The Impact of Investing in Gold for the US Investors

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Abstract

Despite abundant studies, the fundamentals behind gold price developments and its characteristics in diversified portfolios have not been fully identified. Gold investors have often been misled by analysts’ forecasts because the underlying fundamentals behind value mechanism are not well-defined. While some analysts blame on the political uncertainties, others simply admit that the gold price characteristics are too complex for a reliable projection.

As gold price has been through a substantial hike and later, a significant fall during 2009 to 2015, many previous theories about gold price properties are undermined, paving the need for new researches. In this study, the author explores the factors that influence gold price by analysing the relation to oil price, bonds, equities, interest rate, inflation and USD exchange rate. Furthermore, Gold’s role as hedge, safe haven and diversifier to the US equities is covered. The author also studied the adequate proportion of gold in a three-asset portfolio to explore the optimum ratio of the assets. Moreover, the effect of market ‘fear factor’ by analysing the relation of gold volatility index to gold price was examined.

The finding was that the USD exchange rate was negatively correlated to gold and bonds were similarly negatively correlated to gold since 2009. Gold acted as safe haven to the US equity market, S&P 500, during the market turmoil but in a longer period, gold is uncorrelated to S&P 500 and can function as a diversifier in the portfolio. Another outcome of this study was that a high level of gold volatility index, which is based on investors’ ‘fear factor’, influences the way gold price emerges in the future.

Key words: Gold; Bonds, S&P 500, Hedge; Safe Haven; Diversifier, Fear factor and Portfolio optimisation.
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1 INTRODUCTION

1.1 Outline

This dissertation is written based on literature studies as well as empirical research to explore the impact of gold in investors’ portfolios in the USA. Thus, this study will focus on the US market data from the US investors’ point of view to obtain gold price’s characteristics and its impact on investors’ portfolio. The US market is important due to its size and for the fact that gold is denominated in the US Dollar (USD). The existing literature do not cover the recent events in gold price movements specifically in the US market. A stronger USD normally leads to a lower gold price as gold is denominated in USD, as per chapter 4.1.7, which explains that the return from gold price negatively correlates to the USD exchange rate. US investors may lose on gold whereas investors in another country may not lose in their currency if that currency depreciates against USD. So gold investment may bring profit to some investors and loss to other investors depending on their currencies’ movement towards USD. Therefore, a study covering all currencies may not provide any significant result. Hence, I believe my research will obtain more concrete results by focusing only on one currency.

Through analysis of existing literature, I have noticed some main gaps that this thesis will address and attempt to fulfill. The existing studies do not cover the gold price crash during 2012-2015. They have not evaluated whether the gold price went through a correction after a bubble or simply crashed from a reasonable level. This will be thoroughly studied in this research, particularly in chapter 4.4. Several academic papers like Wang (2012) analyse the characteristics of gold price in the long-term perspective. In this paper, the analysis will be
carried out over a long-term period as well as shorter periods with special importance. For instance, analysing the years 2009-2011 when the stock market crashed after the world financial crisis provides a valuable conclusion which is shown in chapter 4.2.

In the literature review section, a history about gold and its importance as currency will be provided. The key historical dates for gold price are given as well, leading to a discussion on the influential factors of gold prices. The selected literature will discuss the relationship between gold price and oil price, the US equity market (S&P 500), interest rate, inflation and USD Index. The hedge and safe haven characteristics of gold towards S&P 500 will be examined as well.

Furthermore, the effect of gold in an investment portfolio will be studied in the literature reviews. As this paper is focused on the recent events in gold price, many academic journals authored by market analysts will be explored in order to understand the gold price volatility and the reasons behind the recent fall. Later on, gold’s supply and demand factors will be examined extensively through the incumbent literature. Demand for gold is triggered by the jewellery market, central banks, investors and technology, whereas supply comes from gold mining and scraps. The impact of each sector to the gold price is reviewed in chapter 2.6. There are many different ways to invest in gold from buying coins and bullions to ETF’s, equities and funds. These methods of investment alongside with its advantages and disadvantages are studied and explained in chapter 2.9 as well.

In the methodology and analysis chapters, four research questions are examined. Firstly, the empirical factors that influence gold price will be studied as they provide a foundational understanding for gold price movements. Secondly, these factors will be used to analyse the question if investing in Gold is a hedge or safe haven against the US equity market, S&P
This research question is particularly important to diversify portfolios during the market turmoil as it provides valuable information to investors for investing in gold at the right time in order to mitigate losses.

Thirdly, the thesis will analyse and recommend the optimal allocation of gold, S&P 500 and bond in a portfolio based on US market data in order to answer the question: “When, how and to what extent should we invest in gold?” This is the section that will directly address the gap identified in the literature to obtain the adequate proportion of gold in the portfolio.

Lastly, the question on what caused the sharp decline in gold price during the period of 2011-2015 will be answered. This study is performed by utilising gold’s volatility index, as explained in Chapter 2.8.

Daily data is collected from open sources for the past twenty years, from 1/10/1995 to 30/9/2015. In the first research question, by deploying regression analysis, the relationship between several financial factors towards gold will be tested. In the regression model, it is evaluated whether the financial factor as oil price, bonds, S&P 500, interest rate, inflation and US dollar exchange rate can explain the price of gold. Specifically, this analysis focuses on the period after 2011 in order to address the gap in the existing literature. In this analysis, the significance of relationships of these factors to gold is examined. Another important aspect is if any of these financial factors have a substantial impact on gold price. In the analysis of the second research question, the hedge and safe haven characteristics of gold with regards to S&P 500 will be examined. In this part, a regression model is used to find out whether gold can explain S&P 500.
Normally, investors seek the optimum proportion of assets like equities (S&P 500), bonds and commodities in their portfolios. In the third research question of this paper, the optimum ratios of three assets: bonds, S&P 500 and gold in a portfolio will be evaluated. As the prices of these assets are highly dynamic, several optimum portfolios for different time periods are constructed. The optimum portfolios are built based on the “minimum variance” method. By this method, the maximum return at certain risk or lowest risk levels for a target return can be obtained in detail, which is presented in chapter 3.8 and 4.3.

The last research question is about studying the gold price volatility and crash since the end of 2011. The important issue is to find out whether the gold price at the end of 2011 was overvalued or it simply plunged due to other factors such as sell offs. In this research question, gold volatility data against gold price will be analysed by regression analysis. The historically accumulated return of gold will also be evaluated to understand whether the gold price at the end of 2011 was a bubble or can be justified.

At the end of this research, the conclusion will present the findings from literature reviews and a summarised analysis of the research questions. It will, among other objectives, explain factors affecting the gold price alongside the hedge and safe haven properties of gold. Furthermore, the ample proportion of gold in the portfolio will be outlined and the relation between the gold volatility index and gold price is explained.

The first part of the research is the literature review that covers relevant academic papers, books and online articles. In the second part, by deploying econometric methods and analysing the market data, four chosen research questions related to gold price are answered. A combination of the findings from the literature studies and empirical research is meant to provide strategic guidelines to invest in gold, particularly for US investors.
1.2 Research Questions

The objective of this study is to provide answers for the following research questions:

1. What are the empirical factors that influence gold price?
2. Is investing in Gold a hedge, safe haven or diversifier against US equity market, S&P 500?
3. What is the optimal allocation of gold, S&P 500 and bond in a portfolio based on US market data? When, how and to what extent should we invest in gold?
4. What was the cause(s) of the sharp decline in gold price during the period of 2011-2015?

1.3 Motivation

I have been fascinated by the fact that many financial analysts struggle to forecast the price of gold. In 2008, the majority of analysts found gold expensive a USD 900 per ounce. Three years later, they recommended buying gold at USD 1800 / ounce and in 2014, their advice was to sell gold at USD 1200 per ounce. One would think that a commodity with such high intrinsic value as gold should not fluctuate so heavily.

I have been a commodity and bond investor for many years and since 2010, I have managed a portfolio on a part-time basis. My interest is investing in commodities, bonds and equities. These recent steep price variations in gold have motivated me to explore the factors that impact its price.

My idea is to come up with concrete ideas that could be used by investors and financial institutes. As an investor, I have always appreciated gold for its intrinsic value and I think investing in gold in the right time is always safe. The fact that gold might be or might not
be a hedge or safe haven should not be the main decisive factor. Investment in gold because of its own value and as a diversifier to other investments has always been appealing to me.

1.4 Research Contribution

By completing literature studies and empirical analyses, this paper aims to make several contributions. The aim is to find out the relation and effect of other financial factors such as bonds, equity market, oil price, interest rate, inflation and USD index on gold price. This is done by analysing long-term as well as selected short periods, as explained in chapter 3.6. Another contribution is to realise if gold can act as hedge, safe haven or diversifier with regards to the US equity market in the long-term as well as short-term. Finding out the optimum allocation of gold, bonds and equities in an investment portfolio is also a key element in this paper.

The price fluctuation of gold, particularly in the last eight years, is discussed in this study. The main reasons for the rise in gold price until 2011 and then its subsequent fall are analysed as well. Another contribution is to verify the influence of the supply and demand factors to the gold price. Additionally, different methods of investment in gold with their advantages and disadvantages are studied and explained in chapter 2.9.

1.5 Assumptions and Limitations

This study considers gold investment in the US market based on data from the US only. Hence, the relationship of the equity market, inflation rate and interest rates of only the US market to gold price is considered. Typically, investing in assets such as gold, bonds and equities includes some costs imposed by banks or financial institutes. These costs vary depending on the asset and may come up to 1-2% at highest. The cost of buying and selling
assets is not considered in this study. Cost of buying, keeping and insuring gold is not considered either. Another assumption in the portfolio analysis is not allowing negative position in an asset (shorting the asset). The impact of leveraging on the assets in the portfolio is not considered as well. Normally, financial institutions provide credit on the assets as security. Investors can take these credits and build up the portfolio further. This is, however, not considered within the portfolio analysis of this study.
2 LITERATURE REVIEW

2.1 The History of Gold

The Latin name for gold is Aurum which means “shining down” (Cartwright, 2014). Gold is the most precious metal that has been used in the production of coinage, jewellery, sculptures and decoration of buildings (World Gold Council, 2016). Gold has been perceived as a symbol of immortality and power as it does not corrode. Its aesthetic qualities and rarity made gold precious and demonstrated position and power (Cartwright, 2014).

As early as 550 BC, gold was used as coinage and stamped by images of leaders like kings. The first gold coins were made after an order from King Croesus of Lydia (Cartwright, 2014). The high value of gold has enticed many people since its value was understood. Since the time of King Croesus, gold coins have circulated as currency in many countries until paper money was introduced. Even in the late 19th Century, most of the major currencies in the world were fixed to gold (World Gold Council, 2016). Until today, around 175,000 tons of gold has been mined (World Gold Council, 2016).

2.2 The Importance of Gold as Currency

Gold’s importance has been discussed in abundant literature and researches like Cammarosano (2014), Erb and Harvey (2013) and Wang (2012). Gold could take the form of currency; it embraces its intrinsic value as well as the legal tender (Cammarosano, 2014). Therefore, confidence to invest in this precious metal has always existed. Russell (2009) argues that confidence in gold is growing due to unsupported paper currencies and uncertain monetary policies. As early as 1900, gold was the US Dollar’s single standard
under the Bretton Woods system, according to the International Monetary Fund (2008). The Bretton Woods system seemed to work until the 1960s. However, due to heavy deficits in the US economy, accelerated by military spending and Great Society programs, USD became noticeably overvalued. Hence, the US government started to dissolve the Bretton Woods system in 1968 and it was completely abandoned in 1973 (International Monetary Fund, 2008). After that time, the gold price was allowed to float freely against USD.

According to Jagerson & Hansen (2011), gold plays a vital role in the monetary system internationally and was considered a denominator for various currencies. Hence, the central banks have been showing their strength by holding reserves in gold. The central banks have, therefore, used their gold reserves in order to appreciate their currencies (Butler & Deaver, 1967).

