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COMPARISON OF INVESTMENT STRATEGIES IN INNOVATION AND NON-INNOVATION PORTFOLIOS WITH PORTFOLIO OPTIMIZATION

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ABSTRACT

This study aims to examine whether asset allocation strategies to the innovation sector can provide superior portfolio performance to investors. This type of research is comparative research using secondary data sources. The sample used is ETFs (Exchange Traded Funds) from investment companies namely BlackRock and Ark Invest since 2015. The focus of this study is to compare the performance of portfolios without an allocation to innovation assets and portfolios with allocations to innovation assets. This study analyzes the difference in performance between the two portfolios for various weightings and several portfolio optimization approaches, such as 'equal weighting' (1/N), optimality Lagrange, minimum-variance (MinVar), mean-variance (MV), and market-value weighted strategy.

Keywords: Asset Allocation, Innovation-Investing, Non-Innovation vs Innovation Allocation, Portfolio Optimization

INTRODUCTION

The world of finance and investment consists of a wide variety of financial instruments. A wide variety of these financial instruments are traded in the capital market. The capital market is a system that becomes a forum for buying and selling financial assets, which includes securities, derivatives, or financial transactions, which usually involve long-term financial obligations, aimed at meeting capital needs or additional capital (Wieland et al, 2020). Investors, both individuals, and institutions, are often faced with the problem of how to allocate a fund to a variety of investment assets available in the capital market. To answer this problem, investors often use a portfolio management strategy, to be able to choose, analyze, and evaluate each fund to be allocated to a financial instrument in the investor's portfolio.

In forming a good stock portfolio, investors need to choose the company's stocks wisely. A good portfolio should be able to provide diversification benefits that can lower the risk of the investor's overall portofolio. Diversification is a strategy of investing in many assets to minimize risk or maximize portfolio returns (Jayeola, et al, 2018). Diversification is not only done by investing in many assets. According to Grubel (1968), international diversification is also an important diversification strategy that investors need to pay attention to. Diversification internationally is a risk management technique that aims to reduce volatility by spreading risk across different geographical areas (Grubel, 1968).

Diversification strategies to build a good portfolio can be possible through ETFs. Investors who invest in ETFs aim to diversify portfolio risk and profit from overseas markets. This is in line with a study conducted by Grubel (1968) which showed that international diversification provides benefits for investors' portfolios due to the high correlation between domestic markets, so this causes domestic diversification to make portfolios less effective for diversification benefits.

Investors who have diversified their portfolios internationally cannot be said to already have a good portfolio. According to Leggi (2020), investors who do not allocate their portfolios to innovation assets have the potential to face disruptive risks caused by these emerging innovations. According to Chaves & Fine (2018), a disruptive risk is a risk that will fundamentally change the financial prospects of an industry and the companies it contains. This research is in line with research conducted by Innosight (2018) which shows that in the 52 years from 1964 to 2016, the average life span of companies in the S&P 500 decreased by 25%, from 33 years to 24 years and is predicted to continue the decline back by 50% to 12 years in 2027. The decline in the lifespan of this company is due to innovative technologies that disrupt the industry in the traditional field at a very fast speed.

A good portfolio must be able to hedge from disruptive risks while capturing the huge growth opportunities offered by these emerging innovations (Leggi, 2020). According to Leggi (2020), advances in innovation technology emphasize the importance for investors to allocate their portfolios to financial instruments that have an allocation over innovation technologies.

ETFs can make portfolio allocation to financial instruments with allocations for innovation technology and international diversification possible. Investors can invest in innovative technology assets through ETFs with the ticker ARKK. ARKK ETFs can be used by investors to allocate portfolios to several kinds of innovative technologies. The types of companies in the ARKK ETF consist of genomic revolution companies, automation transformation companies, energy transformation companies, artificial intelligence, and next-generation internet companies/fintech innovation companies. This ARKK ETF will be an innovation asset that demonstrates the performance of innovation stock instruments in the portofolio. In addition, there are three other ETFs that investors can use to diversify and allocate portfolios to foreign markets through ETFs with the tickers ITOT, EFA, and EEM. This ITOT ETF will be a benchmark for stock market performance in America. The EFA ETF will be a benchmark for stock market performance in developed countries (other than America). The EEM ETF will be a benchmark for stock market performance in emerging markets. These four types of ETFs are traded on the New York Stock Exchange (NYSE) exchange in America.

