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MASTER'S THESIS

THE ROLE OF GOLD IN DIVERSIFIED PORTFOLIOS ACROSS ECONOMIC CYCLES

Ljubljana, January 2026 PRIMOŽ SIMONIČ

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ABSTRACT

This thesis explores the role of gold in diversified portfolios across different economic cycles. Drawing from theoretical research and simulation analysis based on historical data, it examines the impact and effect that gold has on modern portfolios. The findings show that gold's inclusion in portfolios delivers substantial performance benefits. It enhances long-term efficiency by improving risk-adjusted returns and contributes to portfolio resilience during periods of market turmoil. Ultimately, this thesis demonstrates that gold still serves the same purpose it has for centuries, that of a diversifier and a source of financial stability.

KEY WORDS: gold, portfolio theory, diverzification, correlation, economic cycles, portfolio efficency, asset allocation

SUSTAINABLE DEVELOPMENT GOALS

POVZETEK

To magistrsko delo proučuje vlogo zlata v diverzificiranih portfeljih skozi različne gospodarske cikle. Na podlagi teoretičnih raziskav in simulacijskih analiz, ki temeljijo na zgodovinskih podatkih, preučuje vpliv in učinke, ki jih ima zlato na sodobne portfelje. Ugotovitve kažejo, da vključitev zlata v portfelje prinaša pomembne koristi za njihovo uspešnost. Zlato izboljšuje dolgoročno učinkovitost z izboljšanjem tveganju prilagojenih donosov ter prispeva k odpornosti portfeljev v obdobjih tržnih pretresov. Končno to delo dokazuje, da zlato še vedno opravlja enako vlogo kot že stoletja, saj deluje kot razpršev alec tveganja in vir finančne stabilnosti.

KLJUČNE BESEDE: zlato, teorija portfelja, diverzifikacija, korelacija, gospodarski cikli, učinkovitost portfelja, razporeditev sredstev

CILJI TRAJNOSTNEGA RAZVOJA

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LIST OF ABBREVIATIONS

CBOE − Chicago Board Options Exchange

CML − Capital Market Line

ETF − Exchange-Traded Fund

LEGATRUU − Bloomberg Global-Aggregate Total Return Index Value Unhedged USD

MSCI − Morgan Stanley Capital International

MXWO − MSCI World Index

USA − United States of America

VIX − Volatility Index

1 INTRODUCTION

The stability and performance of the global financial markets have been increasingly challenged over the past two decades. The major crises, such as the 2008 Global Financial Crisis and the COVID-19 crisis, as well as the more recent times of inflationary shocks and geopolitical tension have shown vulnerabilities in many traditional investment portfolios. In these times, we have witnessed extreme equity downturns, inconsistent bond markets and an increase in correlation between assets previously assumed as diversifiers. These developments have shown a higher interest for assets that do provide stability, protection and diversification benefits as well. Among these, gold has held a historical reputation as a store of value, hedge against inflation and a safe haven during market stress.

Throughout human history, gold has consistently played a pivotal role both as a medium of exchange and as a reliable store of value. Its uniqueness, inherent beauty, and ability to withstand corrosion made it ideal for a form of currency that is firmly established in economic systems ranging from ancient civilizations to contemporary central banks. In a world dominated by financial innovation, digital alternatives and cryptocurrencies, many investors view gold as obsolete. Recently gold prices have risen significantly, making gold an interesting addition to a portfolio. That increase has led to questions of why does the gold price increase in times of turmoil and uncertainties and does gold still hold its diversification benefits as it has historically?

This thesis aims to address these questions through a comprehensive quantitative analysis of gold's role in investment portfolios across different economic cycles. By combining theoretical insight from modern portfolio theory and empirical evidence acquired from market data, the study examines how an inclusion of gold in portfolios affects their performance. By analysing the stock, bond and gold markets over the period of 20 years, with an emphasis on four major periods: the 2008 global financial crisis (2007−2009), high growth pre-covid period (2018−2019), Covid-19 crisis (2020−2021) and the current economic period (2023−2025), it aims to determine how gold affected the performance of different portfolios during these times. Three investment approaches will be compared: a traditional buy and hold strategy (Scenario 1), an optimally timed strategy (Scenario 2), and a practical realistic strategy using volatility indicators such as the VIX (Scenario 3). Together these approaches would lead to a comprehensive evaluation of both the theoretical and practical aspects of holding gold in diversified investment portfolios.

The core of the analysis relies on three performance metrics commonly used in portfolio evaluation: annualised returns, volatility, and the Sharpe ratio. Returns measure how much an investment has increased on average each year during a specific period, volatility represents its level of risk, and the Sharpe ratio will allow us to compare the return per unit of risk across different portfolios. It will help us identify portfolios that provide the most efficient returns per

the level of risk. By examining how these metrics change with the inclusion of gold, this study aims to gauge gold's impact on portfolio performance.

The thesis will be comprised of seven chapters. The first three will set a theoretical foundation for the study. They will explore the role and historical significance of gold, examine the evolution and importance of portfolio theory and how it impacts the research of the thesis as well as the significance of holding gold in investment portfolios. The following two chapters will more directly explore the aims of this thesis, set the research questions and analyse the time period in which this study takes place. The latter chapters will be of an empirical nature where the main part of the analysis will take place such as analysing the provided data, constructing portfolios and interpreting the results. Lastly, with the help of this research, the main conclusions of the thesis will finally be presented.

The research findings would give investors, asset managers and institutions guidance, advice and help develop optimal strategies to help diversify their portfolios and mitigate its risks. This would lead to better asset allocation decisions as well as giving investors more confidence in navigating turbulent markets. From a theoretical standpoint, the study would contribute to the many existing research done in portfolio management and financial theory. Lastly, the current state of the world is marked by geopolitical tensions, economic uncertainty and financial market volatility which makes this research particularly timely. These factors make investing much more difficult and increase the demand for trustworthy hedging tools. Assessing gold's performance directly in such demanding settings should provide direct and prompt advice on how gold allocations can support investors in navigating these times of increasing uncertainties.

In summary, this study aims to explore the importance of holding gold in investment portfolios by combining theoretical and empirical approaches. Using historical data over a 20-year period, it examines how adding gold to portfolios comprised of stocks and bonds impacts their returns, volatility and risk-adjusted returns. Through this approach this research intends to provide a deeper understanding how gold contributes to portfolios and help guide investors seeking greater stability in the current ever increasingly unstable financial environment.

The findings of the study show that gold's inclusion in portfolios delivers substantial performance benefits. It enhances long-term efficiency by improving risk-adjusted returns and contributes to portfolio resilience during periods of market turmoil. The results across all scenarios and periods show that gold has a consistent and important impact on portfolio performance, particularly during times of market stress or economic uncertainty. For investors, this research carries several practical findings. Firstly, having a strategic 5−15% gold allocation seems optimal across a wide range of conditions. Secondly, while tactical allocations can improve portfolio performance in certain times, a long-term approach offers safer and more reliable returns. These findings also contribute to literature by bridging theory and practice and showing that gold's diversification benefits are time and portfolio dependant. Ultimately, this thesis demonstrates that gold still serves the same purpose it has for centuries, that of a diversifier and a source of financial stability.

2 PORTFOLIO THEORY

A collection of securities is called a portfolio. A quantitative technique for choosing the best portfolio that can balance maximizing return and lowering risk in a variety of uncertain situations is portfolio analysis. The answers to the questions "what is the return of a portfolio" and "what is the risk of the portfolio" are necessary before choosing the best portfolio (Huang, (2010). The primary goal of investors' research into various financial assets is to increase their profits. However, probable earnings are not independent from risk, which is measured by volatility of returns. Therefore, investors create portfolios with a variety of different investment tools with different weights. That is called diversification. Small variance assets are typically selected to build a portfolio. The relationship between the assets invested in the portfolio was however not considered in this traditional method. It is not enough to only choose small variance assets for investments as stocks may move together (Bilir, 2016).

2.1 Evolution of portfolio theory

The first person to explain the significance of the relationship between the financial assets included in a portfolio was Markowitz in 1952. He first had to discredit the then widely accepted rule that an investor chooses a portfolio by selecting securities that maximise discounted expected returns. Markowitz points out that if an investor follows this principle, their portfolio will consist of only one stock, namely the one that has the highest expected return which is contrary to what diversification stands for. Therefore, it is necessary to reject a behaviour rule that does not result in portfolio diversification. After that, Markowitz suggests the Mean-variance approach (Constantinides & Malliaris, 1995).

According to this model, choosing a portfolio is determined by either its minimising risk for a given level of expected return or maximising its return for a given level of risk. It suggests many statistical methodologies for constructing the optimal portfolio for maximising return and minimising risk. His model showed that the risk of a portfolio depends not only on the individual variances of the assets but also on the correlation between them. He introduced the following fundamental equations.

Expected portfolio return is:

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

where $E(R_p)$is the expected return of the portfolio, $w_i$is the weight of asset i, and $E(R_i)$is the expected return of asset i.

Portfolio variance is:

$$\sigma_p^2 = \sum_{i=1}^{n} \sum_{j=1}^{n} w_i w_j \sigma_{ij}, \quad (2)$$

where $\sigma_{ij}$is the covariance between the returns of assets i and j (Bartkus & Bartkute, 2013). Covariance reflects how assets move together.

Covariance formula is:

$$\sigma_{ij} = \rho_{ij} \sigma_i \sigma_j, \quad (3)$$

where $\rho_{ij}$is the correlation coefficient between the returns of assets i and j. The correlation coefficient is used to quantify the strength and direction of a linear relationship between two variables, making it useful for assessing investment risks and optimising portfolios. It offers valuable insights into how variables move in tandem, which can improve diversification and help control volatility (Fernando, 2025). On the other hand, correlation has no effect on the expected return of a portfolio. However, the volatility of the portfolio will differ depending on the correlation. In particular, the lower the correlation, the lower the volatility we can obtain (Berk & DeMarzo, 2023).

A key part of modern portfolio theory is diversification. As the total number of assets in a portfolio increase, diversification starts to play a bigger role. In an equally weighted portfolio, where each asset is assigned the same weight, the portfolio's volatility can be understood as a combination of the average volatility of all the assets and the average degree to which they are correlated. As the portfolio expands, the influence of each asset decreases. When assets are combined that do not move perfectly together, the resulting portfolio will always have lower volatility than a simple weighted average of individual volatilities. Diversification thus allows investors to achieve lower risk in their portfolios without necessarily reducing the return (Berk & DeMarzo, 2023).

Markowitz illustrated that the relationship between risk and return creates the efficiency frontier, a set of optimal portfolios that delivers the highest possible expected return for a specific level of risk. This frontier visually depicts portfolios that achieve maximum returns relative to the risk taken. The returns depend on the mix of assets within the portfolio. A key finding of the concept was the advantage of diversification, reflected in the curved shape of the efficiency frontier. The curvature is important in revealing how diversification improves the portfolio's risk/reward ratio. It also reveals that there is a diminishing return to risk (Bartkus & Bartkute, 2013).

2.2 Finding efficient portfolios

In constructing portfolios with two assets, investors can create an efficient portfolio by evaluating all possible combinations of portfolio weights to determine the resulting expected return

and risk. Plotting the combinations of expected return and volatility produces a curve representing the set of possible portfolios. Only the portfolios which offer the highest expected return for a given number of risk, or the lowest volatility for the highest expected return, are deemed efficient. Portfolios laying below the efficient frontier are suboptimal, as other combinations exist that provide a better risk-return trade off (Berk & DeMarzo, 2023). As mentioned before, adding more stocks to a portfolio reduces its risk through diversification. Even when an additional asset appears unattractive when considered on its own, it may still provide diversification benefits when combined with existing holdings. When multiple assets are combined, the set of all feasible risk–return combinations forms a region that represents the possible portfolios achievable with those assets. As the number of available investment opportunities increases, the efficient frontier shifts outward, reflecting improved trade-offs between risk and return. In practice, the more assets incorporated into the analysis, the greater the potential to construct portfolios that approach the best possible combinations of expected return and volatility (Berk & DeMarzo, 2023).

Another way of reducing risk in a portfolio, besides diversification, is through risk-free assets. Even though the expected return would decrease, the risk to return ratio would improve. When a risk-free return is combined with any portfolio of risky assets, the resulting portfolios lie along a straight line connecting the risk-free rate to the chosen risky portfolio. The slope of this line represents the increase in expected return per unit of additional risk and is determined by the Sharpe ratio of the risky portfolio used.

Sharpe ratio formula (Berk & DeMarzo, 2023):

$$S = \frac{E[R_p] - R_f}{\sigma_p}. \tag{4}$$

Formula 4 shows the Sharpe ratio which measures the return to risk ratio provided by a portfolio. The optimal portfolio to combine with the risk-free asset will be the one with the highest Sharpe ratio, where the line with the risk-free investment just touches and is tangent to the efficient frontier of risky investments (Berk & DeMarzo, 2023).

Having established that the tangent portfolio represents the optimal combination of risky assets we can examine how this result determines the required returns of individual securities. When considering whether to add more of a security to an existing portfolio, the investor must weigh the increase in expected return against the increase in risk that the security contributes to the portfolio. Only the portion of the security's risk that is correlated with the portfolio is relevant, which is captured by the security's beta, which measures its sensitivity to fluctuations in the portfolio's return. Beta therefore determines how much additional risk the security introduces, and thus the return required to justify including more of it. A security's required return consists of the risk-free rate plus a risk premium proportional to its beta relative to the portfolio. If its expected return exceeds this required return, increasing its weight improves the overall Sharpe ratio (Berk & DeMarzo, 2023). Thus, adding more investments to a portfolio improves the Sharpe ratio if Formula 5 is true.

$$E[R_i] - r_f > SD(R_i) * Corr(R_i, R_p) * \frac{E[R_p] - r_f}{SD(R_p)}. \quad (5)$$

Building on the foundation of Markowitz mean variance model William Sharpe and John Lintner developed the capital asset pricing model (CAPM). In Markowitz's model an investor chooses a portfolio at time t – 1 that produces a stochastic return at t. The model assumes that investors are risk averse and only consider the mean and variance of their one-period investment return when selecting a portfolio. Consequently, investors opt for "mean-variance-efficient" portfolios, which are defined as minimizing the variance of the portfolio return given the expected return and maximizing the expected return given variance. Sharpe and Linter add multiple assumptions to the Markowitz model to identify a portfolio that is mean variance efficient. These are frictionless trading, the ability to borrow and lend at the risk-free rate, and homogeneous expectations among investors (Fama & French, 2004). Thus, all the individuals identify the same tangent portfolio as the one offering the highest Sharpe ratio. As all investors choose this efficient portfolio, it must equal the market portfolio itself. Once this is established, the line connecting the risk-free rate to the market portfolio becomes the capital market line (CML), representing the best achievable risk–return combinations available to investors. With the market portfolio identified as the efficient portfolio, a security's beta measures the extent to which its return moves with the market, capturing the portion of its risk that is systematic and cannot be diversified away (Berk & DeMarzo, 2023).

Under these CAPM assumptions, we can identify that the efficient portfolio is equal to the market portfolio. Thus, if we do not know the expected return of a security or the cost of capital of an investment, we can use the CAPM to find it by using the market portfolio as a benchmark.

The CAPM equation is:

$$E(R_i) = R_f + \beta_i(E(R_m) - R_f), \quad (6)$$

where $E(R_i)$ is expected return of asset i, R_f is the risk-free rate, $E(R_m)$ is the expected market return, and β_i is the beta of the security with respect to the market portfolio (Fama & French, 2004).

Investors and fund managers frequently diversify their investments across different asset classes and choose which percentages of the portfolio to devote to each. There are distinct risks and opportunities associated with each asset class. These classes can include stocks, bonds, real estate, ETFs and of course commodities such as gold. Diversification is intended to reduce risk. If you spread your investment out across asset classes, industries, or maturities, you are less likely to experience market shocks that affect all your investments the same way. Before portfolio theory, investors had a vague idea of not putting all their eggs in one basket. Once it started to spread, they had a thorough, organised, and theoretically sound basis for understanding and analysing investment decisions. Its development from mean-variance optimization to CAPM shows how flexible and relevant it is.

3 GOLD AS AN INVESTMENT

Gold is the most common investment metal in the world. There are numerous qualities that make it so appealing to investors. Physical gold carries no credit risks compared to mainstream investments like bonds and equity since it is not a liability to anyone, therefore there is no uncertainty about a counterparty's ability to meet obligations. Gold, like bonds and equity, trades virtually 24 hours a day and creates a highly liquid market for investors, as its liquidity is higher than most mainstream investments. That is in part due to the worldwide demand from many sectors such as jewellery, medicine, industrial manufacturing, the technological sector and financial institutions. The availability of numerous official and unofficial investment channels, including bullion bars, coins, jewellery, certificates as well as futures and options also play a part. The gold market's depth indicates a smaller spread and a more rapid trading possibility. Consequently, this takes away the liquidity risk and makes gold more liquid than most diversifiers. However, benefits usually come as a cost. Therefore, this suggests gold returns are likely lower than comparable assets of similar risk. Because of this, gold is often not viewed as an asset that yields high returns. However, that is not always the case (Fernando, 2017).

3.1 Historical significance of gold

Throughout human history, gold has consistently played a pivotal role both as a medium of exchange and as a reliable store of value. Its rarity, intrinsic beauty, and resistance to corrosion made it perfect for a form of currency, deeply ingrained within economic systems from ancient civilizations to modern central banks. Historically, gold was the foundation of international monetary systems, such as the gold standard, and even after its collapse, gold retains substantial economic significance as a strategic financial asset, safe-haven, and hedge against economic uncertainties (Habashi, 2016). Due to its beauty, widespread world-wide distribution as well as the ease of which it could be obtained and worked on had a wider use as a medium of exchange in the ancient times than any other metal. The first uses of gold as money were in the forms of nuggets of gold, gold moulded in the shape of ornaments and gold dust.