US Congress exercised a bimetallic standard based on gold and silver as the nation’s currency in 1792 (Vronsky, 1997). At the time, gold was valued at USD19.30 for each troy ounce which is 31.1 grams. This price was revised up to USD20.67 in 1834 (Vronsky, 1997). In 1934, the president, Franklin Roosevelt, devalued USD against gold and that event raised gold price to USD35 per ounce (Vronsky, 1997). Thus, from 1934 until the time of this report (82 years later), gold has increased in value almost 33 times, which is equivalent to an annual yield of 4.36%. The gold return of 4.36% per annum can be considered modest by many investors today. Since 1934, gold price has been subject to high fluctuations both on the up and downside. The table below summarises some major key dates for gold price history (World Gold Council, 2016):

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>August 1971</td>
<td>US government decides to take USD off the gold standard scheme. At</td>
</tr>
<tr>
<td>Date</td>
<td>Description</td>
</tr>
<tr>
<td>--------------</td>
<td>-------------</td>
</tr>
<tr>
<td>August 1972</td>
<td>The US government devalued USD to 38 USD per troy ounce of gold. Most of the major countries in the world adapted to a floating exchange rate system in March 1973.</td>
</tr>
<tr>
<td>May 1973</td>
<td>United States government devalued USD once again and gold price rose to 42.22 USD per troy ounce.</td>
</tr>
<tr>
<td>January 1980</td>
<td>Gold price hits all-time high at 850 USD per troy ounce. The reason was an extreme inflation hike due to Soviet intervention in Afghanistan, strong oil price and the effect of the Iranian revolution. These factors prompted investors to opt for the precious metal as safe haven.</td>
</tr>
<tr>
<td>August 1999</td>
<td>Gold price fell to a decade low of 251.70 USD following the concern that central banks will sell their gold reserves.</td>
</tr>
<tr>
<td>October 1999</td>
<td>Spot gold price surged to a two-year high at 338 USD. This was due to an agreement made by 15 major European central banks in order to limit gold sales.</td>
</tr>
<tr>
<td>February 2003</td>
<td>Gold price surged to a 4-year high as a result of investors buying gold in the run-up to the Iraq conflict.</td>
</tr>
<tr>
<td>January 2004</td>
<td>Gold price broke the 400 USD level. Investors felt more confident to increasingly buy gold as a hedge for portfolios.</td>
</tr>
<tr>
<td>November 2005</td>
<td>Spot gold price surged above 500 USD which was an important level from the investors’ point of view.</td>
</tr>
<tr>
<td>April 2006</td>
<td>Gold prices reached the next target of 600 USD, an ounce which was</td>
</tr>
</tbody>
</table>
the highest since December 1980.

May 2006 Gold price surged to 730 USD. This level was the highest since January 1980. The price hike was due to funds and investors taking advantage of a weak dollar to invest heavily in all commodities.

June 2006 Gold price fell 26% to the level of 543 USD after speculators and investors opt for profit taking.

Nov 2007 Spot gold price peaked at 845 USD, which is a 28-year high for an ounce of gold.

Jan 2008 Gold price surpassed 900 USD a troy ounce and looked determined to reach the magical border of 1000 USD per ounce.

2008-2010 Gold price had its best upwards trend in these years and broke the all-time high price record frequently until it reached the highest in September 2011.

Sept 2011 Gold price reached the all-time high of 1920 USD. This is the highest value for a troy ounce of gold to date (April, 2016).

July 2015 Gold price fell more than 40% since the all-time high in 2011, to 1100 USD per troy ounce.

Table 2-1 Key dates for gold price from 1970 to 2015, Source: World Gold Council

2.3 Factors Affecting Gold Price

2.3.1 Gold and Inflation

Gold is believed to act as an efficient hedge against inflation by many scholars. By analysing data in the period of 1976 to 2005, Levin and Wright (2006) found that the
consumer price level in the US and the gold price were positively correlated. They concluded that the correlation was significant in the long-run. However, Levin and Wright (2006) also revealed that there are deviations prevalent in this correlation for the short-run perspective mainly due to credit risks, inflation volatility and fluctuations in the gold price. Co-integration regression techniques were used by Levin and Wright (2006) in order to obtain the main determinants affecting gold price. Besides the positive relationship between gold price and US inflation, they also found a significant negative relationship between price of gold and the US dollar. Levin and Wright (2006) suggested that the price of gold tends to increase when the US dollar depreciates. These results were coherent with findings from Gorton and Rouwenhorst (2006) and Ghosh, Levin, Macmillan and Wright (2002). A paper published by Ghosh et al. (2002) studied the price movement of gold against inflation. They analysed the gold price in USD in the period of 1976 to 1999 and explained that gold price moves in line with inflation in order to maintain the consumers’ purchasing power. Hence, gold is a hedge against inflation. Similar to the conclusion by Levin and Wright (2006), the study by Ghosh et al. (2002) showed this hedge is not valid for the short-term movements of gold price or inflation due to market volatility. In the same context, according to another study by Worthington and Pahlavani (2006), the long-term relationship between gold price and US inflation was concluded. They based their research on monthly data from the US market during the period of 1945 to 2006. The research method utilised by Worthington and Pahlavani (2006), had similarities to the one adopted by Levin and Wright (2006), which was based on co-integration regression technique. Both these researches found gold to be positively correlated to inflation. According to Ranson and Wainwright (2005), gold and other commodities hedge best when the inflation rate is
high. They also claim that gold is the best commodity for investment to hedge against inflation. They examined certain periods of high inflation in the UK and the US and presented that gold’s appreciation was substantially higher than inflation rates in these periods. Hence, investing in gold during periods of high inflation was encouraged by this study. Ranson and Wainwright (2005) also conducted a portfolio analysis and suggested having 18% gold in a bond portfolio that leads to long-term optimal yield.

Moore (1990) examined the return of gold investment in the period of 1970 to 1988 and showed an annual yield of 13.9% for the interval. This return was superior to the yearly return of bonds of 8.7% and 11.2% return of equities. The more interesting part of his study was defining signals to determine high and low inflation. Moore (1990) argues that if gold was bought when low inflation signal is alerted and sold at high inflation signals, a yield of up to 20% could have been achieved during 1970 to 1988. According to Mahdavi and Zhou (1997), gold price will indicate the market information sooner than the consumer prices. Hence, the gold price increases before the inflation hike emerges. Essentially, investors buy gold when they expect higher inflation on the horizon. Therefore, if the expected inflation climbs and value of money subsequently decline, gold will act as a proper hedge for the investors as per Mahdavi and Zhou (1997).

Another study provided by Adrangi, Chatrath and Raffiee (2003), claims that gold price has a positive correlation to inflation in both the long and short-term. This claim is, however, not supported by other literature.

By reviewing the literature, it can be concluded that inflation is one of the major drivers of gold price. Gold is a hedge against inflation, particularly in the long-run; positive correlation is prevalent. However, in the short-run, the volatility in the gold price makes the
correlation towards inflation insignificant.

### 2.3.2 Gold and Exchange Rates

As gold is priced in US dollars, the common understanding is that gold appreciates in price when the US dollar is devalued against other currencies and vice versa. By using data from 1971 to 2002, Capie, Mills and Wood (2004) analysed the movement of gold price against the US dollar and found significant negative correlation. As the US dollar lost value towards a basket of other currencies, gold price appreciated according to Capie et al. (2004). Therefore, the study concluded that gold can be used as a hedge against the falling US dollar. Similarly, Reboredo and Rivera-Castro (2014) and Reboredo (2013) analysed US dollar movement against other major currencies and found out gold can act as an effective hedge when US dollar depreciates. However, during extreme movements in US dollar, gold can be only considered as a weak safe haven (Reboredo and Rivera-Castro, 2014).

A study by Dooley, Isard and Taylor (1995) utilised empirical tests to find out the relation between gold price and exchange rates. The data was obtained for the period of 1976 to 1990. Then co-integration modeling with multivariate vector auto-regression was applied. The tests were done to determine the short and long-term impact of the exchange rate on gold price and vice versa. Dooley et al. (1995) tested the value of the USD against four other dominant currencies: Japanese Yen, British Pound, Deutsche Mark and French Franc. The tests revealed that as the USD lost value against these currencies, gold gained in the USD. Hence, they concluded a significant relation between gold and exchange rate.

Another study conducted by Kuan-Min and Yuan-Min (2010) tested gold price in Japanese Yen towards the Yen’s value in the market. They based their study on data from 1986 to
2007. Instead of measuring gold price towards currency value, they tested gold price against the Yen’s depreciation towards a basket of currencies. In their study, they set a threshold level to define high and low currency depreciation. This threshold was set to 2.6% based on the median of the collected data. Kuan-Min and Yuan-Min (2010) did separate tests of correlation of gold price for high and low depreciation regimes. They concluded that there is an obvious correlation between gold and currency depreciation when the depreciation level is high (>2.6%). However, for the lower depreciation, the correlation was not clear. Hence, Kuan-Min and Yuan-Min (2010) recommended buying gold when Yen’s depreciation is high to cover currency losses.

Sjaastad and Scacciallini (1996) studied the relation of gold and foreign exchange markets for the period of 1982 to 1990. They depicted that devaluations and revaluations of many currencies and particularly European currencies impact on the price of gold. Hence, they rejected the idea that gold price is influenced by only the USD’s depreciation and appreciation. Another finding was that half of the variance of gold price was actually due to fluctuations in the major currencies. A study by Fang, Fan and Lu (2012) verifies the result of other researches and claims that gold acts as an extremely important hedge against any currency especially when that particular currency is in turmoil. Sjaastad (2007) showed that the USD’s value towards Japanese Yen and Euro has a significant impact on the gold price in the USD. However, the exchange rates in gold producing countries like Australia, Russia and South Africa do not have the same level of influence on the gold price (Sjaastad, 2007). After studying the relevant literature, gold can act as hedge towards exchange rate and investors seek to the precious metal to cover for currency depreciation. Most of the studied literature also believe that since gold acts as an implicit currency globally, its value cannot
be simply determined, like any other commodity, by supply and demand relations.

### 2.3.3 Gold and Interest Rates

A study by Martin and Keown (1977) reported that gold price and gold related stocks are very sensitive to interest rate fluctuations. According to their study, there is a long-term negative correlation between interest rates, driven from treasury notes and gold price. This shows that gold depreciates if interest rate is increased. One of the reasons is that investors seek safe treasury notes rather than risky gold if the interest rate is high enough (Martin and Keown, 1977). Zafar, Urooj, and Durrani, (2008) depict same result from their study and claim that when interest rate is decreased, investors see very little incentive to invest in the treasury notes and flee to the equity market or commodities. Hence, gold is considered as an attractive investment during low interest rate periods as per their study.

Mishkin (1977) proved also that lower interest rates steer equities and precious metals higher. On the contrary, when interest rates are attractive, investors tend to stay in safe and risk-free debt market. At that time, investors rarely consider the equity market and precious metals (Mishkin, 1977).

### 2.3.4 Gold and Oil

There are several previous studies determining the relation of gold and oil prices. Cashin, McDermott and Scott (1999) examined the relations between prices of seven commodities during the period of 1960 to 1985. The empirical result of the research presented that there is significant correlation between gold and oil. They demonstrated co-movement of these two commodities in the long-run. Hunt (2006) clarified the relation between oil and
precious metals through inflation. Hunt (2006) argued that higher inflation will lead to increased price of oil and precious metals. Melvin and Sultan (1990) claimed that oil producing countries invest their excess capital in gold. Hence, if oil price is higher, they tend to buy more gold and push up the price of gold. Wang (2012) however, in an empirical analysis, could not find any obvious correlation between gold and oil. The study stretched over the financial crisis in 2008-2009 and during that period, no clear relation between oil and gold was present either.

Thus, based on the existing literature, over the long-term, there has been a positive correlation between oil and gold prices. However, due to the financial crisis, the relation is diminished.

2.4 Gold as a Hedge, Safe Haven or Diversifier

Gold’s potential as a hedging tool has been studied thoroughly in many researches and based on various markets. In this study, several of these literature were reviewed in order to answer the research question two. As per Baur and Lucey (2010) a hedge is a security that is negatively correlated or uncorrelated with equities and bonds in a long-run but a safe haven security is only negatively correlated or uncorrelated during market turmoil. If an asset is positively (but not perfectly) correlated to the portfolio, it is a diversifier (Baur and Lucey, 2010). Certain stocks, some currencies, sovereign bonds, precious metals and commodities may act as hedge or safe haven securities. Ranaldo and Söderlind (2007) found currencies like Japanese Yen and Swiss Franc as safe haven during the financial market stress. They argued that these currencies are not only a safe haven during stress but also act as hedge in normal periods. Hence, these currencies have hedging properties. Similarly, Kaul and Sapp (2006) depicted the USD as a safe haven security from late 90’s
for a couple of years.