The four types of ETFs will be formed into two portfolios, referred to as innovation portfolios and non-innovation portfolios. A portfolio will be called an innovation portfolio if it has an allocation to an ARKK ETF, otherwise, a portfolio will be called a non-innovation portfolio if it has no allocation to an ARKK ETF. Investors need to build a good portfolio, namely by building a portfolio that invests in innovative and internationally diversified technology assets. Therefore, this study builds an innovation portfolio as a portfolio that has diversified internationally while allocating to innovation technology assets, while non-innovation portfolios only diversify internationally without allocating to innovation technology assets. The difference between an innovation portfolio and other portfolios is shown by whether there is a portfolio allocation to five types of innovation industry platforms according to Ark Investment Management, namely artificial intelligence, robotics, energy storage, DNA sequencing, and blockchain technology. The allocation of portfolios to these five types of innovation industry platforms will protect investors' portfolios from disruptive risks caused by future developments in innovative technologies.

The composition of the innovation portfolio consists of four ETFs, namely ITOT, EFA, EEM, and ARKK. The composition of the non-innovation portfolio consists of three ETFs namely ITOT, EFA, and EEM. The composition of the innovation and non-innovation portfolio consists of the same three ETFs namely ITOT, EFA, and EEM which aims to show that both portfolios are already diversified internationally. This same ETF composition is intended to show how the performance of an innovation ETF, namely the ARKK ETF, can provide additional risk-adjusted returns on a portfolio that is even already diversified internationally. According to Jogiyanto (2010), portfolio performance is not only measured by the number of portfolio returns but also must consider the amount of risk to get the portfolio return, in other words, it is mandatory to consider the returns and risks inherent in the portfolio returns.

The study also looked at the impact of a larger proportion of weights on innovation technology ETFs, namely ARKK, which can increase the risk-adjusted return rate of the portfolio as measured using the Sharpe ratio. The portfolio weighting technique will use four portfolio optimization theories, namely: optimality-Lagrange, mean-variance portfolio, minimum variance portfolio, equal-weighted portfolio, and market-value weighted portfolio. Portfolio optimization is the process of allocating funds to a collection of assets (portfolios) periodically, based on the risk profile of investors (Yu, 2019).

According to research conducted by Leggi (2020), innovation portfolios have better portfolio performance than non-innovation portfolios. In addition, a higher level of portfolio allocation on innovation assets, namely the ARKK ETF, provides a higher level of risk-adjusted return or Sharpe ratio on the portfolio.

LITERATURE REVIEW

Return on Investment

Return is a return expressed where the cash inflow is received in the current currency at the time of receipt (Biktimirov, Ernest & Barnes, Thomas,2003). An investor who invests in an investment instrument, such as stocks, will get a return called yield and capital gains (loss). Yield shows the percentage of dividends earned by investors, while capital gains (losses) are gains (losses) on the decline in stock prices received by investors.

One way to calculate the expected return of a security is to use the arithmetic mean method. The arithmetic mean is a statistical calculation method that is generally used to calculate the average value. Systematically, the arithmetic mean formula can be written through the following equation:

$$A = \frac{1}{n}\sum_{i=1}^{n} a_i \quad (1)$$

Investment Risk

In addition to considering the potential return on investment, investors need to consider the level of risk of an investment instrument. Investment risk can be defined as the possibility of losses or deviations in actual returns from the expected returns expected by investors. Mathematically, investment risk can be represented by how far the data is scattered or deviated from the average. There are two statistical measuring instruments used to represent investment risk, including variance and standard deviation. The farther the actual return deviates or spreads from the expected return, the higher the risk level of an investment instrument. Mathematically, the formula for calculating variance and the standard deviation is as follows:

$$\sigma^2 = \frac{\sum(X-\mu)^2}{N} \quad (2)$$

$$\sigma^2 = \sqrt{\frac{\sum(X-\mu)^2}{N}} \quad (3)$$

Information:
X = possible returns
μ = average return of a security
N = number of possible returns