Egypt was the leading gold-producing country in ancient times. Egyptian hieroglyphs described gold as being "more plentiful than dirt" in Egypt. In ancient Mexico and Africa gold was put in transparent quills, which served as a means of payment. These early media were usually made almost exclusively out of pure gold, as alloy-hardening techniques were not yet introduced. Towards the start of the common era, many other cultures discovered the beauty of gold. There were several great gold-mining centres in Asia Minor and around the Mediterranean where the first gold coins were struck. Although Romans had little gold-bearing places in their regions, their military expeditions brought them major amounts of the precious metal (Habashi, 2016). During the Middle Ages, gold mining spread through all over Europe and Asia. In Europe, it became so prevalent that the mines were almost emptied, which lead to the period known as The Great Bullion Famine in the 15th century (The Royal Mint). The European exploration of the Americas was in no small part contributed to the reports of gold deposits in

the area. Following the discovery of America, the Spaniards moved a significant amount of gold from the New World to Europe.

The lustrous colour of gold as well as its resistance to tarnishing have made humans use it not only as a means of payment, but for special decorative ornaments and jewellery as well. It was often used in religious artifacts and in forms of idols of many cultures across the world. By the medieval alchemists it was also regarded as a metal of perfection. Thus, many have tried to convert other metals into gold which led to many advancements in science and chemistry.

In 1717, Great Britain accidentally adopted a de facto gold standard, where Isaac Newton, as master of the mint, set a too low price of gold for silver which caused all of the silver coins to disappear from circulation. Due to Great Britain's ever-increasing role as a world's leading commercial and financial power, other countries started to adopt its monetary system. The more countries adopted the system, the more attractive it was for other countries. It spread outside of Europe and countries like the USA, Russia, Japan, and India adopted the system. The only significant country not on the gold standard was China (Eichengreen & Flandreau, 1997).

The gold standard linked national currencies to gold at a fixed rate. As a result, the system would encourage overall stabilisation, balanced trade and effectively managed the distribution of gold reserves among nations (Cassel, 1936). But in practice the system did not work as simply, and the pre-war gold standard system thus never attained the results that were constantly proclaimed and generally believed. It assumed that the value of gold could be regarded as stable and that the maintaining a fixed gold parity would guarantee the currency' stability in purchasing power. All these defects of the system became even more obvious when it had to face post-war disturbances (Cassel, 1936). That coupled with the decline of Britain's commercial and financial leverage over the war as well as the rise of the USA led to governments no longer playing harmoniously. The gold standard collapsed in 1931 (Eichengreen & Flandreau, 1997).

After the Second World War, the gold standard is replaced by the Bretton Woods Agreement. It is commonly referred to as a gold-dollar standard. Countries other than the US pegged their currencies to the dollar, the US as the reserve currency country continued to peg the dollar to gold. This system differed from the gold standard by the increase of controls on capital movements and the ability of countries to realign, but the inspiration drawn from the gold standard was evident. In 1971−73 US President Richard Nixon abandons the Bretton Woods Agreement. This means that the dollar and other global currencies are no longer linked to the value of gold. While the monetary role of gold receded with the collapse of Bretton Woods, the chairman of the Federal Reserve Board still cited the price of gold as one of the indicators of inflationary pressure he considered when framing monetary policy (Eichengreen & Flandreau, 1997).

Today gold is still prevalent in many industries and the obsession people had with this precious metal in the past has not waned. Gold differs from other metals in that most of the metal that has been mined is still in existence. It is estimated that there is currently 125.000 tons of gold

in total. Approximately 2000 tons of that are used in jewellery. Different regions of the world have different uses of gold in jewellery. While in the west it plays largely a decorative role and the role of a status symbol, it plays a highly monetary role in the east, where it is usually purchased and kept as an investment (Habashi, 2016). Due to its chemical and physical properties as well as its longevity, functionality, aesthetic, biocompatibility and ease of manufacturing it is also needed in many modern industries. Gold has a significant role in the biomedical industry and dentistry as well as nanotechnology (Rudolf et al., 2012).

3.2 The role of gold in investment portfolios

Understanding portfolio theory, explained in the Chapter 1, provides a good and solid framework for understanding gold's value as an investment asset and a hedge. Diversification is the foundation of portfolio theory, emphasising the reduction of unsystematic risk through the combination of assets with different correlations. Usually, there is little to no correlation between gold and conventional financial assets like stocks and bonds. According to the Markowitz mean-variance framework, adding gold to a portfolio balances out negative price movements in conventional asset classes, lowering overall volatility. During the stock market downturns, gold usually appreciates in value due to increased demand for safer assets. Using portfolio theory, investors can find the best asset allocations. By employing Markowitz's efficient frontier strategy, investors can methodically assess various stock, bond, and gold portfolio combinations to find allocations that maximise returns for specific risk levels. Additionally, this methodology contributes directly to practical portfolio management decisions by demonstrating how various economic conditions (crisis, inflation, stability) influence the optimal allocation to gold, thus allowing explicit assessment of gold's effectiveness as a hedge during different economic scenarios.

A diversifier is defined as an asset that is positively (but not perfectly correlated) with another asset or portfolio on average. The diversifier does not have the specific property of reducing losses in times of turmoil since the correlation property is only required to hold on average (Baur & Lucey, 2009). The fundamental reasoning behind gold's inclusion in a diversified portfolio lies in its low or negative correlation with traditional financial assets such as stocks and bonds. Correlation is measured by the correlation coefficient (ρ), which shows the strength and direction of the linear relationship between two asset returns.

Correlation is:

$$\rho_{i,j} = \frac{\mathrm{Cov}(R_i,R_j)}{\sigma_i \sigma_j}, \tag{7}$$

where $\mathrm{Cov}(R_i, R_j)$ represents the covariance between the returns of asset i and j, and σ_i and σ_j are their respective standard deviations (Fernando, 2025).

Traditionally, investors have diversified their investment portfolios with core asset classes such as equities (stocks) and fixed incomes (bonds). Unfortunately, recent research has shown that

the correlations within and between these main asset classes are increasing steadily over time in an era of globalisation. What's worse is that during times of economic instability, as seen during the 2008 financial crisis, the correlation between these financial assets tends to move towards 1. While stocks, bonds, and other financial instruments are ways for investors to include financial assets in their portfolios, asset classes like real estate and commodities are ways for investors to include real assets in their portfolios. As a result, investors experience dwindling diversification benefits and a lack of protection when they need it most. Theoretically, real assets' returns should be different from traditional assets since the factors that determine their prices are different. Many investors have thus chosen gold as that asset (Fernando, 2017). These effects will be empirically demonstrated in the following chapters.

Gold is viewed as a good diversifier because of its low or negative correlation with other assets. Thus, when the prices of other assets decrease, the price of gold may increase, and this could maintain the portfolio's value even in times of crisis (Hoang et al., 2015). The low correlation between gold's returns and the returns of other common investment assets, such as stocks and bonds, suggest that it can be useful for reducing the portfolio's exposure to fluctuations. Many studies in the past have concluded that portfolios that contain precious metals perform significantly better than ones without them. Lucey & Tully (2006) found that a financial portfolio can be diversified by including an optimal weight of gold between 6% and 25% to lower the risk and achieve higher returns. Even with the extended time, adding gold to a portfolio is beneficial. With the analysis of the Paris stock exchange Hoang et al. (2015) concluded that gold is good in the diversification of stock portfolios. On the other hand, some studies have shown that the diversification benefits of gold are non-existent. Works such as Johnson & Soenen (1997) claimed that diversification benefits of gold are almost non-existent and Ruano & Barros (2022) stated that its diversification benefits are time-dependent and decreasing.

Another important measure of an asset's role within a portfolio is the beta (β), which shows the volatility of an individual stock compared to the systematic risk of the entire market.

Beta is defined as:

$$\beta_i = \frac{\mathrm{Cov}(R_i, R_m)}{\sigma_m^2}, \tag{8}$$

where $R_m$represents the market or portfolio return. A beta greater than 1 means the asset moves more than the market (higher risk), a beta less than 1 means it moves less (lower risk), and a negative beta implies that the asset tends to move in the opposite direction of the market (Kenton, 2025).

Gold has historically had a low or negative beta relative to equity markets, implying that it provides protection against systematic market risk. When stock prices decline sharply, as during the 2008 crisis or the early stages of the COVID-19 pandemic, gold's beta becomes even more negative, confirming its function as a countercyclical asset. This characteristic is one reason why investors perceive gold as a diversifier and a hedge and often associate an increase

in its value with temporary instability of the world markets. For instance, Shahzad et al. (2020) found that gold acts as a safe-haven asset and hedge for G7 stock markets while Bampinas, G. & Panagiotidis, T. (2015) found that gold can act as a hedge against inflation. Although hedging protects against probable losses, it reduces the probability of receiving additional unplanned profit at favourable market movements. As precious metals, such as gold and silver, represent claims to real rather than nominal assets, gold is expected to also act as a hedge against inflation. An expected rise in consumer prices might prompt individuals to convert their liquid assets to gold, influencing its price. As a result, gold prices could effectively gauge inflation expectations because commodity prices are generally thought to be able to incorporate new information faster than consumer prices (Bampinas & Panagiotidis, 2015).

To better show the effects of gold on a portfolio we can use different portfolio risk and performance metrics. The Sharpe ratio, for instance, measures excess return per unit of risk. A higher Sharpe ratio indicates superior risk-adjusted performance. It compares the return of an investment with its risk (Cogneau & Hübner, 2009). It helps identify portfolios that provide the most efficient returns per the level of risk. Two portfolios might have the same return, but if one has lower volatility, it will have a better Sharpe ratio, meaning it's more efficient in terms of risk. A high Sharpe ratio in a portfolio that includes gold could indicate that gold is reducing the risk while not sacrificing too much of its return.

3.3 Forms of gold investment

Investors can take advantage of gold's hedging and diversification properties through a variety of investment instruments, each having their own distinct characteristics, advantages and disadvantages.

Physical gold instruments include bullion bars and coins as well as jewellery. These are preferred by investors wanting direct exposure and full ownership control. Gold bullion includes any form of pure, or nearly pure, gold that has been certified for its weight and purity. This can be coins, bars and other forms of gold of any size and shape (Alfaro, 2025). The advantage of physically holding gold in the form of bars and bullion coins is the liquid market for buying and selling them. The disadvantage is the substantial difference between the purchase and sales price (usually 7% or more). Additionally, there are considerable storage, insurance, delivery and dealing costs (Demidova-Menzel & Heidorn, 2007).

An alternative to buying physical gold is a gold base exchange-traded fund (ETF). Each share of this security represents a fixed amount of gold. ETFs, just like stocks, can be purchased and sold in any brokerage account or individual retirement account. Therefore, this approach is simpler and less expensive than directly owning bars or coins. The disadvantages could arise from management risks. Mutual funds often own gold bullion and gold companies as part of their normal portfolios. However, many mutual funds do not focus solely on gold investing and own several other commodities as well. The advantages of mutual funds are lower costs and

lower minimum investment requirements, higher diversification and easier ownership (Alfaro, 2025).

Investing into companies and businesses involved in gold production and exploration is not the same as directly investing into physical gold. The financial state of the company is not solely dependent on the gold price movements. The company's earnings may be impacted by a wide range of factors beyond the price of gold (Demidova-Menzel & Heidorn, 2007). The advantages of investing into gold mining companies could arise from higher returns through operational leverage or dividend yields not present in owning physical gold. On the other hand, market risk, company risk, and operational risk could pose as disadvantages.

Gold futures are exchange-traded standardised contracts that bind the buyer, to buy a definite amount of gold at a predetermined price on a future delivery date. The future buyer assumes that the price of gold will rise at the due date. The advantages of this type of gold investment are that it allows one to bet on rising as well as falling gold prices based on market expectations, all without having to deal with the inconvenience of receiving the actual gold. Consequently, the high risk resulting from the high short-term volatility of gold prices is the disadvantage (Demidova-Menzel & Heidorn, 2007).

4 RESEARCH PROBLEM

For investors investing in financial markets, managing portfolio risk and safeguarding against economic uncertainties remain some of their most crucial concerns. Market volatility, unstable yields, government regulations, and geopolitical concerns all affect portfolio performance. Considering these issues many investors and institutions seek ways to combat and minimise their impact. They seek different means of hedging their risk and diversifying their assets. Due to its historically accepted role as a protective asset, we can see gold as a standout among them. Despite being a risky asset in and of itself, gold typically yields returns that are distinct from those of other assets. This implies that gold may have a significant role in a diversified portfolio.

The objective of this study is to provide a comprehensive analysis of gold's role in investment portfolios by analysing historical data and empirical studies. Specifically, the study will evaluate whether adding gold to stock and bond portfolios improves their resilience to economic and financial shocks, successfully lowers volatility, and offers significant diversification benefits. This study will provide thorough insights into the usefulness of gold for portfolio management by carefully examining different asset allocation strategies and various investor behaviour scenarios.

4.1 Why this research is important

Historically, gold has been used as a unique tool for financial risk hedging. Many investors believe that gold is a universally safe asset, and they frequently associate an increase in its value with brief global market volatility. Hedging is the investment aimed at making profit from a situation, prevention or compensation of another possible risky situation. Buying gold can thus be a direct investment when its value rises as well as a hedging strategy in the event that demand increases and supply declines. Investors have therefore frequently turned to gold in these periods of uncertainty, hoping that its inclusion in their portfolio can help mitigate the negative effects that may arise. However, in practise, the effectiveness of gold as a hedge and diversifier can vary significantly depending on the market movements, economic context, government decisions, and portfolio strategy.

Therefore, knowing gold's true hedging and diversifying capabilities, rather than relying on assumptions and myths, is significant. The research findings and conclusions would give investors, asset managers and institutions guidance, advice and help develop optimal strategies to help diversify their portfolios and mitigate its risks. This would lead to better asset allocation decisions as well as giving investors more confidence in navigating turbulent markets.

From a theoretical standpoint, the study would contribute to many other existing researches of portfolio management and financial theory. Traditional portfolio theory places a strong emphasis on the significance of asset correlation and diversification in portfolio construction, especially for the previously mentioned mean-variance framework developed by Harry Markowitz. The significance of understanding asset behaviour in various market conditions is also mentioned by other financial theories, such as the Capital Asset Pricing Model (CAPM). Gold would thus make a good case study due to its non-correlated properties and used to test assumptions about diversification and risk mitigation.

Lastly, the current state of the world is marked by geopolitical tensions, economic uncertainty, persistent inflation and financial market volatility which makes this research particularly timely. These factors make investing much more difficult and increase the demand for trustworthy hedging tools. It is especially beneficial to assess gold's performance directly in such demanding settings. It provides direct and prompt advice on how gold allocations can support investors in navigating these times of increasing uncertainties.

Overall, the research problem explored in the thesis holds substantial importance on multiple levels. By examining the role of gold in varied portfolios, as well as its hedging and diversifying capabilities, it would contribute to a deeper understanding of its role by investors, contribute meaningfully to financial theory and offer direct guidance to current economic challenges.

4.2 Evaluating gold's contribution to portfolio efficiency

Having established the theoretical framework of portfolio efficiency, diversification, and the role of asset correlations, I can now apply these principles to evaluate the contribution of gold within a modern investment portfolio. The theoretical framework shows that an asset's value to a portfolio is determined not only by its expected return and volatility, but also by how its returns interact with those of other assets. Because gold is frequently characterised by low or negative correlation, its inclusion can change the efficient frontier and improve portfolio performance.

A correlation close to +1 indicates that two assets move in the same direction, while a correlation close to –1 means that they move in opposite directions. For diversification benefits, the correlation should ideally be low or negative, as this ensures that when one asset underperforms, the other can help offset the loss. To help demonstrate this, I calculated a correlation matrix for gold, stocks, and bonds over the past 20 years in Table 1.

Table 1: Correlation Matrix for Gold, Stocks, and Bonds (2005−2025)

	Gold	Stocks	Bonds
Gold	1.000	0.144	0.511
Stocks	0.144	1.000	0.456
Bonds	0.511	0.456	1.000

Source: Own work based on Bloomberg (2025).

The matrix in Table 1 shows important insights into the relationships between these asset classes. The correlation between gold and stocks is relatively low at 0.144, indicating that gold moves largely independently of equity markets. This supports the view of gold as a diversifier within investment portfolios, as it does not strongly move with stock prices. The correlation between gold and bonds is 0.511 which is moderate, suggesting that they share some sensitivity to macroeconomic factors, but still behave differently enough to provide diversification benefits. Meanwhile, the correlation between stocks and bonds stands at 0.456, which is consistent with the patterns in developed markets where bonds act as a partial hedge to equities but not a perfect one. Overall, these results show that while gold may not be strongly negatively correlated with other assets, its relatively low correlation provides valuable diversification benefits.

Gold and stocks specifically often move in opposite directions during times of crisis and unstable market movements. The effect is demonstrated in Tables 2 and 3.

Table 2: Correlation Matrix for Gold, Stocks, and Bonds (Financial crisis)

	Gold	Stocks	Bonds
Gold	1.000	-0.101	0.553
Stocks	-0.101	1.000	-0.339
Bonds	0.553	-0.339	1.000

Source: Own work based on Bloomberg (2025).