Baur and McDermott (2010) claim that besides hedge against inflation, gold is a favourable investment during economic turmoil and financial crisis. Other studies by Harmston (2003) and O’Connel (2007) supported this idea and argued investors tend to have a higher proportion of gold during equity market stress periods. In the same context, Chua, Stick and Woodward (1990) presented that adding gold to a portfolio will reduce the risk and act as a diversifier.

Despite its importance, investment in gold is considered a risky venture, according to Hillier, Draper, and Faff (2006). They claim that although gold is an uncertain asset but the level of risk and return is independent of other investment instruments. Hence, gold is considered a good diversifier against other type of investments. This idea was supported by Jaffe (1998) and Chua et al. (1990).

On the contrary from Hillier et al. (2006), McCown and Zimmerman (2006) claim that gold possesses the properties of a “zero beta asset”. They imply that investing in gold should not incur any market risk. They support their claim by analysing gold spot rate during 1970 to 2003 and concluded that gold is a low-risk asset in the long-run. However, the claim from McCown and Zimmerman (2006), with regards to gold as risk free asset, is not supported by many other literature such as Hillier et al. (2006).

All literature, however, agree that as gold is priced in the USD and that the gold price rises when the USD depreciates. Literature from Capie, Mills and Wood (2005) and Hammoudeh, Sari and Ewing (2009) depict gold investment as a way to protect against USD devaluation.

Safe haven assets are predominantly attractive during extremely stressed market conditions
(Caballero and Krishnamurthy, 2008). During these periods, risky asset prices crash and shortage of liquidity enforce a chain-effect to plummet asset prices even further. Hence, investors flee to safe havens like precious metals and sovereign bonds. During the 2008 crisis, S&P 500 index shrank 55% from July 2007 until March 2009. Gold, however, gained 40% in value during the same period. Hence, Caballero and Krishnamurthy (2008) declared gold as a safe haven.

In the same context, Baur and McDermott (2010) believe that a hedge asset keeps its properties in average. However, the main property of a safe haven asset is that it is just required for certain periods, particularly in bearish periods and market turmoil. Hence, the main difference between a hedge asset and a safe haven asset is actually the length of the impact. Baur and McDermott (2010) claim that investors normally look for safe havens to reduce their risks during severe market conditions over a short period of time. Baur and Lucey (2010) define market crisis as periods of severe negative equity returns, whereas Baur and McDermott (2010) consider days of extreme volatility as well. The definition of these periods is important in a research in order to validate the safe haven property of an asset.

Baur and Lucey (2010) thoroughly studied gold’s characteristics in the bullish and bearish market conditions. However, they did not consider the impact of exchange rates in their analysis. Baur and Lucey (2010) studied the equity and bond markets of the USA, UK and Germany. Then they set gold as dependent variable and found the correlations towards those securities. Then, the daily data of gold, bond and S&P 500 indices were obtained. In order to verify gold’s safe haven property, the data sample was categorised into two sets with respect to bullish and bearish financial market situations. After analysis, Baur and
Lucey (2010) showed that gold has the capacity to mitigate the losses incurred in the equity and bond markets during market downturns. Therefore, they concluded that gold acts as a safe haven security. However, in the same study, Baur and Lucey (2010) could not verify gold’s role as a hedge in long-run or as diversifier. They added that gold’s safe haven property increases the financial market’s stability overall. This is due to the fact that investors’ losses during severe market crashes will be reduced and investors do not sell assets in panic. Hence, Baur and Lucey (2010) consider gold as an efficient safe haven asset with a great impact when it is mostly needed. Moreover, they believe, the more severe a market downturn is, the more beneficial it is to invest in gold. On the contrary to equity markets, Baur and Lucey (2010) did not find gold to be safe haven against bonds in the USA, Germany and the UK. According to their study, gold could be a weak hedge against bonds in Germany but not in the UK or the USA. The reason was that bonds in Germany showed a negative correlation towards gold but this phenomenon was not prevalent in the US or the UK (Baur and Lucey, 2010).

The study by Baur and McDermott (2010) embraced a multi-country analysis, using major developed and emerging markets. They collected data from 53 stock markets for a 30-year period from 1979 to 2009. Similar to Baur and Lucey (2010), a GARCH-type process was utilised with efforts to avoid autocorrelation and heteroscedasticity. This econometric methodology used the stock markets as independent variable and gold as dependent variable. Hence, the study looked for effects in the gold price caused by stock market changes. Three crisis periods were considered: Black Monday in October 1987, the Asian crisis in 1997 and the financial crisis led by Lehman Brothers bankruptcy and collapse of sub-prime loans in US during 2008. As a result of their study, Baur and McDermott (2010)
concluded that gold appears to be a (weak) hedge and a strong safe haven for the equity markets in developed countries. However, the same properties could not be observed for the stock markets of the emerging markets.

In a research by Ciner, Gurdgiev and Lucey (2010) performed a similar study on USA and UK markets impact on the gold price. They utilised an econometric method based on a quintile regression approach. In this methodology, gold regresses towards other assets such as bonds, equities, oil price and currencies. They used daily data during 20 years from 1990 to 2010. S&P 500 and FTSE indices represented the US and UK stock markets respectively. The 10-year sovereign bond from each country was used as the proxy for the bond prices. The study of Ciner, Gurdgiev and Lucey (2010) made the conclusion that gold can act as a hedge towards exchange rate fluctuations and that bond market is a hedge against the equity market. They could not make any statement with regards to gold’s properties as a hedge or safe haven against equity or bond markets in those 2 countries. In another study, Fang, Fan, and Lu (2012) determined gold’s value from three different perspectives. They argued that gold has currency value, commodity value and risk premium value. They utilised a vector auto-regression (VAR) model to find the relations between Commodity Research Bureau (CRB) index, Credit Default Swaps (CDS) spreads, USD index and gold price. U.S. Treasuries’ CDS spreads were used by Fang et al. (2012) as a proxy to evaluate gold’s sovereign risk premium. The research by Fang et al. (2012) depicted that there exists a positive correlation between gold’s default risk premium and U.S. Treasury CDS (Credit Default Swaps) spreads. This correlation is highly positive and obvious particularly in the financial crisis. It means that when risk of default in the market increases, investors flee to gold and this could be a safe haven property.
Gorton and Rouwenhorst (2006) also demonstrated the positive return of the commodities and particularly precious metals during market crisis and claimed gold as a safe haven. Jaffe (1989) argues that gold is considered as hedge towards both inflation and stock losses. Jaffe (1989) showed that having gold in the portfolio reduces the risk and variance of the portfolio although the return may only increase marginally. Johnson and Soenen (1997) define gold as a diversifier, which makes the investors’ portfolio robust and more stable. Joy (2011) explained in his study that there is no evidence that gold can be considered as an efficient and solid safe haven. However, in a long-run, gold is definitely a hedge against the USD (Joy, 2011). The later conclusion is consistent with several other literature studied in this paper.

The study by Ciner, Gurdgiev and Lucey (2010) showed that gold provides protection during periods with sharp declines in the typical asset classes, such as bonds and equities. Thus, gold could be called a safe haven (Ciner, Gurdgiev and Lucey, 2010). However, studies by Joy (2011) and Capie, Mills and Wood (2005) argue that gold cannot be considered a safe haven although it is an effective hedge. Baur and Mcdermott (2010) claim that gold’s safe haven property is only valid during short periods. Investors have to pick the time to enter and exit correctly in order to take advantage of gold’s properties.

There is a consensus in the studied literature that investment in gold mitigates the risk of steep losses in the turmoil market condition. In this study, gold’s hedging properties are studied in the research question three and the result is presented in the chapter 4.2.
2.5 Gold as an Asset in a Portfolio

In investors’ language, portfolio is a common and widespread term. Portfolio refers to the concept of diversification by investing in assets with diversified characteristics according to Chua et al. (1990). Portfolio theory provides investors ideas to reduce their risks by investing into several securities (Chua et al., 1990). By correct diversification strategies and reducing risks, investors increase their long-term profit. The impact of including gold into a portfolio has been examined by many scholars. In this thesis, some of the researches are reviewed with the purpose of answering to research question three.

Aggarwal and Soenen (1988) claim there exists positive and moderately weak correlation in the long-run between stock index and gold. This claim is however partly rejected by other scholars. McCown and Zimmerman (2006) advocate that the gold price’s relationship with equities is not significant. The significance of investing in gold in the investment portfolios has been subject for numerous studies for many years. Academics and financial analysts have tried to understand the role of gold as a diversifier in a portfolio (Ciner, 2001). The advocacy by many researchers is that gold reduces the variance and volatility of the portfolio. Hence the portfolio has less fluctuation risk and is more balanced (Ciner, 2001). According to Sherman (1982), gold embraces information about inflation, exchange rate and interest rate. Hence, investors choose to invest in gold when they are uncertain about market outcome. Sherman (1982) states gold is the international currency without any borders. Beside its diversification capacity, gold is always a liquid asset and can be exchanged to cash at any point of time (Sherman, 1982).

Both studies from Jaffe (1989) and Chua et al. (1990) argue that gold diversifies the portfolio. They claim prices of stocks and bonds, in the long-run, tend to evolve in the same
direction. However, gold is uncorrelated or negatively correlated with these assets. Hence, a portfolio with both equities and gold moves with less correlation to market condition, less risk and more stability.

Sumner et al. (2010) also emphasises the importance of diversification and refers to investment portfolios that did use gold as hedge or safe haven. Lawrence (2003) showed same result in their study as Sumner et al. (2010) based on the quarterly data analysis from 1975 to 2001. Lawrence (2003) found that gold price and equities were uncorrelated during that period. Hence, he concluded that gold is a good diversifier towards equities and bonds in a portfolio. Hence, including gold in the portfolio would be beneficial for the investors. Moreover, Lawrence (2003) checked the diversification property of several consumption commodities such as copper, oil and zinc. He tested whether other commodities are able to diversify a portfolio as well as gold. However, he found out that gold is less dependent on the business cycles than other commodities. Hence gold’s property as diversifier was superior. Lawrence (2003) concluded that gold’s correlation towards equities is clearly lower than the correlation of other commodities such as oil against equities whereby other commodities are not as good diversifier as gold.

The study by Chua, Stick and Woodward (1990) highlighted the importance of finding the correlation coefficient between the stocks and gold. By determining this coefficient, investors can construct their desired portfolio with an adequate proportion of each asset. The portfolio will then perform and provide yield based on the defined risk ratio.

The literature survey conducted by Hillier et al. (2006) examined importance of precious metals and particularly gold in the financial markets. They investigated the advantage of adding an investment in S&P 500 index with silver, gold or platinum for the period of 1976
to 2004. Hillier et al. (2006) stated that the performance of portfolio was improved irrespective which of those three precious metals were inserted to the portfolio. However, the authors found out that gold provides the highest yield and benefit among the tested precious metals while silver performed worst. Additionally, Hillier, Draper, and Faff (2006) claim investors should change their investment strategy if a market recession is in the horizon by supplementing gold or other precious metals in the portfolio. As per their study, investors should hold onto the precious metal until the equity market can gain confidence within investors.

Jaffe (1998) and Chua et al. (1990) have performed several studies with regards to gold’s performance. They consider gold as a risky and unpredictable investment. One reason is that the investor cannot benefit from any annual return, dividend or coupon payment while investing in gold. Hence, if gold does not appreciate in value, it can be considered as a lost opportunity. However, Chua et al. (1990) claim gold is an efficient diversifier for portfolios. They tested the beneficial values of diversifying portfolios with gold related investments and realised a clear diversifying effect when gold was added. Chua et al. argued that gold is a diversifying instrument during both short and long-term portfolio management. This was due to the fact that the beta of gold price kept fluctuating around zero during 1970’s and 1980’s. Jaffe (1989) utilised data during the period of 1971 to 1987 and constructed four different portfolios. The main difference in these portfolios was the accepted risk and yield. Jaffe (1989) stated that a portfolio with as little as 5% performed better in terms of return comparing to those not having and gold. Moreover he found out that a portfolio with 10% gold improved the return even further. In case a portfolio is held for the entire simulation period, Jaffe (1989) claims 9.5% gold provides the optimal return.
He also emphasised about importance of having gold during the market downturns. According to the study by Lucey and Tully (2005) adding gold definitely increased the probability of creating an optimal investment portfolio. They argued that selection of assets like equities, bonds and commodities, their correlation and horizon of the analysis are important factors to construct a portfolio. This statement is supported by several other empirical studies. Among others, Lucey, Tully and Poti (2003) study the asset allocation and portfolio diversification by skewed return. They find out the importance of gold in terms of achieving optimal portfolio.