Portfolio Returns

Portfolio returns are returns on investments in various financial instruments that are owned by investors for a certain period. According to Jogiyanto (2000, p.142), the expected return on a portfolio is a weighted average of the returns of each security in the portfolio. Systematically, the expected return of the portfolio can be expressed as follows:

$$E(R_p) = \sum_{i=1}^{n}(w_i * E(R_i)) \quad (4)$$

Information:
E(Rp) = expected portfolio return
Wi = the portion of the security i against all securities in the portfolio
E(Ri) = expected return of the i-th security
N = amount of the data security

Portfolio Risk

In addition to considering the potential return on the portfolio, investors need to consider the level of risk for a portfolio that the investor forms. A good portfolio must be able to provide diversification benefits to minimize investor portfolio risk. Good diversification can be obtained by investors by investing in investment instruments that move in the opposite direction or have a low correlation value. There are two measuring instruments that investors can use to see the directional movement of an investment instrument, including covariance and correlation.

Investors can calculate the amount of portfolio risk, starting from a portfolio with two securities and n securities. Before calculating portfolio risk, investors need to know the three components needed, including the variance of each security, the covariance between one security and another, and the weighting for each security in the portfolio. There are three securities used in the non-innovation portfolio and there are four securities used in the innovation portfolio. Systematically, then the formula for calculating the risk of a portfolio with three securities is as follows:

$$\sigma P = (wA\ 2\ \sigma A\ 2 + wB\ 2\ \sigma B\ 2 + wC\ 2\ \sigma C\ 2 + 2wAwB\sigma A\sigma B\rho AB + 2wBwC\sigma B\sigma C\rho BC + 2wAwC\sigma A\sigma C\rho AC)^{1/2} \quad (5)$$

Meanwhile, the formula for calculating the risk of a portfolio with four securities is as follows:

$$\sigma P = (wA\ 2\ \sigma A\ 2 + wB\ 2\ \sigma B\ 2 + wC\ 2\ \sigma C\ 2 + wD\ 2\ \sigma D\ 2 + 2wAwB\sigma A\sigma B\rho AB + 2wBwC\sigma B\sigma C\rho BC + 2wAwC\sigma A\sigma C\rho AC + 2wAwD\sigma A\sigma D\rho AD + 2wBwD\sigma B\sigma D\rho BD + 2wCwD\sigma C\sigma D\rho BD)^{1/2} \quad (6)$$

Covariance

Covariance is defined as a measurement that measures how much two variables change together (Weight, 2013). Covariance with a positive value indicates that the return movement of both assets is moving in the same direction, while a covariance with a negative value indicates that the return movement of the two assets is moving in the opposite direction. Covariance is different from correlation, where covariance cannot be used to measure the strength of the relationship between the two variables, while correlation can be used to measure the strength of the relationship between the two variables. Systematically, the formula for calculating covariance is as follows:

$$Covariance = \frac{\sum(Return_{ABC} - Average_{ABC}) * (Return_{xyz} - Average_{xyz})}{(Sample\ Size) - 1} \quad (7)$$

Correlation

The concept of correlation was first introduced by Sir Francis Galton (1886). Then this correlation coefficient was introduced in the financial world by Harry Markowitz (1952) when developing modern portfolio theory. Correlation in a broad sense is a measure of relationships between variables (Shober, 2018).

The value of correlation coefficient has a range of values from -1 to +1. Perfect correlation has a correlation coefficient value of 1. The negative or positive number contained in the result of the correlation coefficient shows the nature of the relationship between the two variables. A perfect positive correlation means the movement of one of the securities, either up or down, causing the other security to move in the same direction. The value of the perfect correlation coefficient has a positive exact value of 1. A perfect Negative correlation indicates the direction of movement of one of the securities, either up or down, causing the other security to move in the opposite direction. The value of the perfect correlation coefficient has a negative exact value of 1.