Table 3: Correlation Matrix for Gold, Stocks, and Bonds (2023−2025)

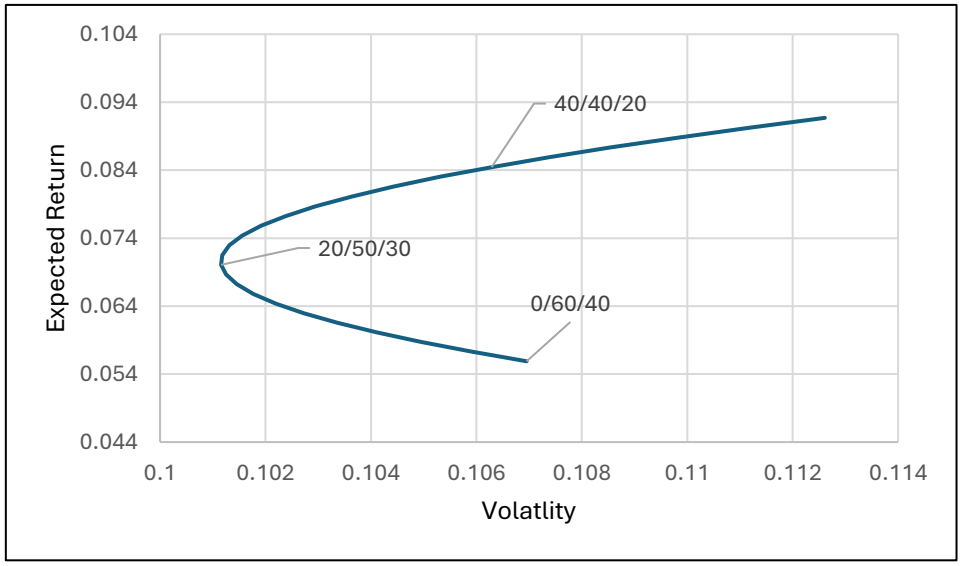
	Gold	Stocks	Bonds
Gold	1.000	-0.141	0.272
Stocks	-0.141	1.000	0.624
Bonds	0.272	0.624	1.000

Source: Own work based on Bloomberg (2025).

The two tables show how gold's diversification benefits increase in more extreme market conditions. During both the financial crisis and the past few years of unconventional market movements, gold had negative correlation with stocks. During the financial crisis, gold exhibited a negative correlation with equities (–0.101), indicating that when stock markets decline sharply, gold tends to move in the opposite direction. In the current period (2023–2025), this negative correlation persisted (–0.141), while stocks and bonds remained moderately correlated, showing the diversification benefits of gold. These findings demonstrate that the benefits of adding gold to a portfolio strengthen in turbulent times.

Building on this, the next step is to examine whether the diversification benefits suggested by modern portfolio theory materialise when gold is introduced into a standard portfolio. I can construct a set of portfolios by incrementally introducing gold to a 60/40 stock/bond portfolio. To make the efficiency frontier the portfolio returns and volatilities were calculated using historical correlations between gold, stocks, and bonds from 2005 to 2025. By varying the proportions of gold and recalculating the expected returns and volatilities for each portfolio, I can plot the efficient frontier. The resulting curve would then represent how the inclusion of gold affects the portfolio. This analysis is important because it tests whether the theoretical diversification benefits of gold show in practice. If the frontier shifts upward or outward compared to the original 60/40 portfolio, then gold can help investors achieve higher returns for the same level of risk or lower risk for the same expected return.

Figure 1: Efficient Frontier of portfolios with varying gold allocations (2005−2025)



Source: Own work based on Bloomberg (2025)

Figure 1 shows the efficiency frontier of gradually adding gold to a 60/40 stock/bond portfolio. Each point represents a specific allocation between gold, stocks, and bonds. The numbers show the percentage weight of each class (gold/stocks/bonds). The 0/60/40 portfolio was the starting one without any gold, then the gold allocation was increased by 2 percentage points. For each 2% increase in gold, stocks and bonds were decreased by 1 percentage point to maintain a fully invested portfolio. The graph is consistent with modern portfolio theory, where adding an asset with low correlation to an existing portfolio can improve the risk to return trade-off. At low or moderate allocations, gold reduces overall volatility making the graph shift upwards and leftward toward more efficient combinations. At portfolio allocation 20/50/30 the lowest volatility is achieved and the efficient portfolios start. However, as the allocation into gold increases further, the benefits start to diminish. The bottom half of the line represents inefficient portfolios, as there are other allocations that yield more return for the same amount of risk. Overall, the figure demonstrates that adding gold to a portfolio can enhance its efficiency, but only within a certain range.

In the next part, I will evaluate how the inclusion of gold affects the portfolio's risk-adjusted returns. In the theoretical framework I explained that efficient investing is not only about achieving the best trade-off between return and volatility, but also about maximizing the ratio of excess return to risk through the Sharpe ratio. Because the tangent portfolio is defined as the portfolio with the highest Sharpe ratio, examining how the Sharpe ratio changes when gold is introduced would provide a good measure of value. When gold is added to a stock/bond portfolio, its low correlation (ρ) and low beta (β) reduce portfolio volatility (σ_p) more than they reduce expected return, leading to an increase in the Sharpe ratio. However, when the gold allocation becomes too large, the benefits start to diminish, and the Sharpe ratio starts to decrease. Efficiency is thus achieved where the combination of assets yields the highest Sharpe

ratio. This effect is empirically demonstrated in Table 4, where a 60/40 portfolio was gradually overlaid with increasing allocations of gold. Unlike the previous graph, this table takes data from the 2010-2020 time period as this one had more conventional gold movements and would thus provide better results.

Table 4: Impact of gold addition to a portfolio (2010−2020)

X_g	$E[R_p]$ (%)	$SD(R_p)$ (%)	SHARPE RATIO	CORR (G, R_p) (%)	BETA
0%	5.91	8.59	0.4552	18.19	0.3386
4%	6.02	8.73	0.4602	25.23	0.4621
8%	6.13	8.91	0.4627	31.89	0.5721
12%	**6.23**	**9.14**	**0.4631**	**38.11**	**0.6669**
16%	6.34	9.40	0.4616	43.85	0.7460
20%	6.45	9.70	0.4584	49.10	0.8097
24%	6.55	10.03	0.4541	53.87	0.8591
28%	6.66	10.39	0.4487	58.16	0.8956
32%	6.77	10.77	0.4427	62.03	0.9210
36%	6.88	11.18	0.4361	65.49	0.9368
40%	6.98	11.61	0.4293	68.58	0.9448

Source: Own work based on Bloomberg (2025).

Table 4 shows how the expected return, volatility and Sharpe ratio change with an increase in allocation of gold. Consistent with modern portfolio theory, the Sharpe ratio initially rises when gold is introduced, showing gold's ability to increase the risk-adjusted return of the portfolio. The Sharpe ratio reaches its maximum at gold allocation of 12%, which also represents the highest risk-adjusted return. Beyond this point the Sharpe ratio starts to steadily decrease, indicating diminishing diversification benefits. These results support the theoretical foundation of modern portfolio theory that including an asset with low correlation and low beta enhances efficiency. Gold's role in investment portfolios is context dependent, improving portfolio efficiency up to a moderate allocation, but becoming counterproductive at larger ones.

This chapter demonstrated how gold interacts with other traditional assets and how its inclusion affects overall portfolio performance. We showed that adding gold to a portfolio improves its returns and helps with diversification. The extent of these benefits is highly dependent on market conditions, performing better during periods of financial stress. Overall, the empirical

evidence supports the theoretical expectation that gold can serve as a valuable part of a portfolio and sets good groundwork for the following simulation analysis.

4.3 Research questions and predictions

This chapter presents the central research questions guiding the analysis of this thesis. The research questions have been carefully chosen to capture the essential aspects of gold's role in diversified portfolios. They focus on its effectiveness as a hedge and diversifier, address gold's influence during various economic conditions and the impact of timing and asset allocation on its performance. The following are the research questions of the thesis:

Research question 1: How does including gold in investment portfolios affect overall portfolio performance during crises?

This question assumes that financial crises disrupt market stability. During these times diversification is an accepted way of mitigating these negative effects. A core assumption of gold is that it can act as a diversifier and a safe haven. Based on this assumption, it is expected that portfolios containing gold would perform better than the portfolios without gold. The research question was selected to test the assumption.

Research question 2: How effective is gold in hedging inflation and geopolitical uncertainty in the current economic environment?

Gold is usually assumed to hedge against inflation, due to its historical reputation as a store of value. The current economic environment is plagued by increasing inflation and geopolitical uncertainties. Thus, the question was selected to both test the effectiveness of gold as a hedge as well as to help investors investing in the current markets. It is anticipated that gold will show better performance during periods of high inflation and will help stabilise the portfolios.

Research question 3: Does the timing and portfolio rebalancing significantly influence the hedging capabilities of gold?

This research question was selected to test the assumption that active portfolio management and active following the financial markets influences overall returns and risk management outcomes. The reason for this assumption is clearly supported by existing financial theory and empirical evidence. It is predicted that timing and rebalancing strategies will significantly impact the hedging effectiveness of gold.

Research question 4: Which portfolio allocation provides the best returns across various economic scenarios?

One of the reasons for examining multiple gold allocations (0%, 10%, and 20%) combined with varied stock-bond mixes (60/40, 80/20, 100/0) is explicitly to identify the allocation strategy that most consistently delivers superior returns. This question was selected to find the best portfolio combinations as well as to help investors manage their portfolios better.

5 SIMULATION ANALYSIS

This chapter will, in greater detail, outline the simulation analysis used to evaluate gold's role within diversified investment portfolios. This methodical approach's main goal is to generate empirically supported findings regarding the function of gold in portfolios. The methodology involves data analysis, the construction of nine different investment portfolios, and their analysis under three distinct investment scenarios.

The study constructs 9 distinct portfolios, each with different asset allocation ratios. Each portfolio varies the proportion of gold to stocks and bonds. Specifically, there would be 3 core asset ratios between stocks and bonds: 60% stocks / 40% bonds, 80% stocks / 20% bonds and 100% stocks / 0% bonds. Within each of these, gold will be added at 0%, 10% and 20% of the total portfolio value, while the stock and bond ratio remains consistent. Three stock and bond ratios coupled with three different levels of gold investment would thus make 9 distinct portfolio combinations. The second critical component of the analysis revolves around applying three distinct investment scenarios to the previously mentioned portfolios. Each scenario reflects a different set of assumptions about investor's decision making and behaviour. The three scenarios include: the Buy and hold scenario, the Optimal scenario and the Practical realistic scenario. The final aspect of the thesis is the selected timeframe of analysis. This would be the last 20 years (July 2005 – June 2025), as these have seen significant economic disruptions with both extreme financial crises and economic growth periods. During the 20 years the thesis will also put an emphasis on 4 distinct periods, these being the economic crisis of 2007−2009, the high growth period of 2018−2019, the covid crisis of 2020−2021 and the current period of 2022−2025.

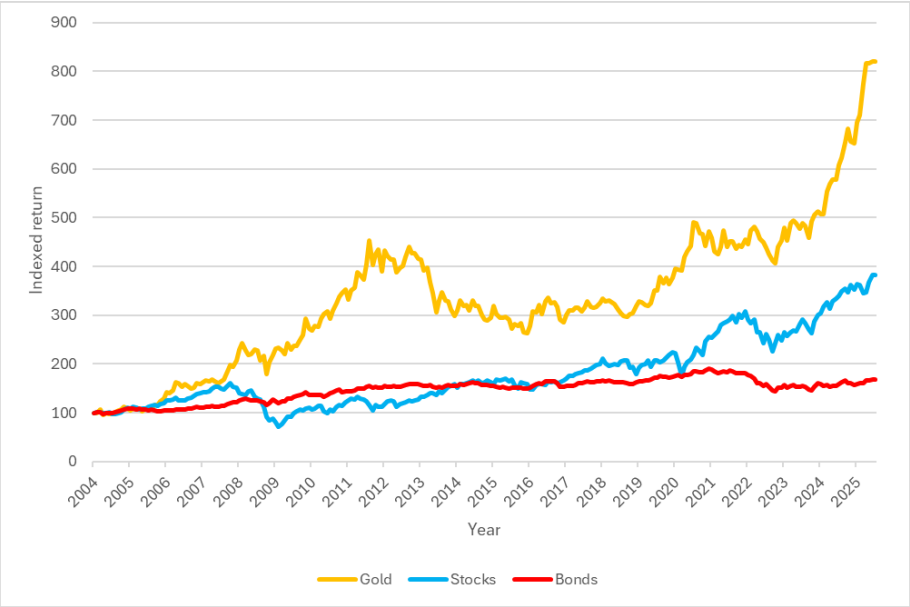
The purpose of these scenarios is to thoroughly test gold's role in investment portfolios by evaluating its performance in comparison to more conventional asset classes, such as stocks and bonds, over the 20-year period under various economic conditions. This method will provide strong and thorough insights into the usefulness of gold in different investment scenarios by outlining portfolio construction, allocation strategies, scenario analysis, and selected performance metrics.

5.1 Data analysis

This chapter will, in extensive detail, visualise and explain the data used for the empirical analysis of the role of gold in investment portfolios. It will provide reasoning for the selected data sources and explain and visualise the data in the forms of graphs. It will also extensively describe the historical movements of each asset class and the real-life events that lead to them. Specifically, the analysis will use monthly historical data spanning from July 2005 to June 2025, covering three distinct asset classes: gold, stocks, and bonds. Monthly data was chosen because the monthly intervals pose a good balance between frequent and overly infrequent adjustments. It is also consistent with standard practices, which provides an option for comparison. The explicit choice of asset classes was made based on their distinct risk-return profiles,

wide usage among investors, and they cover all key investment exposures (equities for growth, bonds for stability and income, and gold for diversification and hedging). How these asset classes moved during the past 20 years we can see in the Figure 2 below.

Figure 2: Indexed Performance of Gold, Stocks, and Bonds (2004−2025)



Source: Own work based on Bloomberg (2025).

In Figure 2 we can see the indexed performance graph of gold, stocks, and bonds from 2004 to 2025. It highlights the distinct return patterns and behaviours of these asset classes over two decades through multiple economic cycles and crises. Gold outperformed both stocks and bonds over the long term, showing sharp increases during periods of economic stress, most notably during the 2008 global financial crisis, the COVID-19 pandemic in 2020, and the current period after 2022. These surges reflect gold's strong appeal, as investors typically flock to it during times of financial uncertainty. Stocks displayed more pronounced volatility, with steep declines during crises but strong recoveries during growth periods. Bonds, on the other hand, showed the most stable but modest growth.

The primary data will be sourced utilising the Bloomberg Terminal provided by the School of Economics and Business in Ljubljana. The Bloomberg Terminal is a computer software system provided by the financial data vendor Bloomberg L.P. that gives professionals in the financial industry and other sectors access to Bloomberg Professional Services, allowing them to trade on the electronic trading platform and monitor and analyse real-time financial market data. It provides highly accurate, timely, and consistent historical and real-time financial market data (Bloomberg). The following Bloomberg indices have been selected to represent the respective asset classes:

5.1.1 Gold (XAU Curncy)

The Bloomberg listing for XAU Curncy represents the spot price of gold denominated in U.S. dollars per ounce. It is actively traded globally and is widely acknowledged as the standard for global gold price quotations. This index was selected because it provides a thorough and transparent representation of the state of the world's gold market. The spot price data offers the most straightforward, accurate, and practical indicator of gold's market value which is essential for gauging its role in investment portfolios.

Figure 3: Gold Price (XAU/USD), 2004–2025

Source: Own work based on Bloomberg (2025).

In Figure 3 above we can see the movements of gold prices from 2004 to 2025. The overall data shows a significant increase over the 20-year period, with some abrupt rises and falls. From 2004 to 2007 we can see gold prices rose steadily from around $400 per ounce to approximately $700. Economic growth in emerging markets, increasing investor interest and some early signs of economic instability drew investors to gold. During the 2008 financial crisis and its aftermath, we can see gold having a significant increase from $700 per ounce to a then all-time peak of near $1900 in late 2011. The cause for that were investors seeking refuge from the effects of the financial crisis and the collapsing stock markets and economic instability that it caused. They turned to gold hoping to mitigate these effects and hedge against uncertainties. From 2012 to 2017, gold saw a small decrease from the peak in 2011 to lower range between $1100 and $1500. Improved economic conditions and higher investor confidence reduced the appeal of gold. In the years leading up the COVID-19 crisis, gold remained stable around $1200 to $1500 range. 2020 and 2021 represent the height of the COVID-19 crisis which quickly brought back gold's role as a safe haven. Many investors flocked to it, seeking refuge from the negative effects of the pandemic on the financial markets. Gold reached a new all-time high price of $2070 per ounce in august of 2020. Due to the increase in inflation, rising geopolitical tensions and economic uncertainties in the years following the pandemic, gold

prices significantly rose again, surpassing $2000 per ounce and reaching new all-time high numbers in 2024 and 2025.

The movements of gold during the past 20 years, and especially during the 2008 financial crisis and the COVID-19 crisis, signify that many investors used it as a means of mitigating the risk of unfavourable market movements. We can also see that the price in 2024 increased by almost 7 times compared to its 2004 value, which would prove gold's role as an asset that maintains its value and is worth investing in the long-term. A conclusion that gold does not provide any significant returns during times of economic stability can also be made.

5.1.2 Stocks (MXWO Index)

The Bloomberg listing for MXWO Index represents the Morgan Stanley Capital International (MSCI) World Index that captures large and mid-cap representation across 23 Developed Markets. It covers approximately 85% of the free float-adjusted market capitalisation in each country (MSCI, 2025). This index was specifically chosen due to its global scope, extensive market coverage and wide acceptance among investors. Its broad exposure helps to get a clearer picture of the global equity market movements and risks.

Figure 4: MSCI World Index (MXWO) in USD, 2004–2025

Source: Own work based on Bloomberg (2025)..