According to Coudert and Raymond (2010) one of the advantages of gold compared to other commodities is the liquidity of gold. Banks accept gold as security and provide credit based on the current value. Hence, gold, compared to many other investments offers peace of mind to investors in the anxious periods.

After studying the above literature, it is realised that diversifying the investment portfolio by deploying gold is recommended by the existing scholars. The issue is rather when to invest in gold and when to exit. Furthermore, investors have to know what the appropriate gold allocation is. Finally, it is not clear how investors should invest in gold as there are many different gold investment instruments available in the market. The portfolio allocation strategies are studied in this thesis and the result is shown in the 4.3.

### 2.6 Gold’s Supply and Demand

The existing literature show quite different views of the impact of supply and demand on the gold price. Although some studies suggest that supply and demand of physical gold
affect the gold price, many analysts and researchers have argued the opposite. This study has reviewed the existing literature about the gold’s supply and demand thoroughly. The reason was to find out whether supply and demand factors have to be analysed as a part of research question one where gold’s determining price factors are studied.

The study conducted by Ghosh et al. (2002), concentrated on the impact of supply and demand on gold price in both short-term and long-term. The result of their study unveiled that short-run demand and supply do not have any significant impact on the gold price. However, in the long-run, demand and supply affect the gold price. More demand from the central banks and jewellery market pushed the gold price up in the long-run whereas sales from central banks and higher gold production reduced the gold price. This finding was in line with the result of research by Wang (2012). The statistics given by World Gold Council (2015) verified that the change in the gold price during 2009-2011 was predominantly due to higher demand from central banks. There are however studies that do not fully agree with the findings from Wang (2012). For instance, recent analyses by Blumen (2013) and Radomski (2015) strongly reject the impact of supply and demand on the gold price.

In summary, the existing literature gives the impression that supply and demand do not have any major impact on the gold price in the short-run. In the long-run, although there might be relations prevalent, but it is quite difficult to distinguish the impact of supply and demand from other factors like inflation. In this thesis, the supply and demand of all relevant sectors are examined to verify their influence to the gold price.

As per World Gold Council, gold is supplied by mining companies and recycling. Gold is purchased to be used within technology, as coin or bars by investors, in jewellery industry
and by central banks. The following table shows the amount of gold supplied and demanded by each sector in 2014:

<table>
<thead>
<tr>
<th>Supply (2014)</th>
<th>(metric Ton)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mine production</td>
<td>3133.5</td>
</tr>
<tr>
<td>Recycling</td>
<td>1168.9</td>
</tr>
<tr>
<td>Total</td>
<td>4302.4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Demand (2014)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Jewellery</td>
<td>2485.3</td>
</tr>
<tr>
<td>Technology</td>
<td>346.5</td>
</tr>
<tr>
<td>Central banks</td>
<td>590.5</td>
</tr>
<tr>
<td>Bar and coin investments</td>
<td>1004.4</td>
</tr>
<tr>
<td>Total</td>
<td>4426.7</td>
</tr>
</tbody>
</table>

Table 2-2 Gold’s supply and demand in 2014, source: World Gold Council

The following graphs show the percentage of each sector in supply respective demand:
Graph 2-1 Gold demand in 2014, Source: World Gold Council

![Gold Demand Graph](image)

Graph 2-2 Gold supply in 2014, Source: World Gold Council

![Gold Supply Graph](image)

Basically only mining production adds to the total gold stock in the world and other sectors do not increase the actual amount of existing physical gold. As gold is not consumed in any industry and is always retrievable, the total amount of physical gold is continuously increasing. There are five main sectors that impact the supply and demand of gold which are mining companies, technical industries, jewellery industry, gold investors and central banks. These sectors affect the gold’s supply and demand in different ways. The list below summarises the buying and selling behaviour of the each sector within gold industry:

<table>
<thead>
<tr>
<th>Sector</th>
<th>Buying</th>
<th>Selling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mining companies</td>
<td>They don’t buy</td>
<td>All produced gold will be sold to the market</td>
</tr>
<tr>
<td>Technical Industries</td>
<td>Mainly for electronics and dentistry</td>
<td>Recovered scraps are sold to the market</td>
</tr>
<tr>
<td>----------------------</td>
<td>-------------------------------------</td>
<td>----------------------------------------</td>
</tr>
<tr>
<td>Jewellery</td>
<td>Buy raw gold to make jewellery</td>
<td>Scrap jewellery is sold back to the market</td>
</tr>
<tr>
<td>Investor</td>
<td>Increase the gold in the portfolio</td>
<td>Reduce the gold in the portfolio</td>
</tr>
<tr>
<td>Central banks</td>
<td>Increase the gold reserve</td>
<td>Reduce the gold reserves</td>
</tr>
</tbody>
</table>

Table 2-3 Buying and selling behaviour of gold in different sectors

In the following chapters the impact of each sector on gold’s supply and demand is studied.

2.6.1 Impact of Mine Production

As gold is not destroyed like other commodities such as oil, almost all produced gold is available and held intact in some form. The yearly mine production of gold, only accounts for around 1% of the total available gold (Sieron, 2015). Hence, the yearly mine production cannot possibly have a major impact on the total supply and is practically negligible. Therefore gold cannot be regarded similar to other commodities and should be considered as a monetary asset. Because the total available gold is much larger than the annual mine production, it can never possibly fall into supply deficit. The economic value of other commodities is obtained by being consumed. For instance Copper is consumed to build water pipes and Coal is burnt in the power plant. These commodities are transformed irreversibly and the original raw material is consumed and destroyed forever. In case of gold, jewellery, bars and coins may at any time be recycled back to the original gold. Therefore, events that can hamper the mine production such as strikes and failed new
discoveries will not impact the price of gold (Sieron, 2015). As the amount of gold possessed by the incumbent owners is extremely higher than the mine production, the impact of the production is considered insignificant. The following chart shows the average gold price against mining production from 1997 to 2014.

![Graph 2-3 Mining production and average gold price since 1997, Source: World Gold Council](image)

If gold price, like other commodities were following the production supply, increased supply would have decreased the gold price. However, from 2008 to 2012, despite the increment in mine gold production, the average price went up as well. Some analysts advocate that the appreciation in gold price during 2008 to 2012 encouraged the mining companies to produce more. However higher gold production from mining did not affect the gold price negatively (Sieron, 2015).
2.6.2 Impact of Technology Gold Consumption

The electronic companies are the main consumers of gold after the jewellery industry. In 2014, around 8% of gold demand was from the technology sector (World Gold Council, 2016). This amount is extremely low compared to the total stock of available gold. Hence, technology sector consumption may not have any impact on the gold price (Sieron, 2015). The following chart shows the relation between the average gold price and the technology sector gold demand during the period 2002 to 2014:

Graph 2-4 Technology demand and average gold price since 2002, Source: World Gold Council.

As it is shown in the chart, during the periods 2007-2009 and 2010-2012, the gold price was actually increasing despite the decline in the gold demand from the technology sector. Hence, technology driven demand’s impact on the gold price is not prevalent.
2.6.3 Impact of the Jewellery Industry on Gold Demand

There are many articles that claim gold price can be pushed higher or lower by the jewellery demand from countries like China and India (OByrne, 2015). For instance, due to the foreseeable jewellery demand, mainly from Asia, the price of gold may double. However, studying the gold demand driven from jewellery industry against the gold price, such impact is not proven. The chart below shows this relation during the period of 1997 to 2014:

![Graph 2-5: Jewellery demand and average gold price since 1997](source: World Gold Council)

As the chart shows, during the periods of 2001-2003, 2005-2009 and 2010-2013, the demand for gold from jewellery industry declined despite the increasing gold price. Once again, the reason is that the jewellery demand is quite small compared to amount of
available gold (Sieron, 2015). Many analysts support the idea that lower gold price encourage people to buy more jewellery and higher gold price repel them (Sieron, 2015). Thus, higher jewellery demand cannot impact the gold price positively.

### 2.6.4 Impact of Central Banks on Gold Demand

There are contradicting literature and articles about the central banks position with respect to gold investment. While some paint a black picture of the situation, there are others like the World Gold Council which are quite bullish about the trend. According to the World Gold Council (2016) the behaviour of Central banks with regards to gold has shifted fundamentally over recent years. As it is shown in the graph 2-6, central banks’ gold demand was negative and they were net sellers until 2010. Hope (2009) argues that the central bank of UK sold more than half of its gold reserves during the period of 1999 to 2002 and this action may have had negative impact on the gold price. However, the trend has changed since 2010. Gold purchased from central banks accounted for 14% of the total gold demand in 2014 compared to 2% in 2010 (World Gold Council, 2016). This is a reflection of large purchases from emerging markets in the Middle East, Latin America and Asia. At the same time, the sales from the central banks in Europe have slowed down (World Gold Council, 2016). In the Central bank’s reserve management, gold plays a distinct role to diversify the portfolios (World Gold Council, 2016). Ogg (2015) interprets the data from World Gold Council in a negative way. Only five nations added to their gold reserve significantly in the first half of 2015 (Ogg, 2015). Countries like Russia, China, Jordan, Mongolia and Kazakhstan added to their gold reserve while Turkey reduced their portion of gold (Ogg, 2015). There is a market sentiment, due to falling gold price from 2011 to 2015 that makes central banks not opt for more gold in their reserves (Ogg, 2015).
On the other hand, Van der Walt and Larkin (2015) wrote an article in Bloomberg.com, stating that gold purchased by central banks in 2014 was 17% higher than previous year. In 2014, the central bank’s total amount of investment in gold was estimated to be 19.4 Billion USD (World Gold Council, 2016). Van der Walt and Larkin (2015) argues that there is a change in market trend and central banks are likely to invest more in gold in comparison to two decades of net selling. Hence, they support the statements from World Gold Council (2016) for more gold investment from central banks. Russia’s central bank is one of the main buyers of gold. However, gold is only 12% of their foreign reserve, as compared to US and Germany that have up to 70% of their reserve in Gold (World Gold Council, 2015). Jamasmie (2016) claimed that the central banks of China and Russia need to buy more gold to reach same diversification level as US and Germany. Despite, new gold purchases by the central bank of China in the recent years, gold still accounts for only 1.7% of their foreign reserves (Jamasmie, 2016). The graph below, based on data from World Gold Council, shows the ten nations with the largest amount of gold in their foreign reserves:
Graph 2-7 Ten nations with the largest amount of gold in their foreign reserves, source: world gold council (2016).

The actual amount of gold held by top 10 nations is given below:

<table>
<thead>
<tr>
<th>Nation</th>
<th>Gold Reserve (tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S.</td>
<td>8,134</td>
</tr>
<tr>
<td>Germany</td>
<td>3,381</td>
</tr>
<tr>
<td>IMF</td>
<td>2,814</td>
</tr>
<tr>
<td>Italy</td>
<td>2,452</td>
</tr>
<tr>
<td>France</td>
<td>2,436</td>
</tr>
<tr>
<td>China</td>
<td>1,709</td>
</tr>
<tr>
<td>Russia</td>
<td>1,352</td>
</tr>
</tbody>
</table>

Graph 2-8 Top nations in gold reserve, source: World Gold Council (2016)

Jamasmie (2016) predicts higher gold purchasing by central banks lead by Russia and China. But in another article Mukherjee (2015) claims that gold price could go further down. The Bullion Capital chief economist is cited by Mukherji (2015) saying: “Had it not been for China and Russia’s central banks buying cheap gold, the price would have gone below 1,000 USD an ounce.” Mukherji (2015) argues that diversification is the main reason for central banks to buy gold.

