Financialization (FinTech) Through Cryptocurrency Integration

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Abstract:- The advent of the Fourth Industrial Revolution has precipitated a plethora of innovative technologies, among which are notable advancements revolutionizing the domain of finance. Particularly prominent within this milieu are the advent of Blockchain technology and the concomitant emergence of Cryptocurrencies, heralding the inception of novel forms of Decentralized Finance (DeFi) that significantly disrupt traditional financial (TradFi) paradigms. The advent of these innovative and technological financial instruments has imbued both laypersons and seasoned investors with a profound sense of curiosity, inciting them to delve into a broader spectrum of investment opportunities, thereby engendering portfolio diversification. This burgeoning interest stems from a dual foundation: firstly, cryptocurrencies deviate from conventional investment assets insofar as they lack a tangible underpinning and operate independently of governmental or monetary oversight. Secondly, cryptocurrencies have historically exhibited unprecedented price appreciation and returns vis-à-vis traditional investment assets. However, these remarkable returns have been counterbalanced by pronounced volatility, distinguishing cryptocurrencies from other asset classes. Such distinct characteristics underpin the inquiry conducted herein, which aims to augment the extant literature on cryptocurrencies as investment assets by scrutinizing the impact of including six cryptocurrencies (Bitcoin (BTC), Ethereum (ETH), Tether (USDT), Ripple (XRP), Litecoin (LTC), and Dogecoin (DOGE)) within the confines of five traditional asset portfolios. The selection of these cryptocurrencies was predicated upon their respective market capitalizations. The analytical timeframe spans from December 2014 to December 2022. The findings of this investigation evince that cryptocurrencies offer a viable avenue for portfolio risk mitigation, given the consistently low correlations between cryptocurrencies and traditional assets, coupled with the higher average daily returns exhibited by most cryptocurrencies vis-à-vis traditional investments. Furthermore, it is discerned that Ethereum presents a superior diversification opportunity relative to Bitcoin.

Keywords:- *Portfolio Optimization Traditional Asset Portfolios Cryptocurrencies Blockchain DeFi Investment*.

➢ *JEL Classification:- E42, F30, G10, G11, G15, G21,G28*

I. INTRODUCTION

Over the past several years, the finance industry has undergone notable digital transformations, closely intertwined with the global integration of international financial markets. These transformations, fueled by new technologies and methodologies, have significantly altered the operational landscape of the financial system. Within this milieu, certain developments have been particularly disruptive, heralding a genuine revolution in finance. Notably, the advent of blockchain technology and the subsequent rise of cryptocurrencies and other digital assets have introduced novel forms of decentralized finance (DeFi), thereby challenging conventional financial paradigms. In light of these developments, a new paradigm of decentralized finance (DeFi) is emerging, accompanied by a profound upheaval in technology-driven transactional systems, notably blockchain. The proliferation of innovative and technological financial instruments has spurred both individual investors and seasoned professionals to explore a wider array of investment opportunities, leading to portfolio diversification. This burgeoning interest can be attributed to two primary factors:

- Cryptocurrencies diverge from traditional investment assets in that they lack a tangible underpinning and are not subject to governance by any governmental or monetary authority.
- Cryptocurrencies have exhibited remarkable appreciation and returns since their inception, outstripping those of other investment assets.

However, these substantial returns have been counterbalanced by pronounced volatility, setting cryptocurrencies apart from other asset classes. Such characteristics serve as the foundation of the research endeavor undertaken in this analysis, which seeks to augment the existing literature on cryptocurrencies as diversification assets by incorporating six prominent cryptocurrencies (Bitcoin (BTC), Ethereum (ETH), Tether (USDT), Ripple (XRP), Litecoin (LTC), and Dogecoin (DOGE)), representing the largest market capitalizations from December 2014 to December 2022, across five physico-financial asset portfolios.

The subsequent sections of this research paper are structured as follows: The first part will encompass a comprehensive literature review on cryptocurrencies as

diversification instruments. Subsequently, the second part will delineate the research methodology employed and expound upon the principal findings attained.