In Figure 4 above we can see the movements of the MSCI Index, representing our stock value, during the period of the last 20 years. We can see a steady increase with some abrupt falls during this time. From 2004 to 2007 we can see stock values rose steadily driven by strong economic growth, positive investor sentiment as well as easy credit conditions that would later lead to the 2008 financial crisis. The years of the crisis brought a steep decline of approximately 40−50% in global stock markets. This resulted in many monetary interventions and new policies and regulations which significantly changed the global economic market and supported sustained equity market growth in the years after the crisis. Prices reached new peaks in 2019,

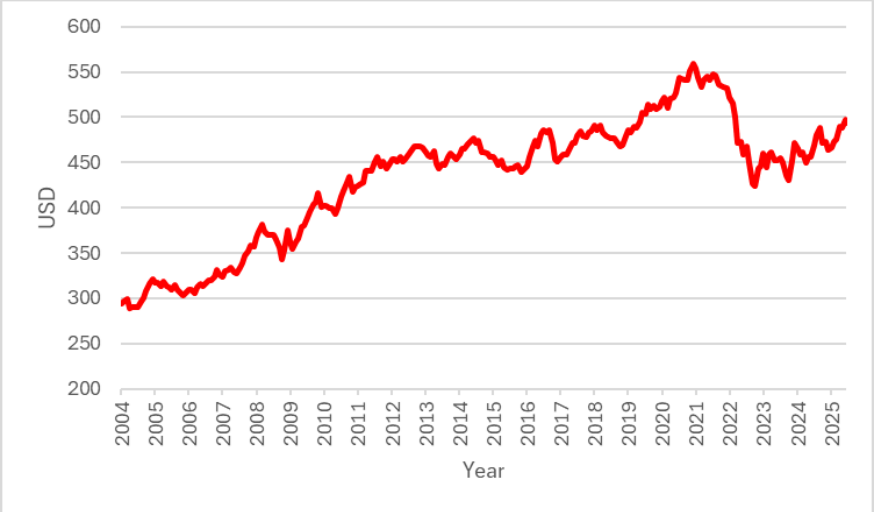
helped by favourable monetary policy, corporate earnings and global economic stability. The year 2020 brough the COVID-19 crisis which lead to an initial collapse of the market. Due to massive fiscal stimulus and monetary easing, prices began to rebound relatively quickly soon after. Despite this recovery, inflation, rising geopolitical tensions and increases in interest rates have been causing persistent volatility in the stock markets since 2022.

The global stock markets have seen many turbulent and extreme movements through the 20-year period. The data consistently shows sharp declines during times of crisis and stable to high increases during times of economic growth and high investor confidence.

5.1.3 Bonds (LEGATRUU Index)

The Bloomberg listing for LEGATRUU Index represents the Bloomberg Global Aggregate Total Return Index. It is a flagship measure of global investment grade debt from twenty-seven local currency markets. This benchmark includes treasury, government-related, corporate and securitized fixed-rate bonds from both developed and emerging markets issuers. This bond index was chosen due to its global scope, its inclusion of both corporate and government debt and wide acceptance among investors. Its detailed representation of the bond market makes it a solid measure to help gauge gold's role in investment portfolios (Bloomberg, 2025).

Figure 5: Bloomberg Global Aggregate Bond Index (LEGATRUU) in USD, 2004–2025



Source: Own work based on Bloomberg (2025).

In Figure 5 above we can see the movements of the LEGATRUU Index, representing our bond value, during the period of the last 20 years. We can see a steady increase with some abrupt falls during this time. From 2004 to 2007 we can see that bond markets provided steady returns driven by stable yields, moderate inflation and stable market conditions. During the period between the years of 2008 and 2015, extensive monetary easing and significantly lowered global yields led to rising bond prices and attractive returns. From 2016 to 2019, low interest rate produced stable to mixed returns. In the years of the COVID-19 crisis, the bond market

initially began to rise due to the falling interest rates and government policies during the period. But inflation and rising interest rates led to an increase in volatility in the market. In 2022, this led to a significant decline with effects still persisting today as bond prices continue to be unstable.

The data shows bonds move stable during periods with low economic turbulence and seem to increase in value during times of crisis. That is caused by low interest rates during the time, which can also lead to a steep decline of the bond market if they keep increasing.

5.2 Specifics of the simulation analysis

The next part of the thesis will focus on simulations on how portfolios react to additions of gold. The study constructs 9 distinct portfolios, each with different asset allocation ratios. Each portfolio varies the proportion of gold to stocks and bonds. Specifically, there would be 3 core asset ratios between stocks and bonds: 60% stocks / 40% bonds, 80% stocks / 20% bonds and 100% stocks / 0% bonds. Within each of these, gold will be added at 0%, 10% and 20% of the total portfolio value, while the stock and bond ratio remains constant. Three stock and bond ratios coupled with three different levels of gold investment would thus make 9 district portfolio combinations.

The 60% stocks / 40% bonds would represent a more balanced portfolio. It serves as a good starting point for asset allocation as it is recommended for long-term investors and those seeking stable growth. Investors with low risk tolerance can utilise balanced portfolios for healthy growth and supplemental income. The equity component ensures long-term preservation and helps to stop the decline of purchasing power. While the balanced portfolio's bond component has two functions: it generates income and reduces portfolio volatility, or the price swings caused by the equity component. Even though they trade every day, highly graded bonds and Treasuries typically do not see the same extreme price fluctuations as stocks. Consequently, a balanced portfolio's share price does not experience wild swings due to the stability of the fixed-interest securities (Kandhari, 2024).

A ratio of 80% stocks / 20% bonds would represent a more aggressive strategy, but not overly so. With time on their side, a younger investor can be sure that the benefits of stocks outweigh their risks. If there's a downturn in the market, there may not be enough time to rebound, especially as the investor will be withdrawing from that portfolio upon retirement. In that case, a ratio nearer 60% stocks / 40% bonds would then be more in line with the investor's risk tolerance (The American College, 2020). This portfolio combination would be especially good at assessing gold's diversification capabilities in a more equity exposed portfolio.

A portfolio comprised of 100% stocks / 0% bonds only involves only long positions in stocks. Such a strategy is typical of mutual funds that avoid riskier strategies like short selling or higher-risk instruments like derivatives in favour of allocating all investable cash to stocks. The market is dominated by 100% equity strategies, which include most offerings. Compared to

alternatives like bonds, money market funds, and cash, stocks are typically regarded as a riskier asset class. Even though a well-diversified portfolio of all stocks can guard against sector or individual company risk, market risks that could impact the equity asset class will still exist. For aggressive equity investors, systemic and idiosyncratic risks are therefore crucial factors to consider. Because of this, most of the financial advice suggests a portfolio that consists of both fixed-income (bond) and equity components (Hayes, 2022). This portfolio would thus prove as an important part of evaluating gold's impact in riskier scenarios.

The idea of using the specific gold proportions (0%, 10%, 20%) comes from both a theoretical and practical standpoint. A 0% gold allocation creates a distinct starting point for assessing portfolio performance without gold. The inclusion of 10% gold represents a moderate allocation that is regularly advised by the World Gold Council and other institutional investors because it has been shown to be successful in increasing portfolio diversification and lowering risk without limiting growth potential. The 20 percent allocation is a more aggressive diversification strategy that tests whether increased exposure to gold can provide extra protective advantages, especially in times of market volatility.

The second critical component of the analysis revolves around applying three distinct investment scenarios to the previously mentioned portfolios. Each scenario reflects a different set of assumptions about investor's decision making and behaviour. The three scenarios include: Buy and hold (Scenario 1), Optimal (Scenario 2) and Practical realistic (Scenario 3).

Buy and hold is a passive investing approach where a buyer purchases stocks or other securities and keeps them for a long time despite market swings. Buy and hold investors, on average, tend to outperform active management over longer time horizons and after fees, and they can typically defer capital gains taxes as well. On the other hand, some argue that these investors might not sell when it's best to. This scenario will test the long-term strategic benefits of gold inclusion without active management interventions. Its inclusion is essential because it provides a baseline against on how gold affects portfolios over an extended period, independent of market considerations (Beers, 2020).

The Optimal scenario is a theoretical scenario that assumes investors have perfect knowledge and foresight. They could time peaks and downturns in the market and thus achieve maximum possible returns. Although this scenario is unrealistic in practice, it would still serve as a theoretical benchmark of gold's maximum hedging potential. Comparing the theoretical and practical outcomes would also show meaningful insights into the limits of realistic investment decisions.

The Practical realistic scenario would thus help combine theory and practice by utilising realistic market indicators to drive investment decisions. Investors would buy and sell their assets based on clearly defined thresholds. The main indicator chosen for the thesis is the CBOE Volatility Index (VIX). It measures the 30-day expected volatility of the S&P 500 Index and is

extensively used by investors to evaluate market sentiment and perceived risk. Due to the extensive historical data set, it provides investors with a useful perspective of how prices have behaved in response to a variety of market conditions. It acts as a measurement of investor fear and uncertainty, making it a crucial tool in assessing market dynamics (Cboe, 2019). Comparing these results to the ones from the previous scenarios we can gauge the gap between what is theoretically achievable and what is possible for the average investor.

The final aspect of the thesis is the selected timeframe of analysis. This would be the last 20 years (July 2005 – June 2025) as these years have seen significant economic disruptions with both extreme financial crises and economic growth periods. The era witnessed many important events, from the collapse of global financial markets in the 2008 financial crisis, to the extreme disturbances caused by the COVID-19 pandemic and to the recent surging inflation, geopolitical conflicts and tariff disputes. Together, these important world events provide a rich context for examining and understanding the place of gold in investment portfolios, especially its effectiveness as a hedge in times of turmoil.

During the early years of the time period, the global economy experienced stable and robust growth due to increasing globalisation and technological advancements. This period also saw the rise of emerging markets such as China and India as well as favourable conditions in already developed markets. However, this perceived stability concealed serious vulnerabilities. Excessive borrowing, defaulting mortgages and the pricing of default swaps in the US market led to the 2008 global financial crisis. This resulted in many monetary interventions and new policies and regulations which significantly changed the global economic market (Murphy, 2008).

After the 2008 financial crisis, the global markets steadily began to stabilise. The 10 years following were marked by modest growth, low inflation and low interest rates. Increase in consumer spending, strong corporate earnings and the general optimistic market sentiment helped the global economies enter a brief high-growth period between 2018 and 2019. That period was short-lived as an unprecedented global pandemic of COVID-19 shook the world in 2020. Global financial markets experienced their worst shock since the 1930s, resulting in a one-third drop in the S&P 500 Index from late December 2019. Governments and central banks around the world responded with significant monetary policies and economic stimuli (Akhtaruzzaman et al., 2021).

By 2023 and 2024, the markets again began to stabilise but not without continuous challenges. Surging inflation rates, geopolitical conflicts such as the Russia-Ukraine war, the Israel conflict and Donald Trumps's trade wars have all plagued the recent years. These resulted in many stock market downturns, increase in volatility and an overall pessimistic view of the economy. These conditions all reinforced gold's relevance, its prices began reaching near record highs as once again many investors turned to it as a hedging and diversification asset.

The thesis will analyse the performance of gold by comparing its performance in differently structured portfolios over the last 20 years. These years encompass a good mix of different

economic cycles to assess gold's impact on portfolios. During the 20 years I'll also put an emphasis on 4 distinct periods, these being the financial crisis of 2008−2009, the high growth period of 2018−2019, the covid crisis of 2020−2021 and the current period of 2023−2024.

5.3 Portfolio construction and timing

This chapter will thoroughly explain the approach and methodologies used for portfolio construction and the employed timing strategies. Utilising the data analysed in the previous chapter (XAU Curncy, MXWO Index, LEGATRUU Index) I will construct the 9 different investment portfolios and test their performance under three distinct investment scenarios. Each portfolio varies in the proportion of gold to stocks and bonds. Specifically, there would be 3 core asset ratios between stocks and bonds: 60% stocks / 40% bonds, 80% stocks / 20% bonds and 100% stocks / 0% bonds. Within each of these, gold will be added at 0%, 10% and 20% of the total portfolio value, while the stock-to-bond ratio remains consistent. Three stock and bond ratios coupled with three different levels of gold investment would thus make 9 distinct portfolios.

Table 5: Construction of the 9 portfolios

PORTFOLIO	STOCK/BOND RATIO	GOLD	STOCKS	BONDS
1	60/40	0%	60%	40%
2	60/40	10%	54%	36%
3	60/40	20%	48%	32%
4	80/20	0%	80%	20%
5	80/20	10%	72%	18%
6	80/20	20%	64%	16%
7	100/0	0%	100%	0%
8	100/0	10%	90%	0%
9	100/0	20%	80%	0%

Source: Own work.

In Table 5 above we can see the 9 distinct portfolios. Importantly, the stock-to-bond ratio remains constant as the introduction of gold proportionally reduces value hold in stocks and bonds without changing their relative allocation. Portfolios 1−3 hold the 60/40 stock-to-bond ratio, portfolios 4-6 hold the 80/20 stock-to-bond ratio and portfolios 7-9 hold the 100/0 stock-to-bond ratio or just stocks. Each of these groups of three portfolios hold 0%, 10% and 20% of gold as well. A total starting investment value of $100.000 will be used for each of the portfolios, as it strikes a good balance between smaller and larger portfolio values.

Portfolio performance will be evaluated using annual returns, volatility and the Sharpe ratio. Using these three metrics will cover the most critical aspects of portfolio performance.

An annual or annualised return is a measure of how much an investment has increased on average each year during a specific period. Returns are calculated as total returns, meaning they include both price changes and all income generated by the asset, such as dividends for stocks and interest for bonds. It can be more useful than a simple return when you want to see how an investment has performed over time or to compare two investments. It offers a straightforward and simple measure of performance. It can be used to easily compare portfolios over different periods of time and clearly shows how including gold in a portfolio affects its performance. It will be calculated using Formula 9.

Annualised returns formula (Chen, 2025):

$$Annualised\ returns = \left(\frac{Ending\ value}{Beginning\ value}\right)^{\frac{1}{Years}} - 1. \quad (9)$$

Volatility was chosen as a metric as it is one of the most common measures of risk, as for investors, understanding how their investments can fluctuate can be very crucial. A high-volatility portfolio might provide high returns, but it also poses a greater risk of large losses. It will be measured using standard deviation of returns as it shows the dispersion of returns and the uncertainty associated with them. It is calculated as the square root of the variance of returns and then converted into annualized volatility as shown in Formula 10.

Annualised volatility formula (Boyte-White, 2024):

$$Annualised\ volatility = \sigma * \sqrt{12}. \quad (10)$$

Historical volatility is frequently used by analysts and traders to develop investing strategies because it enables a longer-term evaluation of risk. The riskier a security is, the higher its historical volatility value. Volatility is reflected in the deviation of the expected future value of assets. It represents the uncertainty of the future price of an asset (Bhowmik & Wang, 2020). It will help gauge the role of gold in the portfolio by showing if including gold would reduce the overall risk and how it would contribute to the stability of the portfolio.

The Sharpe ratio was developed by economist William F. Sharpe in 1966. It compares the return of an investment with its risk. It is defined as the ratio of the mean return in the excess of the risk-free rate over its standard deviation (Cogneau & Hübner, 2009). It will allow us to compare the return per unit of risk across different portfolios. It will help us identify portfolios that provide the most efficient returns per the level of risk. Two portfolios might have the same return, but if one has lower volatility, it will have a better Sharpe ratio, meaning it's more efficient in terms of risk. A high Sharpe ratio in a portfolio that includes gold could indicate that gold is reducing the risk while not sacrificing too much of its return. I will be calculated using Formula 11.

Sharpe ratio formula (Kourtis, 2016):

$$Sharpe\ ratio = \frac{Annualised\ return - Risk-free\ rate}{Annualised\ volatility}. \quad (11)$$

Risk-free rate represents the theoretical return attributed to an investment that provides a guaranteed return with zero risks. The risk-free rate of return represents the interest on an investor's money that would be expected from a risk-free investment over a specified period of time. U.S. Treasuries are seen as a good proxy for risk-free investment since the government cannot default on its debt. For the thesis I will assume a 2% risk-free rate.

Using these metrics, I will effectively measure the performance of the portfolios, as I will be able to measure the return, risk and efficiency. Then depending on how big of a role gold plays in the portfolios I will determine its role in it. I will calculate these metrics with the Microsoft Excel programme, as it is a useful tool for data management and calculations.

6 RESULTS OF THE SIMULATION ANALYSIS

6.1 Buy and Hold (Scenario 1)

In this scenario, I will simulate the Buy and hold scenario. As mentioned before, the buy and Hold method is a passive investing approach where a buyer purchases stocks or other securities and keeps them for a long time despite market swings. This scenario will test the long-term strategic benefits of gold inclusion without active management interventions. Its inclusion is essential because it provides a baseline against on how gold affects portfolios over an extended period, independent of market considerations.

First, I will analyse the scenario over the full period of 20 years (July 2005 to June 2025). Each portfolio will be held through the entirety of the 20-year period. Each portfolio started with $100,000 in July 2005 and was held unchanged through June 2025. Portfolio allocations were diversified across stocks, bonds, and gold in different ratios.

From Table 6 we can conclude that the portfolios with higher gold allocation (P3, P6, P9) outperformed those without gold. The portfolio with the highest final value was the P9 portfolio with the 80-0-20 allocation, it increased by a value of $324,808 to $424,808, which is a 324.81% increase and has a 7.5% annualised return. The other two portfolios with 20% gold allocation (P6 and P3) followed with the second and third highest final values. On the other hand, portfolios with zero gold allocation (P1, P4 and P7) were the lowest in value with P1 only increasing by 167.48% and having a 5% annualised return. Gold's low correlation with stocks and bonds also reduced volatility across the board. Portfolios with gold had the lowest volatilities while portfolios with only two or one assets having the highest volatility, P7 was with the highest since it included only stocks. Likewise, the Sharpe ratio improved as gold exposure increased, with portfolios P3, P6 and P9 all having a similar higher ratio. This indicates that these portfolios offer the best risk-adjusted return.

Table 6: Scenario 1 – Full period (2005−2025)

Portfolio	Final Value (USD)	Absolute change (USD)	Percentage Change (%)	Annualised Returns (%)	Annualised Volatility (%)	Sharpe Ratio
P1 (60-40-0)	267,485	167,485	167.5	5.04	10.64	0.2859
P2 (54-36-10)	317,589	217,589	217.6	5.95	9.89	0.3991
P3 (48-32-20)	367,694	267,694	267.7	6.73	10.11	0.4677
P4 (80-20-0)	303,181	203,181	203.2	5.70	13.00	0.2848
P5 (72-18-10)	349,715	249,716	249.7	6.46	11.56	0.3857
P6 (64-16-20)	396,250	296,251	296.3	7.13	11.20	0.4579
P7 (100-0-0)	338,877	238,877	238.9	6.29	15.60	0.2751
P8 (90-0-10)	381,842	281,843	281.8	6.93	13.43	0.3669
P9 (80-0-20)	424,807	324,808	324.8	7.50	12.47	0.4412

Source: Own work based on Bloomberg (2025).