The main finding is that central banks of China and Russia are investing in gold in order to diversify their foreign reserves. How these purchases affect the gold price is uncertain though. The central banks’ gold demand analysis is more complicated than the other sectors (Radomski, 2015). They buy and sell gold based on the political decisions. Hence, their actions may not follow the trend of gold market. For instance, the accumulated gold
purchase from the central banks was negative from middle of 1989 until 2009 (World Gold Council, 2016). It means that the central banks were net gold sellers rather than buyers. Typically, central banks buy gold as national reserves and currency protection. They can also sell gold due to strategy changes. The following chart shows the relation between gold price and gold demand from the central banks during the period 1997 to 2014:


The right scale of the chart shows gold price and the left scale central banks demand. From 1997 to 2009, the central bank demand was negative. It presents that in these years, central banks were selling more gold than they were buying. However, gold price has been steadily rising since 2001. Hence, the chart above shows that central banks gold buying and selling cannot drive the price of gold. In 2014, when the gold price was declining, central banks
were actually net gold buyers as the demand is positive which is further proof that demand from central banks does not affect the gold price.

2.6.5 Impact of Gold Investors on Gold Demand

Blumen (2013) argues that investors’ preference with regards to holding gold is a major factor that sets the gold price. Each investor tries to maintain their desired holdings of the potential assets, including cash in the national currencies or the most traded currencies, such as the USD or euro. Normally, investors’ preferences change as the market situation alters. Hence, investors adjust the proportion of gold in their portfolios accordingly. These shifts of balance in a portfolio impact the gold’s price positively or negatively (Blumen, 2013). Hence, gold price are likely to go up if investors value the asset higher and are willing to pay higher prices. According to Blumen (2013), transactions continue until a new equilibrium is reached. Although investors’ actions impact the price of gold, their demand is not always the physical gold like gold coins and bullions. In this study, the ways of investment of gold are exhibited in chapter 2.9 whereby many of the ways are transactions of non-physical gold. Therefore, the total amount of physical gold held by investors does not change the gold price significantly (Blumen, 2013).

With reference to the studied literature and articles, the conclusion would be that gold cannot be analysed like other commodities. The supply and demand curves of the physical gold do not affect the gold price like other commodities either. The reason is a high stock to flow ratio of the gold, which means that the existing stock is much bigger than the yearly exploration and yearly sales of gold. Therefore, additional mining supplies or demand from central banks, jewellery industry or electronic industry can affect the price of this precious metal (Blumen R., 2013).


2.7 Gold Price Volatility

Gold price volatility, particularly in the recent years, was studied with the intention of answering the research question four where the gold price decline since end of 2011 is analysed.

2.7.1 Gold’s Upwards Trend Until 2011

Before the gold price started to fall in 2011, it enjoyed a bullish trend for more than ten years. Many analysts, despite reaching all-time highs, envisaged even more price appreciation (Vembu, 2011). Faber (2011) claimed that gold’s exponential price increment would continue due to two main factors. Firstly, FED would continue to print money in the Quantitative Easing scheme. This would increase the inflation fear that would push up the gold price (Faber, 2011). It was believed that the US would face the worst hyperinflation in the same way as the worst economies in the emerging countries (Faber, 2011). Secondly, printing money in the US would harm the USD against other major currencies, which would increase the gold price as well (Faber, 2011). Another factor that was mentioned by Vembu (2011) was that demand for physical gold would increase in line with the boosting economies in China and India. These two countries together are believed to stand for 50% of the physical gold demand in the world (Vembu, 2011). Hence, these analysts were forecasting gold price at 4800 USD in a so called “super-bull scenario”.

Jagerson and Hansen (2011) suggested that the reason behind gold price hike in 2008-2011 was because of excessive money supply by US government. Investors realised the huge deficits in the US economy and anticipated free fall for the USD. Forecasting fall of the USD encouraged investors to invest in precious metals, particularly in gold. The findings by Jagerson and Hansen (2011) were consistent with the result of research by Gulati &

Nguyen (2011) argued that the gold price would increase further due to the speculation that China would diversify their foreign exchange reserves by buying into the precious metal. Nguyen (2011) added that China had plans to invest a part of its 3 trillion USD of reserves in gold. A reason for this investment was the fear that USD will get weaker towards other currencies (Nguyen, 2011). As Chinese currency, RMB, is not traded freely outside China, the central bank keeps the reserves in major currencies like USD and gold. Fearing for weaker USD, encourages the bank to buy more gold and keep less USD (Nguyen, 2011).

By studying articles from 2011, the findings show that many analysts wrongly expected higher gold price. They did not anticipate growth in the US economy and low inflation.

2.7.2 Gold Price Plunge After 2011

After more than a decade of gain, gold price has had a downwards journey since the end of 2011 and the plunge has continued until 2015. The price drop has been quite dramatic in contrast to the price levels of 1900 USD per ounce in 2011 so that many investors believe that gold has lost its shine (Recknagel, 2013). Analysts that are trying to find factors behind the gold price drop, argue that low inflation is one of the culprits (Recknagel, 2013). When the inflation rates are high, people normally try to find alternatives to cash that will reduce their spending power. Hence, investing in Gold can be considered as an alternative during the high inflation periods. As the inflation rate, particularly in US and Europe, has been quite low after the financial crisis, investors tend to stay on cash or other assets rather than gold (Recknagel, 2013). The possible bubble in the gold price inflation factor against gold price was analysed by analytics such as Recknagel (2013) and Yousuf (2011) even before gold price plunged.
Yousuf (2011) quoted Lloyd Thomas, the economics professor at Kansas State University, that there were fears of a gold price crash. Thomas noted that historically inflation and gold price should move in parallel. However, from the year 2001 to 2011, gold’s price increased by 21% per annum against an inflation rate of only 2.4% (Yousuf, 2011). By analysing the historical data, Yousuf (2011) claimed that gold price is clearly in a state of bubble. Another reason for gold price crash was reducing the quantitative easing, QE, by the US Federal Reserve (Recknagel, 2013). Federal Reserve pumped money into the economy after the financial crisis in 2008. However, the QE was gradually reduced. Less money into the market would mean lower inflation leading to lower gold price (Recknagel, 2013). Indemar (2013) shared this view that cutting free liquidity to the market by FED would have negative impact on the gold price. Investors in this situation would not seek a hedge against inflation. Indemar (2013) also claimed that decreased QE would lead to stronger USD, which is also harmful to the gold price.

According to Recknagel (2013), Central banks’ decisions would also be affected by reducing QE. Central banks that feared high inflation and weak USD after the financial crisis increased their holdings in gold (Recknagel, 2013). However, as the economy in the US showed improvement, the fear was faded and central banks did not urge for increased gold possession (Recknagel, 2013).

Indemar (2013) argues that two other reasons have negatively affected the gold price. Firstly, due to falling gold price, investors prefer equity market rather than the precious metal. Equity prices have shown strength since gold price decline from the 2011 top level. Hence, investors have repositioned their portfolios to increase their return by selling gold and buying more equities (Indemar, 2013). Secondly, the fear for higher interest rate
impacts gold price negatively according to Indemar (2013).

From the studied articles by the analysts, the most frequent cited reasons for gold crash are low inflation, strong USD and cutting QE by Federal Reserve in US.

2.7.3 Why is Gold So Volatile?

There has been a myth within the circle of gold investors that implies gold is a safe investment (Shmuel 2014). However, the gold price trends in the past four years have proved the opposite. Thus, many analysts argue that gold is a highly volatile asset. Shmuel (2014) examined both macro and micro trends to find out the reasons behind gold price volatility. Besides the major factors, such as improved the US economy and reduced Quantitative Easing by FED, Shmuel (2014) referred to a three tier table of factors that impact gold price.

The impact of first tier events moves gold price by at least 1%, while tier two events tend to affect the gold price between 0.5% to 1%. The third tier moves gold price by a maximum of 0.5%. These three tiers, which are made by RBC Capital Markets, are shown below:

Tier one events include the US Federal Committee statements, the US GDP, non-farm payrolls, Congressional testimony and major speeches by Janet Yellen, Chair of the FED’s board, and Chinese physical gold import data.

Tier two events include U.S. weekly jobless data, Central Bank of Europe rate decisions and statements, employment data, the US retail sales, the US new house sales and housing starts.

Tier three events embrace many data points, including reports from countries beside G7, European and particularly German inflation data, Chinese economic data, US ISM (Institute of Supply Management) data and Producer Price Index in the US.
In the same context, Reik (2016) gave explanations for the volatility in gold price. Reik (2016) argued that gold’s volatility can be caused by the rebalancing of the financial system in US, fluctuations in the USD and fears for new recessions. The findings by Reik (2016) are that although gold is very volatile, other investments are volatile as well. Hence, investments in gold could be a good alternative in 2016. One of the factors that may help gold price hike is the nation debts in the US that could cause weakened USD and subsequently increased gold price (Reik, 2016).

2.8 Gold Volatility Index, GVZ

Gold volatility index was introduced by Chicago Board Of Exchange, CBOE, in 2008. This index is utilised while analysing research question four in this study. Since 1993, CBOE launched Volatility Index, VIX, for the stock market, currencies and commodities (CBOE, 2017). These volatility indices are known as “fear factors” among investors and practitioners (Rhoads (2013). The volatility index for gold is named GVZ by CBOE. GVZ is calculated by averaging the weighted prices of put and call gold options over quite a wide range of option strike prices (CBOE, 2017). The methodology which is developed by CBOE and Goldman Sachs has become a practical standard by financial institutes for trading and hedging volatility (CBOE, 2017).

According to Rhoads (2013), the gold volatility index spikes due to the fear factor within investors. A high fear factor normally leads to extreme movement in gold price upwards or downwards (Rhoads, 2013). The high level of GVZ can be due to investors’ “fear to buy” or “fear to sell”. The GVZ level higher than 30 normally triggers sharp price changes in gold (Rhoads, 2013).
An article by Mauldin Economics (2016) also claims that GVZ is a good measure of investors’ fear factor with regards to gold price. Every time GVZ is above 30 for a period of time, a steep gold price movement is expected six months later, according to the article. Luby (2009) analysed the relation between gold price and GVZ and found that GVZ represents investors expectation of the gold price in the future. As long as GVZ is below 30, gold price, with high probability, will continue in the same direction or stay stagnated with little fluctuations (Luby, 2009). GVZ higher than 30, however, may spark a change in gold price direction and extreme fluctuation after a certain period (Luby, 2009).

2.9 Ways to Invest in Gold

The total stock of gold in the world is worth about 9 trillion USD (Erb and Harvey, 2013). The market for gold can be basically divided into two markets, which are the physical and paper gold. In the physical market, investors buy gold coins and bullions, whereas in the paper market investors buy gold stocks, options and ETF’s. These two markets are closely related and follow each other (Jagerson and Hansen, 2013). Ways of investment in gold were studied in this thesis with the purpose of answering a part of the research question three. It is interesting for investors to find out “how” to trade with gold in the most advantageous way.

Historically, in the world of economy, gold has been used as a currency and it has always played a vital role in the major world currency systems (Jagerson & Hansen, 2011). Until 1973, the USD’s value was pegged to gold. Despite gold was not a monetary standard since 1973, but central banks and governments still maintained gold to support the paper currencies (Jagerson & Hansen, 2011). Among investors, gold has always been a
favourite security due to its liquidity and diversity characteristics.

There are several ways to invest in gold and, although the result might be the same, the best investment method may vary for different portfolios. Some of the most recognised ways of investing in gold are discussed in this chapter, as well as their advantages and disadvantages.

2.9.1 Physical Gold

Buying physical gold is the most traditional and well-known way to invest in gold. Investors can buy gold bars and gold coins that are offered in various sizes by the banks according to Caldwell (2015). The coins normally range from several grams to a couple of ounces, although gold coins of 10 ounces and bigger are also available.

Gold bars are much bigger than coins. A standard gold bar in the market is 400 troy ounces, which costs 500,000 USD (at a price of 1250 USD / ounce). There are bigger bars available for investment as well.

As per Alex (2013), the advantages of investing in physical gold are:

- Accessibility, investors can access the asset anytime.
- Liquidity, it can be exchanged with money without hassle. The spread on gold price is quite low, so investors won’t lose much on buying and selling gold.
- Tax exemption, some countries have exempted physical gold from GST and capital gain tax. However, US investors have to pay capital gain tax on gold.

There are also disadvantages of buying physical gold (Alex, 2013):

- Cost of storage and insurance, investors have to pay the cost of storage and insurance, which may be high in some countries.
- Mobility, it is not easy to move physical gold, in case the owner wishes that.
• No return while keeping, investors do not receive any dividend on gold. Hence, if gold price does not appreciate, the investor will not receive any return.