II. LITERATURE REVIEW

A decade and a half following their inception, cryptocurrencies have garnered increasing attention from various entities including businesses, individuals, and regulatory bodies such as central banks. Given the characterization of cryptocurrencies as akin to traditional financial assets (Urquhart, 2016), the proliferation of research exploring their potential for diversification is not unexpected. Numerous studies have endeavored to assess whether the inclusion of cryptocurrencies within a diversified portfolio yields favorable impacts on the portfolio's risk-return profile, with a predominant focus on Bitcoin. Several studies, including those by Dyhrberg (2015), Bouri et al. (2017a), and Bouri et al. (2017b), have demonstrated that Bitcoin and other cryptocurrencies can serve as effective diversification assets. Indeed, the integration of cryptocurrencies across various asset classes has been shown to enhance portfolio returns and bolster diversification prospects. Dyhrberg (2015) posits that Bitcoin functions as a diversification tool negatively correlated with traditional financial assets. Unlike conventional assets whose prices are influenced by macroeconomic factors such as governmental monetary or fiscal policies, Bitcoin's valuation is primarily contingent upon speculative forces and market dynamics, as underscored by Garcia Jorcano and Benito (2020). The divergent determinants of stock and Bitcoin price movements suggest the potential utility of Bitcoin as a diversification instrument for mitigating stock market risks within a financial portfolio. Furthermore, findings by Huang, Duan, and Mishra (2021) indicate that Bitcoin can effectively serve as a diversification tool within individual economies, diminishing risks associated with domestic equities as well as foreign assets. Nevertheless, the notable returns associated with cryptocurrencies have been accompanied by pronounced volatility, surpassing that of conventional asset classes such as gold, currency pairs, and constituent stocks of benchmark indices like the S&P500. This heightened volatility can be attributed partly to the nascent nature of the cryptocurrency market, which remains susceptible to frequent systemic crises and speculative bubbles, as elucidated by Pichl and Kaizoji (2017).

III. METHODOLOGY

The conundrum of choice and the formulation of an optimal portfolio composition represent intricate decision-making facets for both investors and fund managers. In this regard, the principle of trade-off between return and risk is fundamental to portfolio management, as elucidated by Harry Markowitz, the 1990 Nobel Prize laureate in economics, in his seminal work "Portfolio Selection," published in the Journal of Finance in 1952. Markowitz posits that investors seek to maximize their expected return under a constant risk constraint or, conversely, to either secure a low but assured return or embrace risk in pursuit of amplified returns, with the anticipated return escalating as risk increases. Moreover, Markowitz formalizes and quantifies the diversification effect, contending that a judicious amalgamation of numerous assets in a portfolio mitigates total risk incurred for a given expected return (or target). It is emphasized that the efficacy of investing in a financial security should be evaluated within the context of the investor's entire portfolio and a competitive market landscape where various savings vehicles (such as stocks, bonds, time deposits, real estate, and land) vie for attention.

- *However, Markowitz's Pioneering Modern Theory (1952) is not without its Limitations, Including:*

- The presumption of stable correlations between different assets in the model, which diverge from the constantly changing correlations observed in reality.
- The reliance on a Gaussian probability distribution curve of returns, which fails to account for improbable events such as financial crises or stock market crashes.
- The assumption of rationality among investors, which contradicts the tenets of Behavioral Finance, as highlighted by R. Schiller (1981).

- *To Address these Limitations, Several Extensions have been Proposed:*

The Black-Litterman model, developed by F. Black and R. Litterman in 1992, integrates market equilibrium with investor expectations to produce a relevant asset allocation reflecting investor forecasts. This model offers enhanced flexibility by allowing investors to quantify their confidence levels in their expectations. The Sharpe ratio, introduced by W. Sharpe, measures the deviation of a portfolio's return from that of a risk-free investment, divided by its standard deviation, providing an indicator of risk-adjusted return. The equal-weighted portfolio strategy allocates the same weight to all selected assets, offering a simpler alternative to mean-variance optimization and often producing superior out-of-sample performance. The minimum variance portfolio (MVP) optimization technique aims to minimize overall portfolio volatility, catering to risk-averse investors prioritizing capital preservation over return maximization. Empirical studies have shown the efficacy of the MVP approach in achieving better out-of-sample returns.

The paper aims to construct and optimize portfolios (with and without cryptocurrencies) using classical techniques (mean-variance analysis, Sharpe ratio, and Excel solver) and subsequently compare their performance. This comparison will provide insights into how the integration of cryptocurrencies can potentially impact the diversified portfolio of an investor. Drawing inspiration from the methodology outlined by Ma et al. (2020), the objective is to identify the optimal portfolio that maximizes asset returns while adhering to specified constraints, including budget constraints, long-only positions, and tolerance for portfolio risk. Through various simulations employing different weighted vectors, diverse portfolios can be designed, and selecting an efficient portfolio entails solving the optimization problem subject to these constraints.

$$MaxE(R)_p = \sum_{i=1}^{N} w_{pi} E(R_i)$$

Under Contraint :

$$\sigma^2(Z_p) = \sum_{i=1}^{N}\sum_{j=1}^{N} w_{pi} w_{pj}\, \sigma_{ij}$$

$$\sum_{i=1}^{N} w_{pi} = w_p = 1$$

With,
w_{pi}, represents the proportion of security i in portfolio p;
w_{pj}, represents the proportion of security j in portfolio p;
Σ , denotes the variance-covariance matrix of returns.
R_i, is the rate of return of security i ;
$E(R_i)$, is the expected rate of return of security i.