The inclusion of gold significantly enhanced portfolio performance by reducing volatility (especially when combined with riskier equities), offering non-correlation benefits and enhancing risk-adjusted returns (higher Sharpe ratios). Even a 10% allocation provides benefits, with 20% being even better. The performance of portfolios with no bonds (P7–P9) suggests that equities and gold can function well together when interest rates are low. All these finding tell us that gold acts as a powerful diversifier, improving returns without significantly increasing volatility.

Secondly, I will test the buy and hold strategy of Scenario 1 in each of the 4 periods. The 2008 global financial crisis (2007−2009), the high growth pre-covid period (2018−2019), the Covid-19 crisis (2020−2021) and the current economic period (2023−2025). Through analysing the scenario through the four separate periods we can get a better idea of how gold behaves and influences the portfolio during different economic trends and conditions. We can thus confirm or deny the assumption that gold helps diversifying the portfolio in times of crisis but does not provide many benefits in times of economic stability.

6.1.1 The 2008 global financial crisis (2007−2009)

The 2008 financial crisis captures the period of the most severe economic downturn since the Great depression. The exact timeframe of the analysis will be January 2007 to June 2009. 2007 showed early signs of stress in the U.S. housing market and subprime mortgage defaults. In 2008, the Lehman Brothers collapsed which led to credit markets freezing and stock market crashes worldwide. In 2009, gradual recovery began as governments introduced fiscal stimulus and central banks lowered interest rates. October 2007 marked the peak in equities before the crash. In February 2009, global equities were near the bottom. Gold prices were stable or rising during this time. The analysis of this period will test how gold performs in the time of great financial crisis.

Table 7: Scenario 1 − The Global Financial Crisis (2007−2009)

Portfolio	Final value (USD)	Absolute change (USD)	Percentage change (%)	Annualised returns (%)	Annualised volatility (%)	Sharpe ratio
P1 (60-40-0)	85,604	-14,396	-14,40	-6.03	13.64	-0.5887
P2 (54-36-10)	91,228	-8,772	-8,77	-3.61	12.87	-0.4354
P3 (48-32-20)	96,851	-3,149	-3,15	-1.27	12.85	-0.2545
P4 (80-20-0)	74,932	-25,068	-25,07	-10.90	17.57	-0.7341
P5 (72-18-10)	81,623	-18,377	-18,38	-7.80	15.86	-0.6180
P6 (64-16-20)	88,314	-11,686	-11,69	-4.85	15.04	-0.4553
P7 (100-0-0)	64,260	-35,740	-35,74	-16.21	22.62	-0.8053
P8 (90-0-10)	72,018	-27,982	-27,98	-12.30	19.58	-0.7305
P9 (80-0-20)	79,776	-20,224	-20,22	-8.64	17.76	-0.5991

Source: Own work based on Bloomberg (2025).

From Table 7 above we can notice that every portfolio is reduced in value due to the financial crisis, but we can see which of them performed the worst. The portfolio with the highest final value was the P3 portfolio with the 48-32-20 allocation, it decreased by a value of only $3,149

to $96,851, which is a 3.15% decrease and has a -1.3% annualised return. In every stock/bond mix adding gold improved returns. In the 60/40 ratio between stocks and bonds, losses went from -14.40% to -3.15%, which shows that gold reduced losses dramatically. The benefit was most pronounced in equity-heavy portfolios (P7-P9) as bonds also helped reduce losses as they did not experience that big of a drop as stocks. Gold allocation also consistently lowered portfolio volatility across all mixes. The P7 portfolio with 100% stocks went from 22.62% to 17.76% volatility with an addition of 20% of gold in the P9 portfolio. That was because gold's low correlation with equities and bonds acted as a natural volatility dampener. Although all Sharpe ratios were negative, portfolios with gold had less negative Sharpe ratios. This means they offered better risk-adjusted performance during the crisis.

Due to gold being one of the few assets that held or gained value in the late stages of the crisis, it helped offset losses from equities. During financial panic, investors also sought assets perceived as stable stores of value, which played an influence as well. From the analysis we can conclude that gold proved to be a crisis hedge, especially when stock markets collapsed and even small allocations (10–20%) meaningfully reduced losses and portfolio risk. Even though it did not fully offset equity losses, it still significantly lowered the losses.

6.1.2 High growth pre-covid period (2018−2019)

The next period analysed will be the high growth pre-covid period with the exact timeframe from January 2018 to December 2019. The two years from 2018 to the end of 2019 were characterised by stock market growth before the COVID-19 shock in early 2020. Most major economies experienced expansion, low unemployment, and strong corporate earnings. Bond yields were relatively low while gold prices were stable early in 2018 but began rising from mid-2019. This period featured strong stock market growth with relatively low volatility and low interest rates, making it a solid period for assessing how gold performs when stocks perform well.

From Table 8 we can notice that every portfolio still increased in value with the inclusion of gold, but only marginally. All the portfolios experienced very similar return, which shows the stability of the period. The return of the portfolio with the lowest increase in value (P1) and the portfolio with the highest return (P9) only differed by 2.15%. The portfolio with the highest final value was the P9 portfolio with the 80-0-20 allocation, it increased by a value of $7,809 to $107,809, which is a 7.81% increase and has a 3.8% annualised return. The positive contribution of gold shows that during the gold's steady increase in 2019 it acted as a value enhancer and not only a hedge. Gold also reduced volatility in every portfolio by a few percentage points. Most notably in the P7 portfolio with 100% stocks, volatility went from 13.55% to 10.97% volatility with an addition of 20% of gold in the P9 portfolio. Gold allocations also improved Sharpe ratios in all cases, meaning better risk-adjusted returns. The best Sharpe ratio in each category came from the 20% gold allocation. This suggests that gold provided diversification benefits without sacrificing returns.

Table 8: Scenario 1 − pre-COVID Period (2018−2019)

Portfolio	Final value (USD)	Absolute change (USD)	Percentage change (%)	Annualised returns (%)	Annualised volatility (%)	Sharpe ratio
P1 (60-40-0)	105,663	5,663	5.66	2.79	8.18	0.0969
P2 (54-36-10)	106,376	6,376	6.38	3.14	7.57	0.1505
P3 (48-32-20)	107,090	7,090	7.09	3.48	7.14	0.2077
P4 (80-20-0)	106,112	6,112	6.11	3.01	10.79	0.0937
P5 (72-18-10)	106,781	6,781	6.78	3.33	9.79	0.1363
P6 (64-16-20)	107,449	7,449	7.45	3.66	8.95	0.1851
P7 (100-0-0)	106,562	6,562	6.56	3.23	13.55	0.0907
P8 (90-0-10)	107,185	7,185	7.19	3.53	12.19	0.1255
P9 (80-0-20)	107,809	7,809	7.81	3.83	10.97	0.1669

Source: Own work based on Bloomberg (2025).

Gold helped increase return, decrease portfolio volatility and provide better risk-adjusted return through all portfolios. This period shows that gold is not only a crisis asset, but that it can also enhance returns even in bullish conditions when macroeconomic uncertainty is present. This suggests that gold also acts as a diversification enhancer.

6.1.3 Covid-19 crisis (2020−2021)

The third period is the COVID-19 crisis ranging from January 2020 to December 2021. The COVID-19 pandemic created one of the most volatile market conditions in modern history. As COVID spread globally, lockdowns and uncertainty caused stock markets to plunge over 30%. Governments deployed huge relief packages to support businesses. From April 2020 onward, equity markets rebounded sharply, fuelled by liquidity and investor optimism. Gold prices hit an all-time high in August 2020 as investors sought safety. This analysis will test gold's role in portfolios during times of crisis where stocks recovered earlier and did not experience as big of a drop during the 2008 crisis. The results of the analysis were as follows.

Table 9: Scenario 1 − COVID-19 (2020−2021)

Portfolio	Final value (USD)	Absolute change (USD)	Percentage change (%)	Annualised returns (%)	Annualised volatility (%)	Sharpe ratio
P1 (60-40-0)	123,878	23,878	23.88	11.30	12.87	0.7225
P2 (54-36-10)	123,000	23,000	23.00	10.91	12.13	0.7339
P3 (48-32-20)	122,123	22,123	22.12	10.51	11.65	0.7302
P4 (80-20-0)	130,922	30,922	30.92	14.42	16.34	0.7602
P5 (72-18-10)	129,340	29,340	29.34	13.73	15.12	0.7758
P6 (64-16-20)	127,758	27,758	27.76	13.03	14.13	0.7807
P7 (100-0-0)	137,966	37,966	37.97	17.46	19.95	0.7750
P8 (90-0-10)	135,680	35,680	35.68	16.48	18.24	0.7937
P9 (80-0-20)	133,394	33,394	33.39	15.50	16.76	0.8051

Source: Own work based on Bloomberg (2025).

From Table 9 we can notice that the highest absolute returns came from stock-heavy portfolios. The portfolio with the highest final value was the P7 portfolio, consisting of only stocks, it increased by a value of $37,966. Adding gold generally slightly reduced total returns in this period, particularly in the more stock heavy portfolios. That is because even though gold performed very well in 2020, its performance moderated in 2021, whereas equities surged both years. On the other hand, gold did consistently lower volatility across all portfolio types. Most notably in the P7 portfolio with 100% stocks. Sharpe ratios increased with moderate gold allocation, especially in high-stock portfolios. This show that even though gold reduced returns in some cases, the risk-adjusted returns improved because of the reduced volatility.

In early 2020, gold rallied sharply while stocks crashed, soon after equity markets readjusted and continued their strong post-crash surge in 2021, which meant pure equity portfolios outperformed on returns. This shows that in sharp crises, gold can immediately act as a shock absorber, preventing massive drawdowns, but then in rapid recoveries gold may slightly lower returns but still be contributing to risk-adjusted performance.

6.1.4 Current economic period (2023−2025)

The last period to analyse is the Current economic period that encompasses the time between January 2022 to June 2025. This period reflects global inflationary pressures, aggressive interest rate hikes, and more active monetary policies. Stocks struggled in 2022 due to higher discount rates and economic uncertainty. However, in 2023–2025 we saw a partial recovery as inflation moderated. Gold performed relatively well as an inflation hedge, its prices spiked in early 2022 with the Ukraine war and then saw higher increases in value from 2023 all the way to today. This period will be useful for testing gold's performance in unstable conditions.

Table 10: Scenario 1 − Current Period (2023−2025)

Portfolio	Final value (USD)	Absolute change (USD)	Percentage Change (%)	Annualised returns (%)	Annualised volatility (%)	Sharpe ratio
P1 (60-40-0)	117,104	17,104	17.10	4.61	12.72	0.2055
P2 (54-36-10)	123,774	23,774	23.77	6.28	11.78	0.3636
P3 (48-32-20)	130,443	30,443	30.44	7.89	11.12	0.5297
P4 (80-20-0)	124,364	24,364	24.36	6.43	14.41	0.3073
P5 (72-18-10)	130,307	30,307	30.31	7.86	13.18	0.4443
P6 (64-16-20)	136,251	36,251	36.25	9.24	12.23	0.5922
P7 (100-0-0)	131,624	31,624	31.62	8.17	16.17	0.3815
P8 (90-0-10)	136,841	36,841	36.84	9.38	14.68	0.5025
P9 (80-0-20)	142,058	42,058	42.06	10.55	13.44	0.6362

Source: Own work based on Bloomberg (2025).

From Table 10 we can notice that the highest absolute returns came from portfolios with higher additions of gold. The most notable effect is in the high equity portfolios of 100% stocks where returns went from 31.62% in P7 to 42.06% in P9 with the inclusion of 20% gold. That was also the portfolio with the highest final value, it increased by a value of $42,058 to $142,058, making its annualised return 10.6%. In general, portfolios with a higher percentage of stocks and

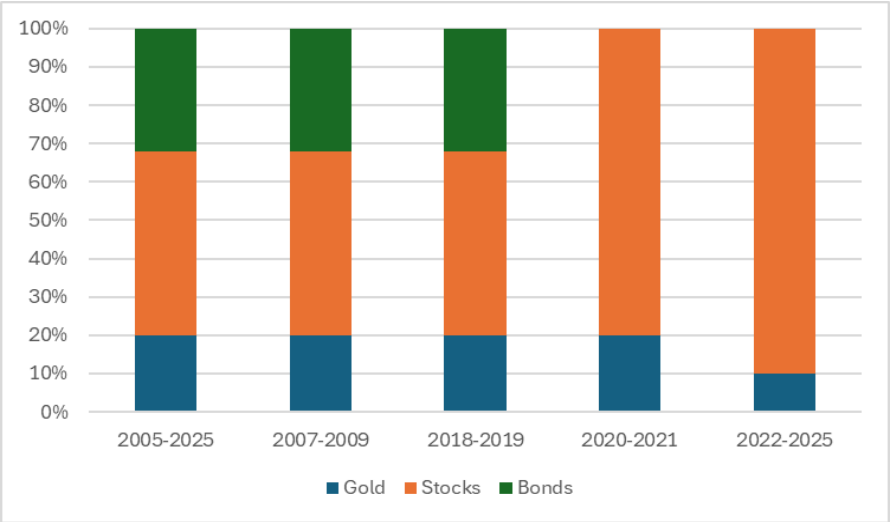
gold performed better, as bonds underperformed in this period. Gold's inclusion also reduced volatility in every case. In the 100% stocks, portfolios volatility went from 16.17% in P7 to 13.44% in P9 with the inclusion of 20% gold. The highest Sharpe ratio in this period belongs to P9 at 0.6362. Sharpe ratio increased more with inclusion of gold here than in previous periods because gold not only reduced volatility, but also meaningfully increased returns.

Due to the underperformance of bonds, persistent inflation and geopolitical uncertainties gold saw even more importance in its inclusion in portfolios. Since both bonds and stocks experienced periods of weakness, gold served as an uncorrelated third asset in the portfolio, improving both returns and stability.

6.1.5 Interpretation of results

The analysis of Scenario 1 tested the buy and hold investment strategy across the whole 20-year period as well as each of the 4 separate periods − the 2007–2009 global financial crisis, the 2018–2019 pre-COVID high-growth phase, the 2020–2021 COVID-19 crisis, and the 2022–2025 inflation and geopolitical tension period. By applying different portfolio structures, I was able to observe the behaviour of gold in multiple market conditions. Below in Figure 6 you can see which of the 9 portfolios structures yielded the highest Sharpe ratio for different periods.

Figure 6: Portfolio structures with the highest Sharpe ratio – Scenario 1



Source: Own work based on Bloomberg (2025).

From Figure 6 we can see that during the full period (2005−2025), the most efficient portfolio consists of a mix of the three asset classes, with gold maintain a 20% share. In times of crisis, such as the 2007–2009 financial crisis, portfolios with higher gold and bond weights outperformed, reflecting the preference for safer assets when market volatility rises. Conversely, during the COVID-19 period (2020–2021) and the current inflationary phase (2022–2025), portfolios with a heavier emphasis on stocks achieved the best risk-adjusted returns, while bonds

lost relevance due to persistently low yields and inflationary pressures. The 2018–2019 pre-COVID growth period also favoured more equity-oriented portfolios, though still benefiting from a moderate gold share.

Gold's performance and role changed with different macro-economic contexts. In crisis periods (2007–2009, 2020–2021, 2022–2025), gold often outperformed most other major asset classes and often boosted both absolute returns and risk-adjusted returns. In strong equity markets (2018–2019), gold still improved Sharpe ratios with volatility reduction, but its return contribution was modest, in some cases slightly lowering total returns compared to pure equity portfolios, across all four periods, regardless of market conditions, adding gold reduced portfolio volatility. The reduction was most notable in the portfolios with higher percentages of stocks. This would confirm gold's role as a diversifier. Risk-adjusted performance improved in nearly every case when gold was included. The improvement was most noticeable in 2007−2009 period and the current 2022−2025 period.

In times of crisis or times with greater uncertainties, 20% gold allocation often yielded the best Sharpe ratios and high returns. In strong equity markets, smaller allocations of 10% still improved risk-adjusted returns without meaningfully lowering returns. The Scenario 1 buy and hold analysis shows that gold can serve both as a defensive asset or hedge as well as a diversifier. Having a 10-20% gold allocation seems more than justifiable across all economic conditions.

6.2 Optimal (Scenario 2)

In this scenario I will simulate the Optimal scenario. The Optimal scenario is a theoretical scenario that assumes investors have perfect knowledge and foresight. They could time peaks and downturns in the market and thus achieve maximum possible returns. It will still serve as a theoretical benchmark of gold's maximum hedging potential. Unlike Scenario 1, where the gold was held through the entire period, Scenario 2 analyses what would happen if investors could time their allocation to gold at the most advantageous moments. The analysis of the optimal reallocation of gold would help us learn the true extent of gold's hedging capabilities as well as gauging how portfolios perform when timing is maximised. By introducing an optimal scenario, we would be able to see how much gold could potentially add to the value of the portfolio. By comparing it to Scenario 1 we could see whether gold works better as a permanent diversifier or more as a crisis-management tool and whether timing produces drastically higher results as the ones in the Buy and Hold scenario.

First, I will analyse an optimal scenario over the full period of 20 years (July 2005 to June 2025). In Table 11 we can see the final values of the analysis. From Table 11 we can conclude that the portfolios with higher gold allocation (P3, P6, P9) outperformed those without gold. The portfolio with the highest final value was the P9 portfolio with the 80-0-20 allocation. The other two portfolios with 20% gold allocation (P6 and P3) followed a similar pattern. On the

other hand, portfolios with zero gold allocation (P1, P4 and P7) were the lowest in value. Comparing these values to those of Scenario 1 in Table 6, we can see a significant increase in values across the board. The bigger differences are in portfolios with a higher allocation of gold and stocks, as bond prices remained more stable through the years. Even with an increase in volatility the Sharpe ratios of the Scenario 2 portfolios managed to show better results.

We can conclude that perfect timing does have a significant effect on portfolio returns and that speculative strategies can have an upper hand in theory. On the other hand, this does increase the overall volatility of the portfolios which some risk-averse investors would find off putting.