2.9.2 Gold ETF’s

Gold Exchange Traded Funds (ETF) are securities which are based on gold and follow the gold price exactly (MacBride, 2016). Buying gold ETF is just like buying any company share. The idea of ETF was to create an instrument to make several commodities available to investors, especially for small investors. Gold ETF’s generally offer a high level of transparency and low cost. Hence, gold ETF’s are favoured among the investors (Caldwell, 2015). Kennedy (2016) claims that the best way to invest in gold is investing in gold ETF’s. This is due to the simplicity of the trade, hassle-free asset and straight forward price relationship to physical gold. The ETF’s are designed in different ways for various purposes and different levels of risk taking. Some ETF’s appreciate when gold price increases, which means “long” position in gold. Some others move against the gold price, which is a short position in gold. If investors anticipate gold price rise, they opt for a long position and, if they think gold price will decline, they choose a short position. Some ETF’s are based on derivatives which are much more volatile when the gold price moves. Some favoured gold ETF’s in the market are the following (Alex 2013):

• **Long in gold**
  
  SPDR Gold trust (GLD), COMEX Gold Trust (IAU), DB Gold Double and Long ETN (DGP)

• **Short in gold**
  
  DB Gold Short ETN (DGZ), DB Gold Double Short ETN (DZZ) and Ultra Gold (UGL)
If an investor buys ETF’s that are designed to be long in gold, increasing gold price will result in profit. On the other hand, if an investor buys ETF’s that are structured to be short in gold, decreasing gold price will result in profit. Advantages of investing in gold ETF’s are (Alex, 2013):

- Easy to buy and sell and investors can buy any amount of security they wish.
- Investors can leverage the possession of ETF’s and increase the chances of profit.
- No cost of storage is involved.

There are also disadvantages of buying physical gold:

- Some ETF’s may be very volatile due to their structure, so investors have to be careful with their choice of ETF.
- ETF’s normally do not generate dividends. Other types of gold investments do not typically provide dividends either.

As buying ETF’s is the easiest way to invest in gold, ETF’s are very popular within investors (Alex, 2013). Many analysts like Kennedy (2016) and MacBride (2016) consider buying gold ETF’s as the best and most convenient way to pursue gold investment.

### 2.9.3 Gold Stocks

Many investors prefer to invest in gold stocks, which are predominantly companies in exploration and mining sectors (Wiggin, 2007). The main reason is the high percentage dividends given by some of them. Barrick Gold Corporation (ABX), Newmont Mining Corp. (NEM), Goldcorp Inc. (GG), Kinross Gold Corporation (KGC) and Gold Fields Ltd. (GFI) are some of the most known traded gold stocks (Alex, 2013).
Investors may buy these stocks directly, or alternatively buy the derivatives related to them (Caldwell, 2015). The derivative products, which are much riskier, consist normally of “call” and “put” options.

Advantages of investing in gold stocks are (Alex, 2013):

- Easy to buy and sell and investors can buy any amount of security they wish.
- Investors can leverage the possession of these stocks and increase the chances of profit.
- Some of these stocks provide high dividends.
- No cost of storage is involved.

There are also disadvantages of buying physical gold (Alex, 2013):

- Investors have to assess the company thoroughly before deciding to invest. Unlike physical gold and ETF, investors take two risks here, which are the gold price and the company itself.
- Some of these gold related stocks may not be liquid, especially during the bear market periods. Hence, investors may lose if they intend to sell in these periods.
- Investors may lose due to company’s miss-management, country-specific issues or geographical problems.

2.9.4 Gold Futures

Futures were one of the original instruments for investing in gold. These are exchange-traded contracts whereby the buyer agrees to take the gold delivery in future (MacBride, 2016). These contracts are standardised with a specific amount of gold at a pre-determined price on a delivery date. Normally, gold mine companies issue futures to guarantee their selling price in the future. Investors will make a profit if the gold price at the time of
delivery is higher than the future contract’s pre-determined price (Caldwell, 2015). Some of the most favourite gold futures are GC Gold, GVF Gold Volatility Index and MGC E-micro Gold.

Savvy investors with access to big capital can buy and sell futures for the same delivery date at different prices and make a safe profit. For instance, they can buy futures from mine manufacturers at lower prices and sell them to the jewellery industry (Alex, 2013).

Advantages of investing in gold futures are (Alex, 2013):

• Big investors can leverage on the arbitrage created between buy and sell price of futures and make a profit.

• In case the price of futures goes much higher than the current spot price, investors can simply buy gold, keep and deliver at the future date.

There are also disadvantages of investing in gold futures (Alex, 2013):

• This is not a game for small and novice investors, as some of the future contracts may be quite complex to understand.

Besides, the investment methods presented in this chapter, there are several other ways, for instance “mutual gold fund”, which is also a popular instrument among the big investors.

2.10 Gaps in Existing Literature

There are many existing academic studies about the gold price. While studying these papers, two major problems were faced. Firstly, the studies do not cover the gold price downturn after 2011. Most of the existing literature considers the gold price rise in the past decade and declares gold as a hedge towards the stock market. Secondly, the current studies do not consider investors’ behaviour factor, such as VIX fear factor, which is equally important to understand the fluctuations in the gold price.
There is an abundance of articles on the web about the gold price written by experts and analysts. Although many of them provide a very good insight into the characteristics, one should be careful about the objectiveness of these articles. The analysts and experts are often working for financial institutes. These investment firms, at the time of publishing the articles, may have long or short positions in gold. Hence, in order to protect their own position, they might advocate reasons to buy or sell gold.

This dissertation is done with the aim of covering the above mentioned gaps. The gold price after the 2011 downturn is properly analysed. The investors’ fear factor with respect to gold price is also considered and analysed in the research question four.
3 METHODOLOGY

3.1 General

This study will provide a thorough analysis of the impact of investing in gold. The main goal is to evaluate and answer the four research questions. The three first research questions will methodically analyse the characteristics of the gold price in the past 20 years until the objective of this study is obtained. In the fourth research question, by analysing the market events during 2008 to 2015, the massive gold price variation during this period will be examined.

Within the first question, an analysis will be carried out to establish what financial factors influence the gold price. In this part, the relationship between gold price and factors such as inflation, interest rate, currency exchange rate and other commodities like oil are tested. The idea is to verify whether gold is positively/negatively correlated or uncorrelated towards these factors. This analysis is important from the investors’ point of view to realise what factors may trigger the movement of gold price upwards or downwards. Hence, the appropriate period for investment in gold can be established.

In the second question, the relationship between gold price towards S&P 500 is tested. The correlation of gold to S&P 500 shows if gold can act as hedge, safe haven or diversifier. The analysis focuses on the events of extreme stock market conditions in order to find out whether investment in gold reduces the investors’ risks in such cases and to establish the right time to invest in gold.

The third question covers the analysis of a three assets portfolio, gold, S&P 500 and bonds. The objective is to create a strategy that shows how much gold should be allocated in a
portfolio. Normally investors are looking at strategies to maximise their returns at certain risk levels or minimise the risk given certain expected returns. The outcome of this part of study presents the allocation of each asset for the optimal portfolio.

Finally, the fourth research question will analyze the gold price movements during 2009 to 2015. The aim of the study is to relate the high price variation to the market events in the period. Hence, the sensitivity of the gold price towards various market events will be examined.

### 3.2 Data collection

#### 3.2.1 Data collection approach

In order to answer research question 1, potential financial factors that can influence gold price have to be identified. For this matter, the existing literature with similar context were studied and presented in chapter 2.3.

There are many scholars that claim gold is positively correlated to inflation, such as Levin and Wright (2006), Gordon and Rouwenhorst (2006) and Ghosh et al. (2002). They argue that investors move to buy gold during the time of high inflation in order to not lose the purchasing power. As gold is denominated in the USD, the strengthening and weakening of this currency will impact the gold price. Studies by Capie et al. (2004), Dooley et al. (1995) and many others have verified that if USD weakens, gold tends to go higher, and a stronger USD will push the gold lower.

Studies from Zafar et al. (2008), Martin and Keown (1977) and Mishkin (1977) argue that gold price decrease when interest rates are increased. The reason is that investors seek safe investments like treasury bonds, rather than gold, when the interest rate is high.
The relation between gold and oil price is studied by many scholars and the opinions are divided. Some older studies e.g. Cashin et al. (1999) claimed that gold and oil are positively correlated. However, newer studies like Wang (2012) did not find any clear relation between these two commodities.

Gold as an investment asset is always compared to other assets, such as equities and bonds (Baur and McDermott, 2010). Hence, investors are always looking into the relation of gold price return against returns from equities and bonds in order to make an optimum portfolio (Wang, 2012). Therefore, it is imperative to study whether changes in equities and bond prices impact the gold price.

After studying quite a number of existing papers, the potential contributing factors are selected such as interest rate, USD Exchange rate, S&P 500, bonds, inflation and oil price. There might be other factors that could be related to gold price. However, if a new factor is strongly correlated to any of the factors above, it may not improve the model. For instance, Consumer Price Index, CPI, might have a relation to gold price, but CPI is strongly correlated to the inflation factor. Hence, due to multicollinearity, the model will become inaccurate if both CPI and inflation are included in the model.

For research questions 2 and 3, the same variables as in research question 1 are utilised. In the research question 4, the gold volatility index, GVZ, is obtained from Chicago’s Board Option Exchange, CBOE. This index is measured based on market expectation on gold price movements in the coming 30 day period. The higher index indicates higher volatility and risk of sharp heavy gold price fluctuations.
3.2.2 Data collection sources and proxies

The following tables present the proxies and sources of data for each factor related to the research question one:

<table>
<thead>
<tr>
<th>Variable</th>
<th>Proxy</th>
</tr>
</thead>
<tbody>
<tr>
<td>The US Equities</td>
<td>S&amp;P 500 index</td>
</tr>
<tr>
<td>Bonds</td>
<td>Moody's Seasoned BAA Corporate Bond</td>
</tr>
<tr>
<td>USD Exchange Rate Index</td>
<td>Weighted USD exchange rates against a list of currencies</td>
</tr>
</tbody>
</table>

Table 3-1 Proxies used for research question one

S&P 500 is regarded widely as the best single proxy of the equities market in the US (S&P Dow Jones indices, 2016). S&P 500 includes 500 largest companies, in terms of market capital, from the leading industries in the US (S&P Dow Jones indices, 2016). As S&P 500 covers approximately 75% of the market capital of US equities, it is considered as an ultimate proxy for the total equity market (Zhao, 2016).

Moody's BAA Corporate Bond, which is also known as "Moody's BAA" is an investment bond that represents an index for the performance of all BAA rated bonds given by Moody's Investors Service (Zhao, 2016). Moody’s BAA is often used as a benchmark for bond investors interested in BAA rated company bonds. This index was chosen for this study, as the return of it is substantially higher than US treasury bonds which normally have low yields (Zhao, 2016). Sovereign Bonds issued by US government normally have extremely low returns. These bonds yield similar to the banks’ saving accounts or fixed deposits. Hence, the low yield bonds are not interesting investment objects for investors.

Moody's Seasoned BAA Corporate Bond generates relatively good (5% in April 2015)
return annually. According to AssetMacro (2016), BAA corporate bonds are stable bonds with little fluctuation. These bonds are popular with investors, due to low risk and higher yield than Sovereign Bonds.