Indeed, in addition to conventional mean-variance optimization techniques, we propose a resolution of the optimization problem geared towards maximizing the Sharpe ratio while upholding the prescribed weights for each asset within the portfolio. This approach seeks to optimize portfolio performance by prioritizing risk-adjusted returns, while ensuring adherence to predetermined asset weightings. The primary condition of this optimization strategy revolves around the constraints associated with asset weighting, encompassing the following key considerations:

- Budget Constraint: The sum of the portfolio weights assigned to individual assets must equate to one, reflecting the total available investment capital allocated across the portfolio.
- Long-only Positions: All assets within the portfolio are held in long positions, precluding the inclusion of short-selling or negative weights.
- Risk Tolerance: The portfolio's overall risk level must adhere to specified thresholds or tolerance levels set by the investor or fund manager.

By incorporating these constraints, the optimization process seeks to identify the optimal allocation of assets that not only maximizes the Sharpe ratio but also maintains the desired asset weightings. This comprehensive approach ensures that the resulting portfolio strikes an optimal balance between risk and return, aligning with the investor's objectives and risk preferences. Through rigorous computational analysis and iterative refinement, the proposed optimization methodology aims to deliver robust and effective portfolio solutions tailored to the specific requirements and constraints of the investor.

$$\boldsymbol{Max\ \frac{E(R) - R_f}{Ecart\ type}}$$

$$\boldsymbol{S/C}$$

$$\boldsymbol{w^T \sum w = \alpha}$$

$$\boldsymbol{\sum_{i=1}^{m} w_i = 1}$$

With;

w_i :l the weights of assets in a given portfolio.

The second condition articulated in the formula posited above stipulates that the aggregate of all asset weights within the portfolio must attain unity. Primarily, the problem elucidated above is tackled by initially permitting long positions exclusively on assets, implying that the weights attributed to each constituent asset of the portfolio are constrained to be non-negative or zero, denoted as $wi \geq 0\ \forall i$. Subsequently, the optimization problem is further addressed by authorizing short sales of cryptocurrencies to attain an optimized solution, whereupon the original constraint $wi \geq 0\ \forall i$ on the weights is relaxed. This problem is solved using Excel's Solver tool.

IV. DESCRIPTION AND DATA SOURCE

To substantiate our investigation, we curated a portfolio comprising six cryptocurrencies selected based on their respective market capitalizations, namely Bitcoin, Ethereum, Tether, Ripple, Dogecoin, and Litecoin. Data pertinent to these cryptocurrencies was sourced from the coinmarketcap.com platform, encompassing the temporal span from December 2014 to December 2022.

Furthermore, we conducted an exploration of various portfolios and portfolio management methodologies by incorporating these cryptocurrencies into pre-existing stock portfolios, including equities of technology firms, currency holdings, oil assets, and commodities. Data corresponding to these asset classes was collated from multiple sources, including the MSCI database, the OECD, the World Bank, and Yahoo Finance, spanning the same timeframe as the cryptocurrency data.

In terms of the risk-free rate, we employed the yield of US Treasury bonds as a benchmark for risk-free returns.

Table 1 Nature of Investments

Stocks	Tech. Stocks	Currencies	Commidities	Oil	Crypto.
Johnson & Johnson (JNJ)	Google	USD/Dollar Canadien	Gold	Crude Oil	Bitcoin
Procter & Gamble (PG)	Amazon	USD/Livre sterling	Wheat		Ethereum
Berkshire Hathaway Inc (BRKa)	Microsoft	USD/Euros	Copper	Brent Crude Oil	Tether
JPMorgan Chase & Co (JPM)	Apple	USD/Yen Japonais	Coffee	Natural Gas	Ripple
Visa (V)	Meta	USD/Dollar Australien			Dogecoin
					Litecoin

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V. RESULTS AND INTERPRETATIONS

The financial-economic analysis of asset portfolio managers' performances elucidates underlying investment strategies reflective of management style and risk propensity. Informed by the seminal contributions of pioneers in portfolio management such as J. Treynor (1965), W. Sharpe (1966), and M. Jensen (1969), specifically the development of the alpha performance index, our study employs descriptive statistics to scrutinize the risk-return trade-off. Aligned with the methodology delineated by Y. Maa, F. Ahmadb, Miao Liu, Z. Wang (2020, p.5), our investigation focuses on a sample spanning the period from December 2014 to December 2022, comprising six cryptocurrencies alongside conventional stocks, currency exchange rates, commodities, and energy products. This diversification strategy aims to analyze:

The return on investment solely in cryptocurrencies, encompassing Bitcoin (BTC), Ethereum (ETH), Tether (USDT), Ripple (XRP), Litecoin (LTC), and Dogecoin (DOGE).