Table 11: Scenario 2 – Full period (2005−2025)

Portfolio	Final value (USD)	Absolute change (USD)	Percentage change (%)	Annualised returns (%)	Annualised volatility (%)	Sharpe ratio
P1 (60-40-0)	267,485	167,484	167.48%	5.04%	10.64%	0.2859
P2 (54-36-10)	339,379	239,379	239.38%	6.30%	10.30%	0.4175
P3 (48-32-20)	439,453	339,453	339.45%	7.68%	10.07%	0.5643
P4 (80-20-0)	303,181	203,181	203.18%	5.70%	13.00%	0.2848
P5 (72-18-10)	398,834	298,834	298.83%	7.16%	12.44%	0.4149
P6 (64-16-20)	529,226	429,226	429.23%	8.69%	11.95%	0.5597
P7 (100-0-0)	338,877	238,877	238.88%	6.29%	15.60%	0.2751
P8 (90-0-10)	457,695	357,695	357.70%	7.90%	14.72%	0.4009
P9 (80-0-20)	617,539	517,539	517.54%	9.53%	13.97%	0.5390

Source: Own work based on Bloomberg (2025).

Next, I will focus on the 4 distinct periods: The 2008 global financial crisis (2007−2009), the high growth pre-Covid period (2018−2019), the Covid-19 crisis (2020−2021) and the current economic period (2023−2025). For Scenario 2, focusing on shorter and more defined periods is more meaningful as timing strategies often work better in volatile, shorter periods.

6.2.1 The 2008 global financial crisis (2007−2009)

Firstly, I will test the Optimal strategy of Scenario 2 in the 2008 global financial crisis period. Unlike Scenario 1, where we held gold throughout all of the period, we will hold gold for only a specific amount which would give us the most optimal result. For this period, gold was introduced into the portfolios in July 2007 and held it until February 2009. In July 2007, gold's value was at its lowest in the period while in February 2009 the value of stocks was at its lowest. Buying gold at its cheapest in July 2007 and hedging with it before equities fell, until the stock market rebounded in February 2009 and not missing out on an equity roundabout, would make this the most optimal timeframe to test the impact of timing with gold.

Table 12: Scenario 2 – The Global Financial Crisis (2007−2009)

Portfolio	Final value (USD)	Absolute change (USD)	Percentage change (%)	Annualised returns (%)	Annualised volatility (%)	Sharpe ratio
P1 (60-40-0)	85,604	-14,396	-14.40	-6.03	13.64	-0.5887
P2 (54-36-10)	95,254	-4,746	-4.75	-1.93	13.22	-0.2970
P3 (48-32-20)	104,903	4,903	4.90	1.93	13.34	-0.0050
P4 (80-20-0)	74,932	-25,068	-25.07	-10.90	17.57	-0.7341
P5 (72-18-10)	86,483	-13,517	-13.52	-5.64	16.46	-0.4642
P6 (64-16-20)	98,034	-1,966	-1.97	-0.79	15.98	-0.1747
P7 (100-0-0)	64,260	-35,740	-35.74	-16.21	22.62	-0.8053
P8 (90-0-10)	77,725	-22,274	-22.27	-9.59	20.51	-0.5649
P9 (80-0-20)	91,191	-8,809	-8.81	-3.62	19.24	-0.2922

Source: Own work based on Bloomberg (2025).

From Table 12 we can notice that almost every portfolio was reduced in value due to the financial crisis, but compared to Scenario 1 in Table 7, the losses were less meaningful. Comparing all the portfolios in Scenario 2 to the ones in Scenario 1 we can see that the differences are significant. For the 60/40 portfolios P1 lost –14.4% while P3 (20% gold) noticeably reduced

losses to –3.15%. For Scenario 2 on the other hand P3 generated a gain of 4.9%, showing that correct timing of gold and its entry and exit date was important. These were also the only portfolios in this period that generated any profit at all. Across the board all other portfolios significantly increased in returns compared to the buy and hold strategy. Comparing annualised volatility in both scenarios shows that it increased in all portfolios compared to Scenario 1, although it still decreased with a higher inclusion of gold. On the other hand, Sharpe ratios improved in all cases, even though they are still mostly negative. This shows that that risk-adjusted returns were much better with Scenario 2's timing.

Timing gold in an optimal way helped increase the returns on all portfolios and significantly helped minimise the effects of the global financial crisis. While in Scenario 1 it managed to dampen its effects modestly, in Scenario 2 we can see a more significant change. An increase in volatility makes sense as the introduction of gold caused the portfolio to fluctuate more in the short term but ended up having higher risk-adjusted outcomes as shown in the better Sharpe ratios.

6.2.2 High growth pre-covid period (2018−2019)

The second analysed period was the high growth pre-Covid period from 2018 to 2019. Gold was added to the portfolios in September 2018 when its price was at its lowest and held until August 2019 when its price was at its peak in this period. Gold hit its lowest levels in September 2018 after a strong downturn and from late 2018, as global growth concerns escalated, investors flocked back to gold, pushing its price higher through August 2019. By reallocating into gold at a low and exiting at a high, it would capture gold's upside while maintaining balance.

As we can see from Table 13, the returns for each of the portfolios increased compared to Scenario 1 in Table 8. For the gold portfolios in Scenario 1, the returns ranged from 5–7.8%, while the returns in Scenario 2 range from 8.3% to 13.0%. The increase from the portfolios without gold to the ones with gold are now even more obvious as return range from 50% to 100% higher in the 10% and 20% gold portfolios compared to those without gold. The portfolio with the highest returns remains the P9 portfolio with and 13.4% increase. Volatility in Scenario 2 ranged from 0.071–0.108 for balanced portfolios and higher for equity-heavy ones. These were very similar to the ones in Scenario 1 but overall lower. Again, Sharpe ratios increased from Scenario 1 while also being much better in portfolios with gold than those without.

Table 13: Scenario 2 − pre-COVID Period (2018−2019)

Portfolio	Final value (USD)	Absolute change (USD)	Percentage change (%)	Annualised returns (%)	Annualised volatility (%)	Sharpe ratio
P1 (60-40-0)	105,663	5,663	5.66	2.79	8.18	0.0969
P2 (54-36-10)	108,326	8,326	8.33	4.08	7.56	0.2751
P3 (48-32-20)	110,990	10,990	10.99	5.35	7.10	0.4723
P4 (80-20-0)	106,112	6,112	6.11	3.01	10.79	0.0937
P5 (72-18-10)	109,062	9,062	9.06	4.43	9.85	0.2471
P6 (64-16-20)	112,011	12,011	12.01	5.84	9.04	0.4243
P7 (100-0-0)	106,562	6,562	6.56	3.23	13.55	0.0907
P8 (90-0-10)	109,800	9,800	9.80	4.79	12.29	0.2266
P9 (80-0-20)	113,038	13,038	13.04	6.32	11.17	0.3867

Source: Own work based on Bloomberg (2025).

The optimal strategy in the 2018−2019 period shows that by reallocating into gold at its lowest point in September 2018 and selling near its peak in August 2019, portfolios captured gold's appreciation during the period which led to higher returns. Gold's inclusion also lowered volatility in all portfolios and even slightly lowered it compared to Scenario 1. Furthermore, it also led to a stronger Sharpe ratio due to higher returns and slightly lower volatility. In this scenario we can also see a more drastic difference between the portfolios with and without gold compared with the previous scenario.

6.2.3 Covid-19 crisis (2020−2021)

The third analysed period was the Covid-19 crisis of 2020 and 2021. Gold was added at the start of the portfolio in January 2020 until March of the same year when stock was at its lowest. This tactical allocation allowed portfolios to benefit from the reallocation into stocks at historically low valuations, maximizing recovery gains. By selling gold in March and reallocating

into equities, portfolios effectively “bought low” on stocks. The results of the analysis were as follows.

From Table 14 we can see that all portfolios delivered extremely high returns compared to previous periods, the highest return of 45% being from the P9 portfolios with an 80/20 split between stocks and gold. The portfolios with 10−20% gold allocation outperformed those without on all fronts. Scenario 2 also showed much higher returns than Scenario 1, where the P9 portfolio’s return was 33.39%. Annualised volatility increased compared to the previous period but remained manageable. A higher percentage of gold in each portfolio managed to decrease its volatility. Volatility also decreased compared to Scenario 1 as gold was only held during the most turbulent times. All the Sharpe ratios were also very high, ranging from 0.723 to 1.00. Notably the P9 portfolio achieved a perfect 1.00 Sharpe ratio, showing that gold both improved absolute returns and delivered superior risk-adjusted returns. Compared to Scenario 1 of the same period, the Scenario 2 returns were much more efficient as well.

Table 14: Scenario 2 − COVID-19 (2020−2021)

Portfolio	Final value (USD)	Absolute change (USD)	Percentage change (%)	Annualised returns (%)	Annualised volatility (%)	Sharpe ratio
P1 (60-40-0)	123,878	23,878	23.88	11.30	12.87	0.7225
P2 (54-36-10)	126,021	26,021	26.02	12.26	12.47	0.8225
P3 (48-32-20)	128,165	28,165	28.16	13.21	12.10	0.9264
P4 (80-20-0)	130,922	3,.922	30.92	14.42	16.34	0.7602
P5 (72-18-10)	133,751	33,751	33.75	15.65	15.76	0.8662
P6 (64-16-20)	136,580	36,580	36.58	16.87	15.22	0.9771
P7 (100-0-0)	137,966	37,966	37.97	17.46	19.95	0.7750
P8 (90-0-10)	141,481	41,481	41.48	18.95	19.16	0.8846
P9 (80-0-20)	144,996	44,996	45.00	20.41	18.41	1.0000

Source: Own work based on Bloomberg (2025).

This period shows that gold can also act as a return enhancer if timed correctly. Scenario 2 shows that investors could achieve the highest return and Sharpe ratios of all periods. Tactical timing let portfolios rotate gold into stocks at their lowest point in March 2020 to achieve highest returns while still reducing the overall volatility.

6.2.4 Current economic period (2023−2025)

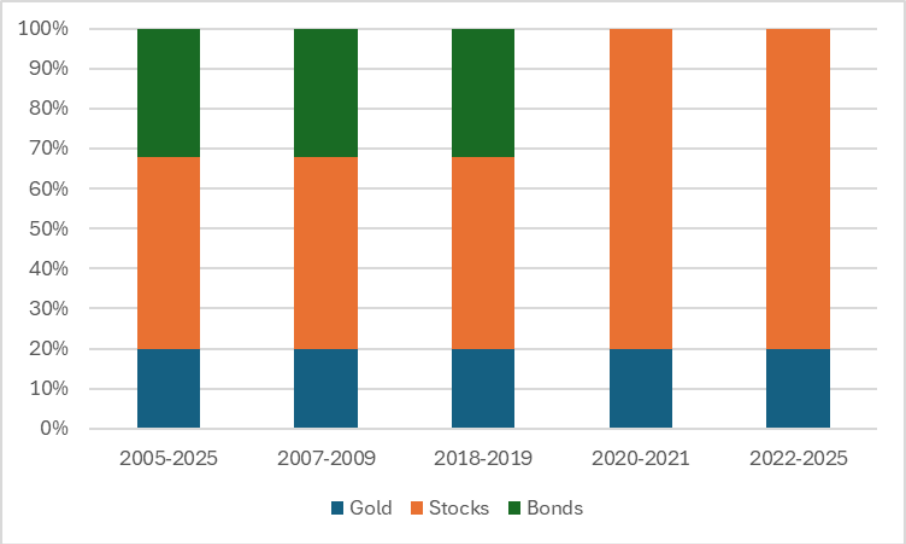
The last analysed period was the current economic period of 2023 until 2025. During the current period, both stocks and gold trended upwards consistently. Unlike in the global financial crisis (2007–2009) or the COVID-19 crisis (2020−2021) period, there was no sharp change where gold spiked while equities crashed. Because of this there was no optimal tactical point to buy or sell gold in. The highest returns were thus achieved in the same way as in Scenario 1, by buying at the start of the period in January 2023 and holding it until June 2025. During this time, gold was a return-producing asset in addition to a hedge. In addition to providing protection from inflation risk, it also boosted portfolio growth. The fact that gold and stocks increased together shows that gold's function is not just to provide safety in times of crisis, but that it can also function as a growth asset alongside stocks in inflationary and geopolitically unstable environments. This also shows the limits of tactical reallocation, as they work best in more unstable environments.

6.2.5 Interpretation of results

The analysis of Scenario 2 tested how gold would perform in an Optimal setting across each of the 4 separate periods − the 2007–2009 Global financial crisis, the 2018–2019 pre-COVID high-growth phase, the 2020–2021 COVID-19 crisis, and the 2022–2025 inflation and geopolitical tension period. By applying different portfolio structures, I was able to observe the behaviour of gold in multiple market conditions. The analysis of the optimal reallocation of gold helped us learn the true extent of gold's hedging capabilities as well as gauging how portfolios perform when timing is maximised. Below in Figure 7 you can see which of the 9 portfolios structures yielded the highest Sharpe ratio for different periods.

As we can see in Figure 7, the ideal mix of asset classes changes depending on the economic period. During the full period (2005−2025), the most efficient portfolio consists of a mix of the three asset classes, with gold maintain a 20% share. During the 2007–2009 financial crisis, the optimal portfolio contained a notable allocation to bonds and gold, reflecting a flight to safety due to the collapsing stock markets. In contrast, during the 2018–2019 pre-COVID growth period, portfolios remained diversified but leaned slightly more toward equities as market conditions and returns were more stable. The COVID-19 crisis (2020–2021) period saw the dominance of equities within the optimal portfolio, supported by a 20% share of gold, which served as a stabiliser during the initial market shock. Finally, in the current inflationary period (2022–2025), the structure again shows a heavier focus on equities with gold maintaining a consistent role and bonds losing much of their previous relevance.

Figure 7: Portfolio structures with the highest Sharpe ratio – Scenario 2



Source: Own work based on Bloomberg (2025).

During the Global Financial Crisis (2007–2009) and the COVID-19 crisis (2020–2021), optimally timed tactical reallocation into gold significantly outperformed the buy and hold strategy from Scenario 1. Early entry into gold during crises and exiting close to market enabled portfolios to reinvest in stocks at advantageous prices and avoid significant equity losses. On the other hand, the benefits of gold during the pre-COVID growth period (2018–2019) were more modest. While gold movements provided some extra gains, the returns were more dominated by equities. In the current economic period (2023–2025), both gold and equities trended upward together, meaning Scenario 2 offered no advantage over Scenario 1. Here, gold acted less as a hedge and more as another growth asset.

Together these finding show that gold's role in portfolios is context dependant. In crisis it can act as a hedge or value preserver while in stable environments it can work as any other asset. Tactical allocation in an optimal way in this scenario also shows different effect during different periods. Even though the returns of Scenario 2 are unrealistic they can still help paint a picture to investors of when to invest into gold and what can they expect from it.

6.3 Practical realistic (Scenario 3)

In this scenario I will simulate the Practical realistic scenario. The Practical realistic scenario simulates how investors would actually behave relying on systematic indicators and signals rather than on perfect foresight like in Scenario 2. This way Scenario 3 would let us explore the difference between theory and practice and asses if tactical allocation in gold outperforms the simpler buy and hold strategies explored in Scenario 1.

The VIX (CBOE Volatility Index) was chosen as the guiding indicator for Scenario 3. It measures the 30-day expected volatility of the S&P 500 Index and is extensively used by investors to evaluate market sentiment and perceived risk. It acts as a measurement of investor fear and uncertainty, making it a crucial tool in assessing market dynamics (Cboe, 2019). When VIX rises sharply it reflects investor uncertainty and anxiety. Historically, such spikes in volatility go hand in hand with falling stock market prices and an increase in demand for safe-haven assets such as gold. By applying thresholds (e.g., entering gold as VIX rises above 20, exit gold when it falls under 15) to each period we can establish a rule of when to invest. This makes VIX a good choice for testing volatility-based tactical allocation in Scenario 3.

The purpose of analysing Scenario 3 in this thesis is to measure the gap between a the theoretically optimal timing (Scenario 2) to a more practical one that could realistically be achieved by average investors. Another reason for examining Scenario 3 is that by comparing it to Scenario 1 we can determine if the function of gold is closer to a tactical safe-haven or more of a long-term asset. In Table 15 we can see the results of Scenario 3 through the whole period.

Table 15: Scenario 3 – Full period (2005−2025)

Portfolio	Final value (USD)	Absolute change (USD)	Percentage change (%)	Annualised returns (%)	Annualised volatility (%)	Sharpe ratio
P1 (60-40-0)	267,484	167,485	167.48	5.04	10.64	0.2859
P2 (54-36-10)	296,191	196,191	196.19	5.58	9.93	0.3604
P3 (48-32-20)	326,185	226,185	226.19	6.09	9.77	0.4186
P4 (80-20-0)	303,181	203,181	203.18	5.70	13.00	0.2848
P5 (72-18-10)	339,194	239,194	239.19	6.30	11.97	0.3590
P6 (64-16-20)	374,494	274,494	274.49	6.82	11.47	0.4206
P7 (100-0-0)	338,877	238,877	238.88	6.29	15.60	0.2751
P8 (90-0-10)	382,016	282,016	282.02	6.93	14.27	0.3456
P9 (80-0-20)	424,123	324,123	324.12	7.49	13.38	0.4104

Source: Own work based on Bloomberg (2025).

As before, we can conclude from Table 15 that the portfolios with higher gold allocation (P3, P6, P9) outperformed those without gold. The portfolio with the highest final value was the P9 portfolio with the 80-0-20 allocation, as both gold and stocks achieved much higher returns. The other two portfolios with 20% gold allocation (P6 and P3) followed a similar pattern. Comparing these values to those of Scenario 1 in Table 6, we can see that + of the portfolios here did not outperform the simpler buy and hold approach. In fact, only P8 and P9 with a higher allocation into stocks came close to the values of Scenario 1 as they both took advantage of the overperformance from stocks. Both volatility and the Sharpe ratio showed weaker results as well. Comparing them to Scenario 2 in Table 11, the differences are even more significant.