As the proxy for USD Index, the weighted foreign exchange value of the USD against the major currencies in the world was chosen. This index is defined and measured by the economic research of Federal Reserve Bank of St Louis, USA. Broad USD index includes currencies from the Euro Area, Japan, Canada, Mexico, Taiwan, Hong Kong, Indonesia, Thailand, Argentina, Israel, Brazil, Korea, China, United Kingdom, Malaysia, Switzerland, Philippines, Australia, Chile, India, Saudi Arabia, Russia, Sweden, Venezuela, Singapore and Colombia (Zhao, 2016).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Link of the data source:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily oil price</td>
<td><a href="https://research.stlouisfed.org/fred2/series/DCOILWTICO/downloaddata">https://research.stlouisfed.org/fred2/series/DCOILWTICO/downloaddata</a></td>
</tr>
<tr>
<td>Interest Rate daily</td>
<td><a href="http://www.federalreserve.gov/releases/h15/data.htm">http://www.federalreserve.gov/releases/h15/data.htm</a></td>
</tr>
<tr>
<td>Inflation rate monthly</td>
<td><a href="http://inflationdata.com/Inflation/Inflation_Rate/HistoricalInflation.aspx">http://inflationdata.com/Inflation/Inflation_Rate/HistoricalInflation.aspx</a></td>
</tr>
<tr>
<td>S&amp;P 500 index daily</td>
<td><a href="https://research.stlouisfed.org/fred2/series/SP500/downloaddata">https://research.stlouisfed.org/fred2/series/SP500/downloaddata</a></td>
</tr>
<tr>
<td>Bond index</td>
<td><a href="https://research.stlouisfed.org/fred2/series/BAA?cid=47#">https://research.stlouisfed.org/fred2/series/BAA?cid=47#</a></td>
</tr>
</tbody>
</table>
Table 3-2 Link of data sources for research question one

| Daily USD Index, Daily | https://research.stlouisfed.org/fred2/series/TWEXBPA |

The data was collected from reliable websites, mainly published by the US government. For the gold price, the daily closing price was retrieved from the World Gold Council portal. For the oil price, the daily closing price was acquired from the economic research site of Federal Reserve Bank of St Louis, USA. The 20 years daily data for Bond Index, Moody’s BAA together with USD Index and S&P 500 Index were also obtained from the site of Federal Reserve Bank of St Louis, USA. Inflation data was collected from the US official website for inflation and consumer price indices. Daily interest rate data was acquired from the official website of US Federal Reserve.

To analyse research question two, daily data for the gold price and S&P index were collected using the same proxies employed in research question one.

Similarly, for the research question three, the daily data for the gold price, bond index and S&P 500 index were collected using the same proxies employed in research question one.

To analyse the research question four, the daily data for gold price and Gold Volatility Index were collected. The same proxies as in the research question one were used for the gold price: Gold volatility index, GVZ, is defined by Chicago Board Of Exchange, and CBOE. GVZ is calculated by averaging the weighted prices of put and call gold options over quite a wide range of option strike prices. This is measured by applying the VIX methodology to the gold price options (Chicago board options exchange, 2016). This index was introduced by CBOE on 2008 and data is available since then.
The variables and data sources are given in the table below:

<table>
<thead>
<tr>
<th>Variable</th>
<th>Link of the data source</th>
</tr>
</thead>
</table>

Table 3-3 Link of data sources for the research question four

### 3.3 Conversion of Non-Stationary Time Series

Before doing the regression model, it has to be examined whether the collected time series are stationary (Gujarati and porter, 2009). In other words, it is verified if autocorrelation exists in the time series.

Autocorrelation is explained as a mathematical representation, which shows the degree of similarity in a time series at a certain time to a lagged version of the same time series Chatfield (2004). If a time series is positively autocorrelated, then there is a tendency in the time series. Thus, the future values can be dependent on the past values. Autocorrelation generally complicates the regression analysis, as the coefficients will not be accurate. Hence, the model loses its prediction value. Therefore, to avoid autocorrelation, the time series for the dependent and independent variables have to be checked.

One way to detect if a time series is non-stationary is to make a graph of the time series to detect the trend. The time series are non-stationary if a trend exists (Gujarati and Porter, 2009). As this visual examination might be perceived as subjective, there are tests to verify the existence of autocorrelation. Two of these tests are AutoCorrelation Function, ACF test and Augmented Dickey-Fuller, ADF test that can be run on the data series (Gujarati and Porter, 2009). If case tests show that any data series are non-stationary, the data series must be transformed to stationary, as exhibited by Gujarati and Porter (2009).
As mentioned previously, the other way to check autocorrelation is by the Augmented Dickey Fuller (ADF) test. The ADF test can be done and the output shows whether data is stationary or not. The ADF test is left-tailed. In this test, the following hypothesis is prevalent:

\( H_0: \text{Autocorrelation is present in the time series} \)

\( H_1: \text{Autocorrelation is not present in the time series} \)

The null hypothesis of the ADF test means the data needs to be converted to become stationary. The time series that are collected for this study have to be tested to be stationary, or converted before being used in the regression analysis.

### 3.3.1 Checking the time series

There are several ways to detect if a time series is non-stationary. The non-stationary time series can be detected if a trend over the time is prevalent in the graphs. Graphs over the dependent and independent variables are shown below. The graphs are over the 20 years daily data.
Graph 3-1 Gold price in USD over the past 20 years

The figure above illustrates gold’s daily prices over 20 years. As it is shown, gold had a rather weak price development from 1995 to 2002. After that, gold’s price increased 9 years in a row with the exception of year 2009, due to the financial crisis. Gold price during these 9 years soared from 400 USD to a pick of 1900 USD in 2011. After 2011, gold price has been subject to sharp decline, seeing the price level falling towards 1100 USD. The graph is an obvious case of non-stationary time series. Hence, the data needs to be converted before it can be used in the regression model.
Graph 3-2 Oil price in USD over the past 20 years

The graph shows oil price movement in the past 20 years. After being at around 20 USD/barrel for several years, oil price increased tremendously during the period 2002-2007 and had a pick of 140 USD/barrel. Then the price declined back to 30 USD due to the financial crisis. It recovered back to 100 USD, but since 2014 began moving downwards again due to high market supply. The oil price graph shows a clear trend and is certainly a non-stationary time series.
Graph 3-3 Interest rate over the past 20 years

Interest rates in the US decreased after the IT bubble in the year 2000 but started to move up again to a level of 5% per annum. During the financial crisis, interest rates went sharply down to zero as part of a stimulus plan by American central bank in an effort to improve the economy. The interest rate was unchanged at zero until the end of the observation i.e. 30/9/2015. This time series shows obvious trends and is non-stationary.

Graph 3-4 US inflation over the past 20 years
This graph shows the daily inflation rate in the past 20 years. The time series does not show any trend and could well be stationary.

Graph 3-5 USD Index over the past 20 years

USD Index shows how USD has been valued compared to a basket of major currencies. The higher value indicates stronger USD. The graph shows a clear trend. After a dip during the financial crisis, USD has recovered and, since 2013, is on a strong movement upwards. This data series is certainly non-stationary.
S&P 500 index is used in this research as a proxy for the US stock market. During the past 20 years, S&P 500 has had two major turndowns i.e. the IT bubble in the year 2000 and the financial crisis in the year 2008. The trend in this graph is clear, hence the time series is non-stationary and needs to be converted.

Bond yield (%)
The graph above shows the bond return during 20 years. The graph reveals that the bond return soared prior to financial crisis, but after that was substantially lower due to low interest rates. This time series clearly is not stationary, as it has got a trend over the time. It is rather easy to detect a trend in all variables indicating non-stationary time series, apart from the inflation data.

In this study, ADF tests on the time series are carried out in order to verify if they are stationary. The result of ADF tests of all the variables is shown in the following table:

<table>
<thead>
<tr>
<th>Variable</th>
<th>Result of ADF test</th>
<th>Stationary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gold</td>
<td>Augmented Dickey-Fuller test statistic</td>
<td>t-Statistic -0.745 Prob.* 0.834</td>
</tr>
<tr>
<td>Bond</td>
<td>Augmented Dickey-Fuller test statistic</td>
<td>t-Statistic -1.512 Prob.* 0.528</td>
</tr>
<tr>
<td>S&amp;P 500</td>
<td>Augmented Dickey-Fuller test statistic</td>
<td>t-Statistic -1.435 Prob.* 0.567</td>
</tr>
<tr>
<td>Usd Index</td>
<td>Augmented Dickey-Fuller test statistic</td>
<td>t-Statistic -1.503 Prob.* 0.532</td>
</tr>
<tr>
<td>Interest Rate</td>
<td>Augmented Dickey-Fuller test statistic</td>
<td>t-Statistic -0.877 Prob.* 0.796</td>
</tr>
<tr>
<td>Oil price</td>
<td>Augmented Dickey-Fuller test statistic</td>
<td>t-Statistic -1.669 Prob.* 0.447</td>
</tr>
<tr>
<td>Inflation</td>
<td>Augmented Dickey-Fuller test statistic</td>
<td>t-Statistic -10.400 Prob.* 0.000 ***</td>
</tr>
</tbody>
</table>

Table 3-4 ADF test result

In order to interpret the ADF test result, the P-values (Probability) are checked which are highlighted in the table above.
The hypothesis is the following:

\[ H_0: \text{A unit root exists (non-stationary data)} \]

\[ H_1: \text{A unit root does not exist (stationary data)} \]

Hence, if \( P>0.05 \), \( H_0 \) is not rejected and data is non-stationary. If \( P\leq0.05 \), then \( H_0 \) is rejected by 95% confidence interval, which indicates stationary data. In the ADF test, our desire is to have \( P \) values lower than 0.05 in order to obtain stationary data time series. The result of the ADF test is consistent with the observations from the time series. It means that gold price, oil price, S&P 500, bond return, interest rate, inflation and USD index are all non-stationary data. Inflation data is, however, stationary time series.

### 3.3.2 Conversion of the time series to avoid autocorrelation

As per Gujarati (2009), the time series can be converted to eliminate autocorrelation. There are several methods to eliminate autocorrelation:

- using the difference to the first or second lag instead of the actual value
- Using the return instead of the actual value
- Using the Logarithm of the return instead of the actual value

As per Gujarati and Porter (2009), gold price, S&P 500, oil price and USD index are actual values and can be converted in the following way:

\[ X \rightarrow \frac{X - X(-1)}{X} \]

In this way, instead of the actual value, the return is used. \( X(-1) \) is the first lag or simply the value for the previous period. In this case, gold(-1) refers to the previous day’s gold price or the first lag. For interest rate and bond return rate, the first differences will be used, as their values are already presented in percentages (Gujarati and Porter, 2009).
\[ X \rightarrow X - X(-1) \] where \( X(-1) \) is the first lag of the time series

The table below shows the conversion table:

<table>
<thead>
<tr>
<th>Variable name</th>
<th>Conversion method</th>
<th>Variable name after conversion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gold</td>
<td>(Gold - Gold(-1)) / Gold</td>
<td>Goldr</td>
</tr>
<tr>
<td>Bond</td>
<td>Bond-Bond(-1)</td>
<td>Bondr</td>
</tr>
<tr>
<td>S&amp;P 500</td>
<td>(S&amp;P 500 – S&amp;P 500(-1)) / S&amp;P 500</td>
<td>SNPr</td>
</tr>
<tr>
<td>Usd Index</td>
<td>(UsdIndex - UsdIndex(-1)) / UsdIndex</td>
<td>Usdr</td>
</tr>
<tr>
<td>Interest Rate</td>
<td>InterestRate – InterestRate(-1)</td>
<td>InterestR</td>
</tr>
<tr>
<td>Oil</td>
<td>(Oil - Oil(-1)) / Oil</td>
<td>Oilr</td>
</tr>
<tr>
<td>Inflation</td>
<td>No conversion is required</td>
<td></td>
</tr>
</tbody>
</table>

Table 3-5 Variable conversion table

After these time series conversions, the ADF tests on the new time series were conducted.

The result of the ADF tests below shows that all new variables are stationary.

<table>
<thead>
<tr>
<th>Variable</th>
<th>ADF test result</th>
<th>Stationary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goldr</td>
<td>Augmented Dickey-Fuller test statistic</td>
<td>( t )-Statistic Prob.*</td>
</tr>
<tr>
<td></td>
<td>(-70.460) 0.000 ***</td>
<td>Yes</td>
</tr>
<tr>
<td>Oilr</td>
<td>Augmented Dickey-Fuller test statistic</td>
<td>( t )-Statistic Prob.*</td>
</tr>
<tr>
<td></td>
<td>(-72.191) 0.000 ***</td>
<td>Yes</td>
</tr>
<tr>
<td>Variable</td>
<td>Test Statistic</td>
<td>p-Value</td>
</tr>
<tr>
<td>----------</td>
<td>---------------</td>
<td>---------</td>
</tr>
<tr>
<td>SnPr</td>
<td>-76.273</td>
<td>0.000 ***</td>
</tr>
<tr>
<td>Usdr</td>
<td>-67.958</td>
<td>0.000 ***</td>
</tr>
<tr>
<td>Interestr</td>
<td>-37.212</td>
<td>0.000 ***</td>
</tr>
<tr>
<td>Bondr</td>
<td>-70.410</td>
<td>0.000 ***</td>
</tr>
</tbody>
</table>

Table 3-6 Result of ADF tests after variable conversions

If we apply the same hypothesis as before conversion, the H0 for the all time series can be rejected to favour H1. Hence, the time series are stationary and can be used for the regression model. It also shows that the conversion methods were effective.