Adding securities that have a low correlation value or are negatively correlated, can provide diversification benefits to investors' portfolios (Zainal Abidin, Sazali & Haron, Razali, 2006). The formula used to calculate the variable correlation between variables is:

$$r = \frac{\sum(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum(x_i - \bar{x})^2 \sum(y_i - \bar{y})^2}} \quad (8)$$

Efficient Portfolio Determination and Portfolio Optimization Process

An efficient portfolio is a portfolio that has the highest rate of return at a certain level of risk or a portfolio that has the lowest level of risk with a certain level of return (Tandelilin, 2010).

Investors can determine an efficient portfolio that fits their risk profile by using Lagrange optimization methods. Lagrange optimization methods can result in efficient portfolios, such as portfolios with minimum portfolio risk or portfolios with a maximum coefficient of variation while determining the combination of proportions of elements/weights needed to form an efficient portfolio.

The allocation model approach to the portfolio can use both simple and complex models. This research uses a simple allocation model approach first such as equal-weighting and market-value weighted strategy, then will be continued by using a portfolio optimization approach with more complex models such as optimality-Lagrange, minimum-variance, and mean-variance.

The Relationship Between Asset Allocation and Portfolio Performance

According to research conducted by Leggi (2020), businesses and consumers are willing to change their behavior and try innovative products and services that are more productive, fast, and cheap. Changes in business and consumer behavior will lead to an increase in the market share of innovative companies. Research conducted by Ark Investment Management (2020), which states that the market capitalization of innovation technology assets will grow from $6 trillion in 2020 to $50 trillion by 2032, shows a CAGR growth rate of 21% over twelve years.

This is in line with research conducted by Leggi (2020) showing that innovation portfolios have better portfolio performance compared to non-innovation portfolio performance. The superiority of innovation portfolio performance is supported by the low level of correlation between innovation assets and the majority of stock indices and the high growth rate of innovation assets that surpasses the growth rate of stock indices in developed countries (Leggi, 2020).

The Relationship Between Asset Allocation Weights and Portfolio Risk-Adjusted Returns

Research conducted by Leggi (2020) shows that greater weighting on innovation technology assets, namely ARKK ETFs, is directly proportional to the performance and rate of return of the portfolio. The risk-adjusted return rate of a portfolio, as measured using the Sharpe ratio, will be higher if the weight of the allocation to innovation assets is also greater. According to research conducted by Ark Investment Management (2020), the high ratio of Sharpe in portfolios that do a greater weighting of innovation assets, namely ARKK ETFs, is due to the low level of correlation between the innovation industry which is 0.22 while the correlation between the company sectors in the S&P 500 index is 0.55. The low level of correlation has the potential to increase risk-adjusted returns in the equity portfolios of global investors. Thus, the Sharpe ratio will increase if the weight of allocation to innovation assets is greater.

METHODOLOGY

This study compares the performance of innovation portfolios and non-innovation portfolios, so this type of research is comparative research. The data used in this study uses numerical number data so this research is quantitative. The population used in this study was all stocks traded on the New York Stock Exchange (NYSE) exchange. The sampling technique uses the purposive sampling method, which is a sampling method based on certain criteria determined by the researcher. The sample used in this study was an ETF with tickers "ITOT", "EFA", "EEM", and "ARKK" during the period January 2015 – December 2021.

The type of data used in this study is secondary data obtained from Bloomberg Terminal sources located in the Petra Christian University Data Center Laboratory. The data analysis technique uses the basis of Markowitz's theory which is calculated using Microsoft Excel 365.

Operational Definition of Variables

1. Research Variables: Innovation Portfolio
   a. Operational Definition: An innovation portfolio is a portfolio that invests in new products or services in technologies such as DNA sequencing, energy storage, artificial intelligence, autonomous vehicles, and blockchain and is already diversified internationally.
   b. Empirical Indicators: ARKK ETF Mutual Fund
2. Research Variables: Non-Innovation Portfolio
   a. Operational Definition: A non-innovation portfolio is a portfolio that does not invest in new products or services in innovative technologies but has diversified domestically or internationally.
   b. Empirical indicators: ETF ITOT, EFA, EEM Mutual Funds

ANALYSIS AND DISCUSSION

This study discusses the comparison of the performance of an innovation portfolio with a non-innovation portfolio using investment instruments, namely exchange-traded funds (ETFs) because ETFs are one of the indicators that can be used to track the performance of an index. In providing a good comparison, the method of weighting assets in each portfolio refers to five theories of portfolio optimization, including Lagrange optimality, equally weighted, market-value weighted, minimum-variance, and mean-variance.