The impact of integrating cryptocurrencies into portfolios containing technology stocks, conventional stocks, currency exchange rates (forex), commodities, and energy products.

Our analysis concentrates on two statistical indicators characterizing the distribution of observed data over time, presumed to follow a normal distribution: average returns and standard deviation, which quantifies return risk. To further evaluate performance, we utilize the W. Sharpe ratio, facilitating the comparison and ranking of investment funds or portfolio managers employing disparate strategies:

Naive (or equally-weighted) strategies, both pre and post-integration of cryptocurrencies.

Optimized W. Sharpe ratio strategies, under varying conditions of short selling, before and after cryptocurrency integration.

The conventional argument posited by investment fund managers, particularly in the United States, emphasizes the validation of superior market performance through the utilization of performance indices ("How to Beat The Market Performances"). Our comparative analysis encompasses indicators including average asset returns, risk measured by standard deviation (volatility), and the Sharpe ratio.

Over the analysis period of 2014-2022, technology stocks exhibit a return of 35.18% with a volatility of 32.22%, contrasting with the energy sector's return of 28.4% and volatility of 45.05%. The introduction of cryptocurrencies into the portfolio of aforementioned assets engenders a reversal in performance rankings in terms of return/risk.

The asset + cryptocurrency diversification strategy, specifically incorporating BTC, ETH, and Dogecoin, yields compelling results. Within the framework of the optimized Sharpe ratio, technology stocks emerge as the optimal performer, while oil investments rank second, and stocks occupy the third position.

Horizontal analysis of results underscores the superior performance of the Sharpe ratio strategy in the presence of short selling and cryptocurrencies, positioning it favorably across strategies. The vertical reading highlights the dominance of basic asset portfolios augmented by cryptocurrencies, with technology stocks portfolio leading, followed by stocks and oil assets.

Contrary to initial expectations, the most optimal portfolio diversification strategy entails integrating basic asset portfolios with cryptocurrencies (BTC, ETH, and Dogecoin), demonstrating superior performance both vertically and horizontally. These findings furnish operational recommendations to fund managers, suggesting that they can potentially outperform the market through the adoption of our optimized portfolio diversification strategy based on the W. Sharpe ratio.

VI. CONCLUSION

To validate the efficacy of the optimal portfolio diversification strategy within international portfolios amid the backdrop of digitalization or Financial Technology (FinTech), we drew upon insights from a recent study conducted by May Y., Liu M., and Wang Z. (2020). Utilizing data sourced from a variety of reputable platforms including Coinmarketcap.com, MSCI via the OECD, the World Bank, and Yahoo Finance, spanning the period from December 2014 to December 2022, our analysis delved into the performance of diversified portfolios encompassing a spectrum of assets. These assets include cryptocurrencies (six in total), technology stocks (5 stocks), traditional stocks (5 stocks), currencies (5 pairs), four commodities (copper, coffee, gold, and wheat), and three categories of oil.

The assessment of diversified portfolio performance with cryptocurrencies as investment bases, facilitated by the W. Sharpe performance index, yields the following observations:

Comparative analysis of the average return between naive diversification and the Sharpe ratio for portfolios composed of the six cryptocurrencies favors the latter, with a ratio of 1.34 as opposed to 1.43.

Combining cryptocurrencies with technology stocks in the presence of short selling also demonstrates superior performance under the Sharpe ratio, yielding a ratio of 1.58 in contrast to 1.70.

Integration of stocks and cryptocurrencies within portfolios underscores the ascendancy of the Sharpe ratio, recording a ratio of 0.56 compared to 1.50 with optimization in the presence of short sales.

Diversification between cryptocurrencies and currencies manifests a Sharpe ratio of 1.28 in comparison to 1.44.

Lastly, portfolio diversification strategies involving cryptocurrencies with stocks and commodities yield a combined Sharpe ratio of 1.34, outmatched by an optimized Sharpe ratio formed by cryptocurrencies, commodities, and the optimized Sharpe ratio at 1.47.