Most of the static portfolios in Scenario 1 achieved higher returns because they remain continuously invested and benefit from the strong bull markets and the appreciation of gold. Even though timing can lead to higher returns (as we have seen in Scenario 2), it is much harder and riskier to achieve across longer periods of time.

6.3.1 The 2008 global financial crisis (2007−2009)

Firstly, I will test the Practical realistic strategy of Scenario 3 in the 2008 global financial crisis period of 2007 and 2009. As mentioned, the allocation strategy of this scenario was determined by using the VIX indicator, with rules set to enter gold at when the VIX exceeded 20 and exit it when it fell below 15. This rule would make it so that we enter gold once volatility reached higher levels and exit it when it falls back down to a stable. Following these rules, the portfolio entered gold in July 2007 and remained invested until the end of the observation period in June 2009. The results of the analysis were as follows.

From Table 16 we can see that all the portfolios experienced a decrease in value. The portfolio with the smallest decrease remains the P3 portfolio with a 60/40 split between stock and bonds and 20%. Even though investing into gold did not fully minimise the losses, it still managed to decrease them by a non-negligible amount. Gold also managed to decrease the volatility and improve the Sharpe ratio across all portfolios. Compared to Scenario 1, Scenario 3 performed slightly better in all the portfolios. Entering in July 2007 (VIX>20) managed to successfully align with rising stock market uncertainty and correctly signalled the shift into gold. Compared to Scenario 3, the results of Scenario 2 are of course better, where the strongest portfolio managed to even make a profit as the gold entry was sooner.

Table 16: Scenario 3 – The Global Financial Crisis (2007−2009)

Portfolio	Final value (USD)	Absolute change (USD)	Percentage change (%)	Annualised returns (%)	Annualised volatility (%)	Sharpe ratio
P1 (60-40-0)	85,604	-14,396	-14.40	-6.03	13.64	-0.5887
P2 (54-36-10)	91,549	-8,451	-8.45	-3.47	12.89	-0.4244
P3 (48-32-20)	97,494	-2,506	-2.51	-1.01	12.89	-0.2334
P4 (80-20-0)	74,932	-25,068	-25.07	-10.90	17.57	-0.7341
P5 (72-18-10)	81,970	-18,030	-18.03	-7.64	15.88	-0.6072
P6 (64-16-20)	89,008	-10,992	-10.99	-4.55	15.12	-0.4333
P7 (100-0-0)	64,260	-35,740	-35.74	-16.21	22.62	-0.8053
P8 (90-0-10)	72,391	-27,609	-27.61	-12.12	19.61	-0.7203
P9 (80-0-20)	80,521	-19,479	-19.48	-8.30	17.86	-0.5767

Source: Own work based on Bloomberg (2025).

Across all three scenarios, gold consistently improved outcomes relative to portfolios without gold. Scenario 3 managed to also outperform the buy and hold strategy of Scenario 1 but fell short of the Optimal strategy in Scenario 2. This shows that while indicators can guide investors into better outcomes, they are not perfect at predicting the correct entry and exit timeframes.

6.3.2 High growth pre-covid period (2018−2019)

The second analysed period was the pre-Covid-19 growth period of 2018 and 2019. By using the VIX indicator, with rules set to enter gold when the VIX exceeded 20 and exit when it fell below 15, we entered gold in October 2018 and held it until February 2019. Due to the more stable nature of this period, the VIX indicator did not spike that often, so the gold-holding period lasted much shorter.

Table 17: Scenario 3 − pre-COVID Period (2018−2019)

Portfolio	Final value (USD)	Absolute change (USD)	Percentage change (%)	Annualised returns (%)	Annualised volatility (%)	Sharpe ratio
P1 (60-40-0)	105,663	5,663	5.66	2.79	8.18	0.0969
P2 (54-36-10)	106,172	6,172	6.17	3.04	7.89	0.1319
P3 (48-32-20)	106,681	6,681	6.68	3.29	7.65	0.1683
P4 (80-20-0)	106,112	6,112	6.11	3.01	10.79	0.0937
P5 (72-18-10)	106,624	6,624	6.62	3.26	10.36	0.1215
P6 (64-16-20)	107,136	7,136	7.14	3.51	9.98	0.1509
P7 (100-0-0)	106,562	6,562	6.56	3.23	13.55	0.0907
P8 (90-0-10)	107,074	7,074	7.07	3.48	12.98	0.1138
P9 (80-0-20)	107,586	7,586	7.59	3.72	12.47	0.1382

Source: Own work based on Bloomberg (2025).

As we can see in Table 17, unlike the previous period, all of the portfolios managed to raise a profit. As with every scenario that analysed this period, due to its stability all the performances are very close to each other. Adding gold to the portfolio increased the returns of all the portfolios, although by a small margin, with the highest returns belonging to the P9 portfolio. As in the previous period, both the volatility and the Sharpe ratio improved with the increase of gold in the portfolios. Compared to Scenario 1, Scenario 3 returns were lower or very similar in all the portfolios. That can be attributed to smaller gold window due to the relatively stable economic conditions during this period and that equities simply performed better this period, thus tactical gold allocation did not have much of an impact. Scenario 2 held gold for a longer period of time and caught the high point of gold value in the period.

Equities were the main driver of this period. Market volatility was low, thus gold did not play a major role. This scenario shows that gold's tactical role is most valuable during crisis periods, as in calm, growth driven environments, buy and hold strategies tend to do better.

6.3.3 Covid-19 crisis (2020−2021)

The next analysed period was the COVID-19 crisis period of 2020 and 2021. By using the VIX indicator, with rules set to enter gold when the VIX exceeded 25 and exit when it fell below 20, we entered gold in February 2020 and held it until March 2021. This timing strategy captured the protective role of gold during the start of the crisis but avoided holding it for too long into late 2021 when equities far outpaced gold's returns.

Table 18: Scenario 3 − COVID-19 (2020−2021)

Portfolio	Final value (USD)	Absolute change (USD)	Percentage change (%)	Annualised returns (%)	Annualised volatility (%)	Sharpe ratio
P1 (60-40-0)	123,878	23,878	23.88	11.30	12.87	0.7225
P2 (54-36-10)	122,641	22,641	22.64	10.74	12.26	0.7132
P3 (48-32-20)	121,404	21,404	21.40	10.18	11.83	0.6919
P4 (80-20-0)	130,922	30,922	30.92	14.42	16.34	0.7602
P5 (72-18-10)	129,068	29,068	29.07	13.61	15.39	0.7543
P6 (64-16-20)	127,215	27,215	27.21	12.79	14.61	0.7387
P7 (100-0-0)	137,966	37,966	37.97	17.46	19.95	0.7750
P8 (90-0-10)	135,484	35,484	35.48	16.40	18.66	0.7714
P9 (80-0-20)	133,002	33,002	33.00	15.33	17.54	0.7597

Source: Own work based on Bloomberg (2025),

In Table 18 we can see that all the portfolios had significant growth during this period, but unlike the previous periods gold's addition did not increase them. The portfolio with the highest return was the P7 portfolio consisting of only equity, as stocks after a short fall at the start of the period managed to increase in value significantly towards the end of the period. Gold negatively impacted the returns of this period, as they fell in value with an increase of gold in the portfolios. Despite that gold still managed to decrease the volatility and improve the Sharpe ratio in some of the portfolios. Scenario 3 showed similar results to Scenario 1, both showing

slightly lower volatility, but also lower final returns compared to equity-heavy ones. In Scenario 2 gold was removed from the portfolio very early on to maximise the returns from stocks.

During crises like COVID-19, entering into gold when volatility spikes shield portfolios from large drawdowns. However, timing matters as holding gold too long after volatility decreases can drag on performance. Scenario 3 shows that using gold as a tactical asset, and trying to time its entry, can be difficult and does not always outperform the buy and hold approach.

6.3.4 Current economic period (2023−2025)

The last analysed period is the current economic period of 2022 to 2025. By using the VIX indicator, with rules set to enter gold when the VIX exceeded 25 and exit when it fell below 20, we entered gold in February 2022 and held it until December 2022. This exposure allowed gold to fulfil its hedging role during a turbulent phase, while reallocating back into equities and bonds for the remainder of the period.

Table 19: Scenario 3 − Current Period (2023−2025)

Portfolio	Final value (USD)	Absolute change (USD)	Percentage change (%)	Annualised returns (%)	Annualised volatility (%)	Sharpe ratio
P1 (60-40-0)	117,104	17,104	17.10	4.61	12.72	0.2055
P2 (54-36-10)	118,253	18,253	18.25	4.91	12.31	0.2362
P3 (48-32-20)	119,401	19,401	19.40	5.20	11.94	0.2678
P4 (80-20-0)	124,364	24,364	24.36	6.43	14.41	0.3073
P5 (72-18-10)	125,554	25,554	25.55	6.72	13.87	0.3401
P6 (64-16-20)	126,745	26,745	26.74	7.01	13.39	0.3738
P7 (100-0-0)	131,624	31,624	31.62	8.17	16.17	0.3815
P8 (90-0-10)	132,851	32,851	32.85	8.45	15.51	0.4162
P9 (80-0-20)	134,079	34,079	34.08	8.74	14.91	0.4521

Source: Own work based on Bloomberg (2025).

In Table 19 we can see that as the last two portfolios this one also shows positive gains in all the portfolios. The gold holding portfolios outperformed those without it, with P9, consisting of only equity and gold, held the highest returns. This can be explained due to both gold's and stocks' overperformance during this period. Adding gold improved volatility during the peak volatility period and helped increase the Sharpe ratio across all portfolios. As mentioned in Scenario 2, the optimal way to allocate gold during this period was through the buy and hold strategy, due to stocks and gold both performing well. That approach showed decent increases across all the gold-holding portfolios, which shows again that gold acts better as a long-term asset than as a short-term tactical one.

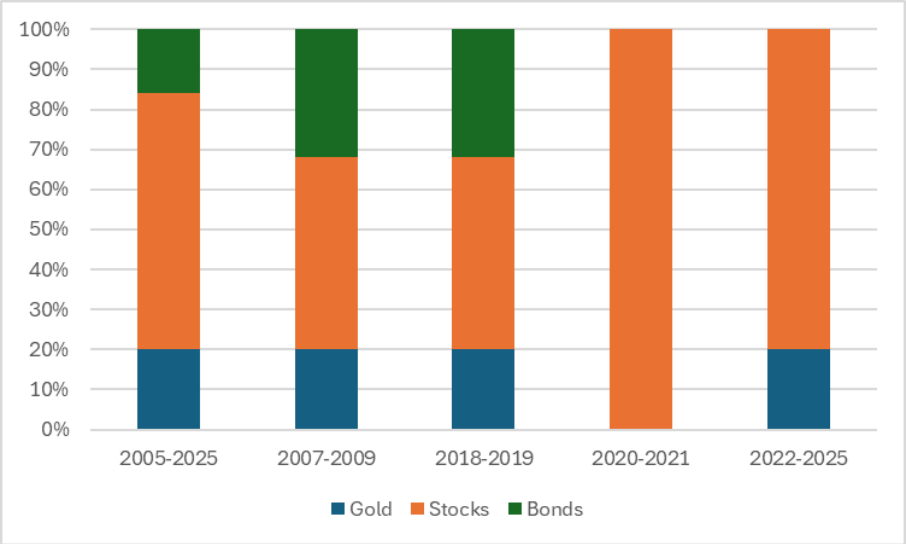
The current period is unique as gold has acted not only as a hedge during early 2022 turmoil but also as a long-term return enhancer due to persistent inflation, monetary uncertainty, and geopolitical risk. Therefore, the buy and hold strategy outperforms any indicator-based speculation. Although using this approach did not maximise portfolio gains, adding gold to the portfolios still increase their performance over not adding it at all.

6.3.5 Interpretation of results

The analysis of Scenario 3 tested how gold would perform in a Practical realistic setting across each of the 4 separate periods − the 2007–2009 global financial crisis, the 2018–2019 pre-COVID high-growth phase, the 2020–2021 COVID-19 crisis, and the 2022–2025 inflation and geopolitical tension period. The scenario managed gold allocations dynamically using market indicators such as the VIX, which is used to evaluate market sentiment and perceived risk. By applying different portfolio structures, I was able to observe the behaviour of gold in multiple market conditions. The analysis of the practical reallocation of gold helped us learn the realistic results of using indicator-based speculation tactics on gold and how that compares to the more conservative buy and hold approach. Below in Figure 8 you can see which of the 9 portfolios structures yielded the highest Sharpe ratio for different periods.

As we can see in Figure 8, during the full period (2005−2025), the most efficient portfolio consists of a mix of the three asset classes, with gold maintain a 20% share. During the 2007–2009 financial crisis, the optimal portfolio incorporated a balanced mix of stocks, bonds, and gold, reflecting the heightened uncertainty captured by the VIX. Similarly, in the 2018–2019 pre-COVID growth period, the portfolio remained diversified, maintaining the same portion of bonds and gold. However, in the COVID-19 crisis period (2020–2021), the model led to a fully equity-dominant portfolio, as the sharp volatility spike was followed by an extended bull market, reducing the need for gold and bonds. The 2022–2025 inflationary period maintained an equity-heavy structure, though with a 20% allocation to gold.

Figure 8: Portfolio structures with the highest Sharpe ratio – Scenario 3



Source: Own work based on Bloomberg (2025).

During the global financial crisis, entering gold positions when volatility spiked helped protect portfolios during periods of extreme uncertainty which also managed to outperform the buy and hold strategy. However, the overall results show that these tactical strategies did not consistently outperform the simpler buy-and-hold approaches seen in Scenario 1. In direct comparison, Scenario 3's tactical reallocations frequently resulted in lower returns than either Scenario 1, where gold was simply purchased and held for the duration, or Scenario 2, where gold was optimally timed. The timing problem with indicator-based strategies is the main issue of this underperformance. Although volatility indices, like the VIX, are useful for spotting stressful times, they can also force early exits from gold positions because they do not keep up with market movements. Consequently, Scenario 3 occasionally lost out on gold's steady increases, particularly in times of inflationary pressures and geopolitical unrest like in the 2022–2025 period.

Scenario 3 shows that gold can be actively managed as a tactical hedge, but the evidence suggests that in practice, the simpler buy and hold strategy frequently offers superior outcomes. This demonstrates that even though market indicators can help increase portfolio performance during times of high market shocks, it is often better that gold is used as a continuous long-term asset than a short-term one.

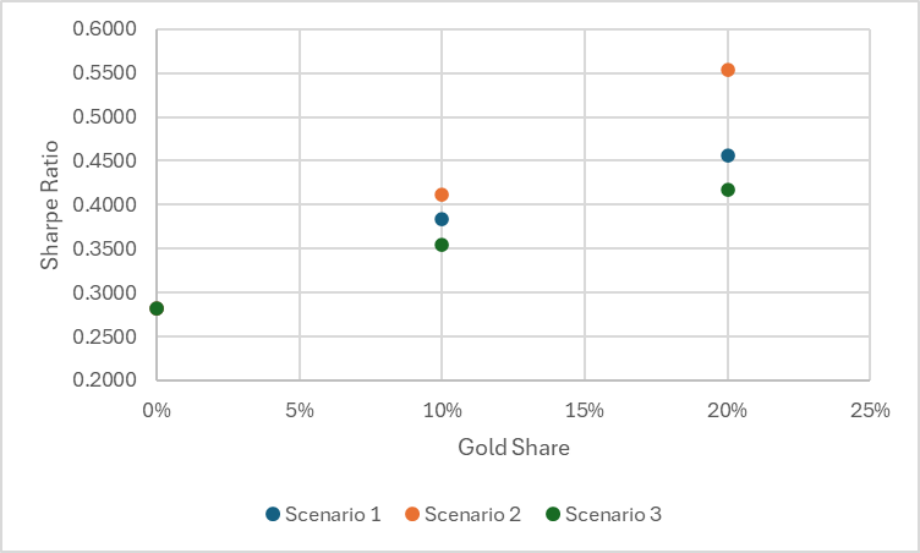
6.4 Summary of results

This thesis tested the role of gold in diversified portfolios across the past 20 years. With the help of data provided by Bloomberg I was able to measure the impact of adding different shares of gold (0%, 10% and 20%) to 3 distinct stock/bond ratio portfolios (60/40, 80/20, 100/0) across the last 20 years. These 9 portfolios were then taken through different scenarios and

timeframes to gauge how gold impacts portfolio performance across different economic conditions. Using the results provided by the analysis we can conclude what the role of gold in varied portfolios is, as well as its hedging and diversifying capabilities. This would contribute to a deeper understanding of its role by investors, contribute meaningfully to financial theory and offer direct guidance to current economic challenges. Below we can se the comparison of the scenarios.

In Figure 9 we can see how the average Sharpe ratio of the three scenarios changes across different gold allocations. In all scenarios, increasing the share of gold from 0% to 10% to 20% leads to an increase in the Sharpe ratio and thus its risk-adjusted return. Scenario 2 shows that optimal timing not only produces the highest returns but also the highest risk-adjusted returns. Scenarios 1 and 3 both show moderate improvements yet confirm the that adding gold to a portfolio improves the Sharpe ratio compared to not holding gold at all, scenario 3 falling behind due to the increased volatility. Overall, the graph demonstrates that gold consistently contributes positively to portfolio efficiency.