The results showed that innovation portfolios performed better than non-innovation portfolios. Portfolio performance measurements were performed using Sharpe, Treynor, and Alpha ratios. The Sharpe and Treynor ratio is a ratio that measures the risk-reward of a portfolio, the higher the ratio of Sharpe and Treynor, the better the risk-reward of a portfolio. The alpha ratio is a ratio that measures a portfolio's ability to beat market returns.

Based on Table 1, it is shown that the Sharpe ratio of innovation portfolios tends to have a higher Sharpe ratio of portfolios than non-innovation portfolios in all types of portfolio optimization. A higher Sharpe ratio in an innovation portfolio indicates that the high level of risk in an innovation portfolio can be balanced against the high level of expected return offered on an innovation portfolio.

However, portfolios with minimum-variance optimization still show the same level of Sharpe ratio of portfolios in both types of portfolios. This is because in minimum-variance optimization, innovation portfolios, and non-innovation portfolios have similar allocations because they both have no allocation to ARKK ETFs.

Table 1. Comparison of Sharpe Ratios on Innovation Portfolios and Non-Innovation Portfolios

Method	Sharpe Ratio of Innovation Portfolio	Non-Innovation Portfolio Sharpe Ratio
Lagrange-Optimality	0.26796	0.26287
Equally Weighted	0.21147	0.15489
Market-Value Weighted	0.18869	0.15972
Minimum-Variance	0.14922	0.14922
Mean-Variance	0.27561	0.26087

Furthermore, based on Table 2, it is shown that Treynor ratios on innovation portfolios tend to have higher portfolio Treynor ratios than non-innovation portfolios on all types of portfolio optimization.

In the calculation of the Treynor ratio, the risk-free rate of return used is a 10-year US government bond yield of 1.67% as of December 30, 2021. Furthermore, the calculation of portfolio beta is carried out using the weighted average method, which is the weight of each ETF in the portfolio multiplied

by the beta of each ETF against the S&P 500 index during the period January 2015-December 2021. The market return is derived from the average monthly return of the S&P 500 index during the period of January 2015-December 2021.

A higher Treynor ratio to an innovation portfolio indicates that an innovation portfolio has a better risk-adjusted return than a non-innovation portfolio compared to market systematic risk.

However, portfolios with minimum-variance optimization still show the same level of portfolio Treynor ratio on both types of portfolios. This is because in minimum-variance optimization, innovation portfolios, and non-innovation portfolios have similar allocations because they both have no allocation to ARKK ETFs.

Table 2. Comparison of Treynor's Ratios on Innovation Portfolios and Non-Innovation Portfolios

Method	Treynor Ratio of Innovation Portfolio	Non-Innovation Portfolio Treynor Ratio
Lagrange-Optimality	0.01003	0.00972
Equally-Weighted	0.00858	0.00554
Market-Value Weighted	0.00705	0.00564
Minimum-Variance	0.00517	0.00517
Mean-Variance	0.01123	0.00962

Finally, based on Table 3, it is shown that the Alpha ratio in innovation and non-innovation portfolios tend to have an Alpha ratio of a negative nature. A negative value in the Alpha ratio indicates that the performance of the innovation and non-innovation portfolio is not capable/successful in beating the performance of the S&P 500 market index.

In the calculation of the Alpha ratio, the risk-free rate of return used is a 10-year US government bond yield of 1.67% as of December 30, 2021. Furthermore, the calculation of portfolio beta is carried out using the weighted average method, which is the weight of each ETF in the portfolio multiplied by the beta of each ETF against the S&P 500 index during the period January 2015-December 2021. The market return is derived from the average monthly return of the S&P 500 index during the period of January 2015-December 2021.