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APPENDIX 1: Summary of Results: Evaluation of Portfolio Managers with Naive Strategy Vs. Optimized with Sharpe Ratio

	Naive Strategy		Optimized Sharpe Ratio		
Catégories d'Actifs	**Before Introduction of Cryptos**	**After Introduction of Cryptos**	**Before Introduction of Cryptos**	**After Introduction of Cryptos**	
				Without Short Selling	**With Short Selling**
Cryptocurrencies					
Weights	1/6				
Average Return	104,92%		119,04%		
Volatility	74,95%		79,92%		
Sharpe Ratio	1,34		**1,43**		
Rankings:					
➢ ***HORIZONTAL***	**2**		**1**		
➢ ***VERTCAL***	1		**1**		
Stocks					
Weights					
Average Return	16,56%	64,75%	23,31%	86,33%	94,95%
Volatility	21,05%	43,54%	28,46%	54,61%	60,29%
Sharpe Ratio	0,56	1,38	0,65	1,49	**1,5**
Rankings:					
➢ ***HORIZONTAL***	5	3	4	2	**1**
➢ ***VERTCAL***	2	1	3	3	**3**
Technology Stocks					
Weights	1/5	1/11			
Average Return	23,93%	68,11%	35,18%	79,50%	106,63%
Volatility	35,60%	46,74%	32,22%	47,18%	59,98%
Sharpe Ratio	0,54	**1,36**	0,94	1,58	**1,7**
Rankings:					
➢ ***HORIZONTAL***	5	3	4	2	**1**
➢ ***VERTCAL***	3	2	2	1	**1**
Currencies					
Weights	1/5	1/11			
Average Return	-0,50%	57%	-2,44%	144,85%	
Volatility	4,45%	40,85%	12,32%	96,96%	
Sharpe Ratio	-1,17	**1,28**	-0,58	**1,44**	
Rankings:					
➢ ***HORIZONTAL***		2		**1**	
➢ ***VERTCAL***		4		**5**	
Commodities					
Weights	1/3	1/9			
Average Return	9,88%	66,90%	10,76%	80,65%	95,49%
Volatility	18,43%	46,35%	16,19%	51,83%	61,80%
Sharpe Ratio	0,28	1,34	0,37	1,46	**1,47**
Rankings:					
➢ ***HORIZONTAL***	5	3	4	2	**1**
➢ ***VERTCAL***	4	3	5	4	**4**
Oil					
Weights	1/3	1/9			
Average Return	5,38%	71,74%	28,40%	93,74%	109,02%
Volatility	66,24%	54,63%	45,05%	57,90%	64,21%
Sharpe Ratio	0,01	1,23	0,52	1,54	**1,62**
Rankings:					
➢ ***HORIZONTAL***	5	3	4	2	**1**
➢ ***VERTCAL***	5	5	4	2	**2**

APPENDIX 2: Comparison and Ranking of Financial Performances of Portfolio Managers: BTC, ETH, and DOGE

CATEGORIES D'ACTIFS	AVANT L'INTRODUCTION DES CRYPTOS	AVEC BIT	AVEC ETH	AVEC DOGE
STOCKS				
AVERAGE RETURN	23,31%	45,66%	75,11%	56,90%
VOLATILITY	28,46%	37,21%	52,42%	46,90%
SHARPE RATIO	0,65	1,1	1,34	1,1
RANKINGS:				
➢ Horizontal	4	2	1	2
➢ Vertcal	2	3	3	3
TECHNOLOGY STOCKS				
AVERAGE RETURN	35,18%	62,95%	91,86%	73,43%
VOLATILITY	32,22%	42,73%	55,17%	48,99%
SHARPE RATIO	0,94	1,36	1,58	1,4
RANKINGS:				
➢ Horizontal	4	3	1	2
➢ Vertcal	1	1	1	1
CURRENCIES				
AVERAGE RETURN	-2,44%	76,62%	153,70%	183,19%
VOLATILITY	12,32%	73,52%	117,30%	184,96%
SHARPE RATIO	-0,58	0,98	1,27	0,96
RANKINGS:				
➢ Horizontal	4	2	1	3
➢ Vertcal		5	4	5
COMMODITIES				
AVERAGE RETURN	10,76%	42,29%	73,45%	46,76%
VOLATILITY	16,18%	37,03%	52,92%	41,27%
SHARPE RATIO	0,37	1,01	1,3	1,02
RANKINGS:				
➢ Horizontal	4	3	1	2
➢ Vertcal	4	4	5	4
OIL				
AVERAGE RETURN	28,40%	62,27%	96,16%	86,72%
VOLATILITY	45,05%	46,98%	62,20%	67,52%
SHARPE RATIO	0,52	1,22	1,47	1,21
RANKINGS:				
➢ Horizontal	4	2	1	3
➢ Vertcal	3	2	2	2