Figure 9: The best Sharpe ratios achieved across periods under three scenarios

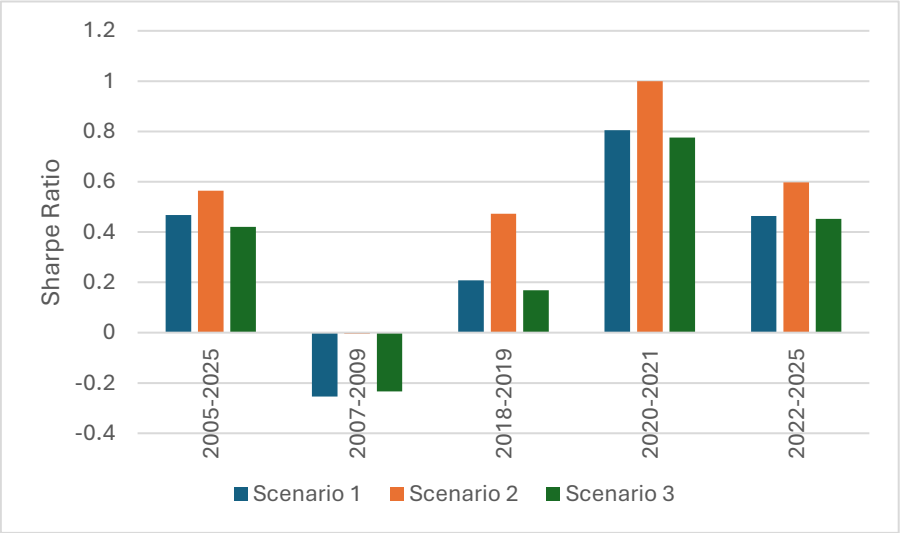


Source: Own work based on Bloomberg (2025).

Figure 10 shows the best Sharpe ratios achieved across the five periods (2005–2025, 2007–2009, 2018–2019, 2020–2021, and 2022–2025) under the three scenarios. It visualises how portfolios performed depending on the gold allocation strategy and market conditions. During the whole 20-year period, all scenarios show relatively high Sharpe ratios. The best highest one belonging to the optimal Scenario 2, followed by Scenario 1 and 3. Scenario 1 outperforming Scenario 3 shows that while there can be times where timing strategies with gold can outperform simpler approaches, it is not recommended for longer periods of time. During the 2007–2009 global financial crisis, all scenarios show negative Sharpe ratios, reflecting the overall market downturn and heightened volatility, though Scenario 2 and 3 slightly mitigated losses compared to the passive buy and hold strategy (Scenario 1). In the pre-COVID growth period

(2018–2019) Scenario 2 significantly outperformed others due to its tactical entry and exit positions in gold, as well as the buy and hold strategy prevailing over Scenario 3. The COVID-19 crisis period (2020–2021) shows the highest Sharpe ratios overall, with Scenario 2 again achieving the peak performance as it fully capitalised on gold's safe-haven behaviour during extreme volatility. Lastly, in the current economic period (2022–2025), all scenarios performed positively, though the difference between them narrowed, with Scenario 1 and Scenario 3 nearly matching Scenario 2. Overall, the chart demonstrates that while optimally timed tactical allocation (Scenario 2) often achieves the best Sharpe outcomes during crises, in a practical sense, the buy and hold strategy should lead to better risk-adjusted returns in the long-term.

Figure 10: The best Sharpe ratios achieved across periods under three scenarios



Source: Own work based on Bloomberg (2025).

7 CONCLUSION

The goal of this thesis was the explore the role of gold in investment portfolios, with a focus on its performance and interactions with stock and bonds across different economic cycles. By analysing the stock, bond and gold markets over the period of 20 years, with an emphasis on four major periods such as the 2008 global financial crisis (2007−2009), high growth pre-covid period (2018−2019), Covid-19 crisis (2020−2021) and the current economic period (2023−2025), it aimed to determine how gold affected the performance of different portfolios during these times. Three investment approaches were compared: a traditional buy and hold strategy (Scenario 1), an optimally timed strategy (Scenario 2), and a practical realistic strategy using indicators such as the VIX (Scenario 3). Together these approaches allowed for a comprehensive analysis of both the theoretical and practical aspects of holding gold in diversified investment portfolios.

The results across all scenarios and periods show that gold has a consistent and important impact on portfolio performance, particularly during times of market stress or economic uncertainty. Throughout the 20-year timeframe gold maintained a low or negative correlation with stocks and bonds, allowing it to serve as an effective diversifier. Adding gold to portfolios, on average, increased both return and risk-adjusted performance. The Sharpe ratio, which measures the return per unit of risk, increased steadily as gold's weight rose. These findings align with those of modern portfolio theory, allowing investors to achieve higher returns without increasing risk.

During crisis periods, the importance of gold became even more obvious. During the global financial crisis, portfolios with a moderate amount of gold exposure saw higher Sharpe ratios than those without gold. The asset's historical function as a safe haven during systemic shocks was confirmed when its value increased as financial markets crashed. Similarly, gold was a protective asset during the COVID-19 pandemic as gold prices rose sharply in early 2020 as global equities crashed. In contrast, gold's impact on portfolio performance was less intense during times of economic stability, such as the pre-COVID growth phase. Gold's defensive qualities were less necessary in these conditions, when volatility was low and equity markets rose steadily. However, despite these calm circumstances, the gold's low correlation with bonds and stocks made sure that it would continue to be a useful diversifier, preserving portfolio balance and reducing possible risks.

The comparative analysis of the three scenarios provided additional insight into the strategic and tactical use of gold. Scenario 1, representing the buy-and-hold approach, produced normal and expected outcomes. Scenario 2, the theoretically optimal approach, produced superior performance during certain times, especially during the global financial crisis and the COVID-19 crisis, where tactical reallocation into gold significantly outperformed the buy and hold strategy from Scenario 1. Scenario 3 on the other hand followed a practical realistic approach based on the VIX volatility thresholds. These outcomes were less impressive. The indicator-based strategy frequently entered or exited too late. This demonstrates that although timing can improve performance in theory, it can be difficult to implement consistently in practice.

At the start of the thesis, I selected 4 research questions to better understand the goals of this work. The research questions were carefully chosen to capture the essential aspects of gold's role in diversified portfolios. They focus on its effectiveness as a hedge and diversifier, address gold's influence during various economic conditions and the impact of timing and asset allocation on its performance. From the analysis I can finally answer these questions based on my own findings.

Research question 1: How does including gold in investment portfolios affect overall portfolio performance during crises?

Answer: Adding gold to investment portfolios improves risk-adjusted performance and reduces the negative effects of crises. The size of the benefit is dependent on the type of the crisis.

Research question 2: How effective is gold in hedging inflation and geopolitical uncertainty in the current economic environment?

Answer: Over the 2022−2025 period gold acted as a credible hedge against inflation and geopolitical risk, but not a perfect one.

Research question 3: Does the timing and portfolio rebalancing significantly influence the hedging capabilities of gold?

Answer: Yes, but asymmetrically. The effects of timing strategies can be seen most in fast, shock-driven scenarios, but it helps less in more bearish markets.

Research question 4: Which portfolio allocation provides the "best" returns across various economic scenarios?

Answer: The "best" depends on whether you care more about absolute returns or risk-adjusted return.

Overall, the results of the thesis show that gold's inclusion in portfolios delivers substantial benefits to its performance. It enhances the long-term efficiency by improving its risk-adjusted return and contributes to portfolio resilience during times of turmoil. Gold's value relies on its special characteristics, such as that it appreciates during market stress, preserves value during inflationary times and remains mostly uncorrelated to other traditional assets. The research also highlights that gold should be view more as a long-term asset than an opportunistic one. Its focus is not to outperform equities and bonds, but to stabilize portfolio returns.

For investors, this research carries several practical findings. Firstly, having a strategic 5−15% gold allocation seems optimal across a wide range of conditions. Such exposure increases the Sharpe ratio while keeping volatility under control. Secondly, while tactical allocations can improve portfolio performance in certain times, a long-term approach offers safer and more reliable returns. From a theoretical standpoint, these findings also reinforce those of Markowitz's portfolio theory and the CAPM. Gold's low correlation and beta characteristics align with the principal that combining assets of different risks leads to a better risk-adjusted performance.

In conclusion, gold remains as one of the most effective and reliable parts of diversified portfolios. Its inclusion improves portfolio efficiency, helps against market shocks and provides long-term stability in markets with ever increasing volatility and systematic risk. While it may be tempting to treat gold as a tactical tool, its core value lies in its consistency. Ultimately, this thesis shows that gold still serves the same purpose it did for centuries, that of a diversifier and a source of financial stability.

KEY REFERENCES

1. Baur, D. G., & Lucey, B. M. (2009). *Is gold a hedge or a safe haven? An analysis of stocks, bonds and gold*. SSRN. https://doi.org/10.2139/ssrn.952289
2. Berk, J., & DeMarzo, P. (2023). *Corporate finance* (6th ed., Global ed.). Pearson.
3. Demidova-Menzel, N., & Heidorn, T. (2007). *Gold in the investment portfolio* (Working Paper No. 87). Frankfurt School of Finance & Management. https://www.econstor.eu/handle/10419/27853
4. Fernando, F. (2017). *The role of gold in an investment portfolio*. Umeå School of Business and Economics. https://www.diva-portal.org/smash/get/diva2:1139896/FULLTEXT01.pdf
5. Hoang, T.-H.-V., Lean, H. H., & Wong, W.-K. (2015). Is gold good for portfolio diversification? *International Review of Financial Analysis, 42*, 98–108. https://doi.org/10.1016/j.irfa.2014.11.020

REFERENCES

1. Akhtaruzzaman, M., Boubaker, S., Lucey, B. M., & Sensoy, A. (2021). Is gold a hedge or a safe-haven asset in the COVID–19 crisis? *Economic Modelling, 102*, 105588. https://doi.org/10.1016/j.econmod.2021.105588
2. Alfaro, I. P. (2025). *Gold investment: Comparing costs and benefits of physical gold vs. ETFs*. Investopedia. https://www.investopedia.com/articles/investing/031913/most-affordable-way-buy-gold-physical-gold-or-etfs.asp
3. Bampinas, G., & Panagiotidis, T. (2015). Are gold and silver a hedge against inflation? A two century perspective. *International Review of Financial Analysis, 41*, 267–276. https://doi.org/10.1016/j.irfa.2015.02.007
4. Bartkus, E. V., & Bartkute, A. P. (2013). The optimization and evaluation of investment portfolio. *Engineering Economics, 24*(4). https://www.inzeko.ktu.lt/index.php/EE/article/view/5416
5. Baur, D. G., & McDermott, T. K. (2010). Is gold a safe haven? International evidence. *Journal of Banking & Finance, 34*(8), 1886–1898. https://www.sciencedirect.com/science/article/abs/pii/S0378426609003343
6. Beers, B. (2020). *Buy and hold: What it means, how the investing strategy works*. Investopedia. https://www.investopedia.com/terms/b/buyandhold.asp
7. Bhowmik, R., & Wang, S. (2020). Stock market volatility and return analysis: A systematic literature review. *Entropy, 22*(5), 522. https://doi.org/10.3390/e22050522
8. Bilir, H. (2016). Determination of optimal portfolio by using tangency portfolio and Sharpe ratio. *Research Journal of Finance and Accounting, 7*(5). https://core.ac.uk/download/pdf/234631291.pdf
9. Bloomberg. (2025). *Global Aggregate Index*. Bloomberg Fixed Income Indices. https://assets.bbhub.io/professional/sites/27/Global-Aggregate-Index.pdf

10. Boyte-White, C. (2015). *How do you calculate volatility in Excel?* Investopedia. https://www.investopedia.com/ask/answers/021015/how-can-you-calculate-volatility-excel.asp
11. Cassel, G. (1936). *The downfall of the gold standard*. Routledge. https://doi.org/10.4324/9780203704455
12. Cboe Global Markets, Inc. (2019). *White paper: CBOE Volatility Index (VIX)*. Simon Fraser University. https://www.sfu.ca/~poitras/419_VIX.pdf
13. Chen, A.-S., & Lin, J. W. (2013). The relation between gold and stocks: An analysis of severe bear markets. *Applied Economics Letters, 21*(3), 158–170. https://doi.org/10.1080/13504851.2013.844321
14. Chen, J. (2025). *Annualized total return formula and calculation*. Investopedia. https://www.investopedia.com/terms/a/annualized-total-return.asp
15. Cogneau, P., & Hübner, G. (2009). *The 101 ways to measure portfolio performance*. SSRN. https://doi.org/10.2139/ssrn.1326076
16. Constantinides, G. M., & Malliaris, A. G. (1995). Portfolio theory. *Finance*, 1–30. https://doi.org/10.1016/S0927-0507(05)80045-3
17. Eichengreen, B., & Flandreau, M. (1997). *Gold standard in theory and history* (2nd ed.). Routledge. https://doi.org/10.4324/9780203978870
18. Fama, E. F., & French, K. R. (2004). The capital asset pricing model: Theory and evidence. *Journal of Economic Perspectives, 18*(3), 25–46. https://doi.org/10.1257/0895330042162430
19. Fernando, J. (2025). *Understanding the correlation coefficient: A guide for investors*. Investopedia. https://www.investopedia.com/terms/c/correlationcoefficient.asp
20. Habashi, F. (2016). Gold – An historical introduction. *Gold Ore Processing*, 1–20. https://doi.org/10.1016/B978-0-444-63658-4.00001-3
21. Hayes, A. (2022). *100% equities strategy: What it means, how it works*. Investopedia. https://www.investopedia.com/terms/1/100-equities-strategy.asp
22. Huang, X. (2010). What is portfolio analysis. *Studies in Fuzziness and Soft Computing*, 1–9. https://doi.org/10.1007/978-3-642-11214-0_1
23. Ikram Ul Haq, Aslam, F., & Aslam, F. (2024). Hedge, diversifier and safe haven properties of precious metals against UK stocks during COVID-19 pandemic. *Dialogue Social Science Review, 2*(5), 54–67. https://dialoguesreview.com/index.php/2/article/view/73
24. Investopedia Team. (2025). *Hedge: Definition and how it works in investing*. Investopedia. https://www.investopedia.com/terms/h/hedge.asp
25. Ischuk, T. L., Zhilkin, D. V., & Aikina, T. Y. (2016). Gold as a tool for hedging financial risks. *IOP Conference Series: Earth and Environmental Science, 43*, 012085. https://doi.org/10.1088/1755-1315/43/1/012085
26. Ita, D.-A. (2025). *ETC vs. ETF: What's the difference?* Investopedia. https://www.investopedia.com/articles/investing/032116/how-etc-different-etf-iau.asp
27. Jaffe, J. F. (1989). Gold and gold stocks as investments for institutional portfolios. *Financial Analysts Journal, 45*(2), 53–59. https://doi.org/10.2469/faj.v45.n2.53

28. Kandhari, J. (2024). *Return of the 60/40*. Morgan Stanley Investment Management. https://www.morganstanley.com/im/publication/insights/articles/article_bigpicturereturnofthe6040_ltr.pdf
29. Kayral, I. E., Jeribi, A., & Loukil, S. (2023). Are Bitcoin and gold a safe haven during COVID-19 and the 2022 Russia–Ukraine war? *Journal of Risk and Financial Management, 16*(4), 222. https://doi.org/10.3390/jrfm16040222
30. Kenton, W. (2025). *What beta means for investors*. Investopedia. https://www.investopedia.com/terms/b/beta.asp
31. Koumou, G. B. (2020). Diversification and portfolio theory: A review. *Financial Markets and Portfolio Management, 34*(3), 267–312. https://doi.org/10.1007/s11408-020-00352-6
32. Kourtis, A. (2016). The Sharpe ratio of estimated efficient portfolios. *Finance Research Letters, 17*, 72–78. https://doi.org/10.1016/j.frl.2016.01.009
33. Lucey, B. M., & Tully, E. (2003). *International portfolio formation, skewness and the role of gold* (SSRN Paper No. 452482). https://doi.org/10.2139/ssrn.452482
34. Lucey, B. M., Peat, M., Šević, A., & Vigne, S. A. (2019). What is the optimal weight for gold in a portfolio? *Annals of Operations Research, 297*(1–2), 277–291. https://doi.org/10.1007/s10479-019-03496-5
35. Markowitz, H. M. (2010). Portfolio theory: As I still see it. *Annual Review of Financial Economics, 2*(1), 1–23. https://doi.org/10.1146/annurev-financial-011110-134602
36. Martins, A. M. (2024). Global equity, commodities and bond market response to Israel–Hamas war. *Finance Research Letters, 67*, 105900. https://doi.org/10.1016/j.frl.2024.105900
37. MSCI Inc. (2025). *MSCI World Index*. https://www.msci.com/indexes/index/990100
38. Murphy, A. (2008). *An analysis of the financial crisis of 2008: Causes and solutions*. SSRN. https://doi.org/10.2139/ssrn.1295344
39. Ruano, F., & Barros, V. (2022). Commodities and portfolio diversification: Myth or fact? *The Quarterly Review of Economics and Finance, 86*, 281–295. https://doi.org/10.1016/j.qref.2022.08.003
40. Rudolf, R., Anžel, M., Marković, E., Čolić, M., & Stamenković, D. (2012). Gold in the past, today and future. *Metalurgija, 51*(2), 261–264. https://hrcak.srce.hr/74867
41. Shahzad, J., Raza, N., Roubaud, D., Arreola Hernandez, J., & Bekiros, S. (2019). Gold as safe haven for G-7 stocks and bonds: A revisit. *Journal of Quantitative Economics, 17*. https://doi.org/10.1007/s40953-019-00163-1
42. Šoja, T. (2019). Gold in investment portfolio from perspective of European investor. *The European Journal of Applied Economics, 16*(1). https://doi.org/10.5937/EJAE15-19652
43. The American College. (2020). *How often should you adjust your investment portfolio?* https://www.theamericancollege.edu/knowledge-hub/insights/how-often-should-you-adjust-your-investment-portfolio
44. The Royal Mint. (n.d.). *A brief history of gold*. https://www.royalmint.com/invest/discover/gold-news/a-brief-history-of-gold/

45. Vidmar, J. (2021). *Strategija rotacije dejavnosti v portfelju: Oblikovanje, uvedba in testiranje uspešnosti* (Master's thesis). University of Ljubljana. http://www.cek.ef.uni-lj.si/magister/vidmar4319-B.pdf
46. Zaimovic, A., Omanovic, A., & Arnaut-Berilo, A. (2021). How many stocks are sufficient for equity portfolio diversification? *Journal of Risk and Financial Management, 14*(11), 551. https://doi.org/10.3390/jrfm14110551