The innovation portfolio with the mean-variance weighting method is the only portfolio that has a positive Alpha value, which shows that the innovation portfolio with the mean-variance optimization method managed to beat the market performance/benchmark S&P 500.

In addition, the Alpha ratio on innovation portfolios tends to have a better portfolio Alpha ratio than non-innovation portfolios on all types of portfolio optimization. Alpha's ratio to an innovation portfolio is negative but not as large as a non-innovation portfolio.

However, portfolios with minimum-variance optimization still show the same level of portfolio Alpha ratio in both types of portfolios. This is because in minimum-variance optimization, innovation portfolios, and non-innovation portfolios have similar allocations because they both have no allocation to ARKK ETFs.

Table 3. Comparison of Alpha's Ratios on Innovation Portfolios and Non-Innovation Portfolios

Method	Alpha Ratio of Innovation Portfolio	Non-Innovation Portfolio Alpha Ratio
Lagrange-Optimality	0.00003	-0.00029
Equally-Weighted	-0.00150	-0.00401
Market-Value Weighted	-0.00288	-0.00396
Minimum-Variance	-0.00435	-0.00435
Mean-Variance	0.00144	-0.00039

The result of the next study is that portfolios that have a greater allocation/weighting of innovation assets are also directly proportional to the portfolio's risk-adjusted returns. Based on Table 4, the results showed

that portfolios that had a larger proportion of weights to ARKK ETF assets performed better, on all four types of portfolio optimization methods. The results of this study are in line with research conducted by Leggi (2020) which shows that a greater weighting in innovation technology assets, namely the ARKK ETF, is directly proportional to the risk-adjusted return of the portfolio. The low level of correlation of ARKK ETFs with the other three ETFs has led to increased diversification benefits on innovation portfolios.

Opposite results are shown in the optimality-Lagrange method where the negative weighting on the ARKK ETF gives a fairly high Sharpe ratio. This is because the optimality-Lagrange method will optimize the weight of each asset in the portfolio to achieve an expected portfolio return of 1.13897% which provides a minimum portfolio variance, regardless of constraint leverage.

However, the conclusions of the study showed that portfolios that had a larger proportion of weighting to ARKK ETF assets performed better on the majority of portfolios tested. Thus, a portfolio that has a larger proportion of weighting to ARKK ETF assets is directly proportional to the portfolio's risk-adjusted return.

Table 4. The proportion of ARKK ETF Weigths and Sharpe Ratio on Innovation Portfolio

Method	ARKK ETF Weights	Non-Innovation Portfolio Sharpe Ratio
Lagrange-Optimality	-13.16958%	0.26796
Equally Weighted	25.00000%	0.21147
Market-Value Weighted	10.81071%	0.18869
Minimum-Variance	0.00000%	0.14922
Mean-Variance	28.47108%	0.27561

CONCLUSIONS AND RECOMMENDATIONS

This research shows that an internationally diversified portfolio will be more optimal if it has an allocation to innovation technology assets. The low level of correlation between ARKK ETFs and the three ETFs of the developed and developing country indices leads to better diversification results. This is shown from the results of this study which show that innovation portfolios perform better than non-innovation portfolios, which are measured using Sharpe, Treynor, and Alpha ratios.

A greater weighting to innovation technology assets, namely the ARKK ETF, is also directly proportional to the portfolio's risk-adjusted return. This is in line with research conducted by Leggi (2020) which shows that a greater weighting in innovation technology assets, namely ARKK ETFs, is directly proportional to portfolio risk-adjusted returns. Thus, this study answers the formulation of this research problem, namely the performance of the innovation portfolio has a better performance than the non-innovation portfolio. In addition, this study also shows that giving greater weight to innovation technology assets, namely ARKK ETFs, has the potential to increase portfolio risk-adjusted returns.

Based on the conclusions of the study, the authors recommend the following suggestions:

1. For investors, the weakness in this study is that all correlations between assets in the portfolio show high (significant) yields due to the study using ETFs. This drawback results in the effect of diversified gains in the portfolio not being very significant.
2. For investors, further research can use samples of innovation assets individually, but asset selection needs to be done rationally, so as not to provide biased research results.

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