### 3.4 Check for the multicollinearity phenomena

Multicollinearity occurs when two or more of the independent variables in a regression model are highly or moderately correlated. The existence of multicollinearity in the independent variables has to be addressed (Frost, 2013). This is a phenomenon that makes the regression model biased (Gujarati and Porter, 2009). After running multicollinearity...
tests, if such high correlation exists, one of the variables has to be omitted or replaced (Gujarati and Porter 2009). A correlation analysis between the independent variables reports the existence of multicollinearity. A correlation value > 0.5 or <-0.5 indicates strong correlation positively or negatively (Gujarati and Porter 2009).

Moderate multicollinearity may not be problematic (Frost, 2013). However, severe multicollinearity is a problem since it may increase the variances of the coefficient estimates. Thus, the estimates become very sensitive to the minor changes in the model (Frost, 2013).

In this study, as there are several independent variables in research question one, the risk of multicollinearity exists. Hence, it is imperative to test for multicollinearity prior to the regression analysis. A correlation analysis thereby is carried out on the independent variables to verify the existence of multicollinearity. The table below shows the result:

<table>
<thead>
<tr>
<th></th>
<th>OILR</th>
<th>SNPR</th>
<th>USDR</th>
<th>BONDR</th>
<th>INTERESTR</th>
<th>INFLATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>OILR</td>
<td>1.000</td>
<td>0.158</td>
<td>-0.239</td>
<td>0.134</td>
<td>0.000</td>
<td>0.103</td>
</tr>
<tr>
<td>SNPR</td>
<td>0.158</td>
<td>1.000</td>
<td>-0.176</td>
<td>0.205</td>
<td>-0.041</td>
<td>0.014</td>
</tr>
<tr>
<td>USDR</td>
<td>-0.239</td>
<td>-0.176</td>
<td>1.000</td>
<td>-0.037</td>
<td>0.006</td>
<td>-0.057</td>
</tr>
<tr>
<td>BONDR</td>
<td>0.134</td>
<td>0.205</td>
<td>-0.037</td>
<td>1.000</td>
<td>-0.008</td>
<td>-0.007</td>
</tr>
<tr>
<td>INTERESTR</td>
<td>0.000</td>
<td>-0.041</td>
<td>0.006</td>
<td>-0.008</td>
<td>1.000</td>
<td>0.010</td>
</tr>
<tr>
<td>INFLATION</td>
<td>0.103</td>
<td>0.014</td>
<td>-0.057</td>
<td>-0.007</td>
<td>0.010</td>
<td>1.000</td>
</tr>
</tbody>
</table>
Table 3-7 Correlation table for all independent variables for the entire 20 years period

As the correlation values are not > 0.5 or <-0.5, the table above does not show any high level of correlation between the variables. Therefore, it can be assumed that the risk of multicollinearity is low and all independent variables can be examined.

3.5 Check for Heteroscedasticity Phenomena

Tests of heteroscedasticity are also very important in the regression analysis. In the regression model, the error term has to be constant and uncorrelated (Gujarati and Porter, 2009). Otherwise heteroscedasticity will exist, which makes the result of regression model unreliable. Heteroscedasticity makes the standard deviation and t-statistics for the coefficients of independent variables inaccurate. Heteroscedasticity can be detected by Breusch-Pagan test (Breusch and Pagan, 1980).

In this study, the risk of heteroscedasticity is eliminated by adequate parameter setting while analysing.
3.6 Data Analysing Methods, Research Question One

3.6.1 General regression analysis

Research question one is: “What are the empirical factors that influence gold price?”

The objective is to find out which financial factors have more influence on the gold price during the past 20 years and in the distinct periods. In order to explore which factor(s) have more influence on the gold price linear regression analysis, an ordinary least squares regression model was used. The relationship between two or more variables is at the center of regression analysis (Kaw, 2007). The variable to be explained is the dependent variable and the variables that are explanatory are called independent variables. Regression analysis provides information about the relationship between the dependent variable and the independent variables, which are the predictors. When a regression analysis is done, the result is used to predict values of the dependent variable and identify variables that have the most impact on the response. The effect of each predictor variable is determined by statistical tests. These tests are done on the estimated coefficients of the independent variables.

A linear regression model is a linear relationship between dependent variable, \( y \) and the independent variables, \( x_i, i = 1,2,...,n \) of the form

\[
y = C + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_n x_n + \epsilon
\]

Equation 3-1 Common linear regression equation

Where:

\( \beta_1, \ldots, \beta_n \) are regression coefficients and

\( \epsilon \) is the error due to variability in the observed responses.
C is the intercept

Hence, in research question one, the response and predictor variables are used after their conversion, as explained in section 3.3:

Response Variable  Goldr

Predictors  Oilr, Bondr, Spr, USDr Interestr and Inflation.

After these tests, a data series will be used to test the regression model. The important outcome of the regression analysis is the value of the coefficient for each independent variable and the P value for each coefficient (Gujarati and Porter, 2009). The coefficients with high absolute value have more impact on the dependent variable, which reveals which independent variable is interesting in the model. The P value for each coefficient shows whether the coefficient is significant or not. If P-value<0.05, the coefficient is significant with 95% confidence interval and if P-value>0.05, the coefficient is not significant. Some literature argue that even if the coefficients are not significant, it is interesting to consider that independent variable (Gujarati and Porter, 2009). That is, due to the characteristics of the data series, an independent variable may be significant in some periods and not significant in other periods (Gujarati and Porter, 2009).

3.6.2 The time periods with high gold price volatility

In this research question, it is intended to find a model that covers the entire 20 years and the periods of special importance to the gold price. According to several articles, such as Carlson (2013), an asset with more than 20% price change per annum should be considered to be exceptionally volatile. This threshold is however subjective and other experts believe that besides the percentage of fluctuation, the length of period is also important.
During the past twenty years, there have been two periods where gold has been subject to tremendous changes. Firstly, during 2009-2011, after the financial crisis, gold price rose sharply from levels around 700 USD to 1900 USD. In those two years, gold price increased by more than 60% annually. After that period, the gold price went through a heavy decline until 2015 to levels around 1100 USD/ounce. In 2012 and 2013, gold price declined by more than 30% annually.

These two periods are highlighted in the graph below:

Graph 3-8 Gold price for the past 20 years

After the financial crisis, many investors fled to gold, as it was perceived as a safe haven. Gold price rose sharply to over 1900 USD/ounce. In years 2009 to 2011, the gold price more than doubled, which was quite uncharacteristic for the precious metal. In this research, regression analysis is carried out during those periods to check the relation between gold and independent variables.
3.6.3 Mathematical model for the research question one

In order to have a regression model that covers the entire 20 year period and the two distinct periods observed in 3.6.2, dummy variables have to be introduced. Dummy variables are normally categorical variables utilised in the regression analysis to signify subgroups of the sample. They are hence used to distinguish different groups in the observation data (Gujarati and Porter, 2009).

In order to distinguish the two extreme periods for gold price, as in 3.6.2, two dummy variables are hereby defined:

D1: to represent the period 2/1/2009 to 30/9/2011

This variable is set to 1 for the above period and to 0 for the rest of the observation period.

D2: to represent 2/7/2012 to 1/7/2015

This variable is set to 1 for the above period and to 0 for the rest of the observation period.

By including these two dummy variables, the regression analysis will provide the result for the entire period, as well as in those two extreme periods. By adding the product of dummy variables and each independent variable, the impact and significance of each independent variable during the extreme periods will be tested as well (Gujarati and Porter, 2009).

After inserting the dummy variable and their products with the independent variables, the model can be represented by the following equation:
\[ \text{Goldr}(t) = C + \beta_1 D1 + \beta_2 D2 + \beta_3 \text{Oilr}(t) + \beta_4 D1 \times \text{Oilr}(t) + \beta_5 D2 \times \text{Oilr}(t) + \beta_6 \text{Bonldr}(t) + \beta_7 D1 \times \text{Bonldr}(t) + \beta_8 D2 \times \text{Bonldr}(t) + \beta_9 \text{Inflation}(t) + \beta_{10} D1 \times \text{Inflation}(t) + \beta_{11} D2 \times \text{Inflation}(t) + \beta_{12} \text{Interest}(t) + \beta_{13} D1 \times \text{Interest}(t) + \beta_{14} D2 \times \text{Interest}(t) + \beta_{15} \text{Spr}(t) + \beta_{16} D1 \times \text{Spr}(t) + \beta_{17} D2 \times \text{Spr}(t) + \beta_{18} \text{Usdr}(t) + \beta_{19} D1 \times \text{Usdr}(t) + \beta_{20} D2 \times \text{Usdr}(t) + \epsilon \]

Equation 3-2 Regression analysis model for the research question one

The following table shows the definition of the parameters in the above equation

<table>
<thead>
<tr>
<th>Name of the parameter</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goldr</td>
<td>Return of gold</td>
</tr>
<tr>
<td>Bonldr</td>
<td>Return of bond</td>
</tr>
<tr>
<td>Interest</td>
<td>Changes in the interest rate</td>
</tr>
<tr>
<td>Spr</td>
<td>Return of S&amp;P 500 market</td>
</tr>
<tr>
<td>Inflation</td>
<td>Inflation rate (daily)</td>
</tr>
<tr>
<td>Oilr</td>
<td>Return of oil</td>
</tr>
<tr>
<td>Usdr</td>
<td>Changes in USD index</td>
</tr>
<tr>
<td>D1</td>
<td>Dummy 1, representing 2009-2011</td>
</tr>
<tr>
<td>D2</td>
<td>Dummy2, representing 2012-2015</td>
</tr>
<tr>
<td>C</td>
<td>Intercept</td>
</tr>
<tr>
<td>(\beta_1) to (\beta_{20})</td>
<td>Coefficients</td>
</tr>
<tr>
<td>(\epsilon)</td>
<td>Error term</td>
</tr>
</tbody>
</table>
Table 3-8 Definition of variables for the model of research question one

Result of the regression analysis is given in 4.1.

3.7 Data Analysing Methods, Research Question Two

Research question two is: “What are the empirical factors that influence gold price? Is investing in Gold a hedge, safe haven or diversifier against US equity market, S&P 500?”

Hence, gold’s hedge and safe haven characteristics against S&P 500 are studied. In order to verify whether gold is hedge, safe haven or diversifier, the definitions from Baur and Lucey (2010) are exercised. According to Baur and Lucey (2010):

“A strong (weak) hedge is defined as an asset that is negatively correlated (uncorrelated) with another asset or portfolio on average.”

Hedge normally does not necessarily reduce losses in the market downturns, because it is negatively correlated to the other assets “on average”. It means that it might be positively correlated to other assets during the market turmoil and negatively correlated during normal periods (Baur and Lucey, 2010).

A diversifier is defined by Baur and Lucey (2010) as:

“A diversifier is an asset that is positively (but not perfectly) correlated with another asset or portfolio on average.”

Diversifier, similar to the Hedge, may not decrease the losses in market downturns because the correlation is averaged over a period of time.

Baur and Lucey (2010) define the safe haven as:

“A strong (weak) safe haven is defined as an asset that is negatively correlated (uncorrelated) with another asset or portfolio in certain periods only, e.g. in times of falling stock markets.”
Hence, as the property of a safe haven asset is to be negatively correlated (uncorrelated) with a portfolio in severe market turmoil, it may compensate for a part of the losses (Baur and Lucey, 2010).

The regression model in this part of the study will have return of S&P 500 as the dependent variable and return of gold as the independent variable. By studying the result during the entire period, it can be established whether gold is hedge or diversifier for the stock market. Then, by focusing on the events on the severe market downturns, the safe haven property of gold will be tested.

3.7.1 Time Periods with High S&P 500 Volatility

It is interesting to find out the relation between gold and S&P 500 during the market turmoil. There are two predominant periods in the past twenty years where the equity market in the US went through extreme decline. These two periods are the so called IT-bubble in the early year 2000 and the financial crisis in the year 2008. These two periods with exceptional market downturn are selected, which are shown in the graph below:
Graph 3-9 S&P 500, 20 years data

In both of these periods, the S&P 500 declined by more than 30% annually. The stock market analysts agreed on the fact that these two periods were the most extreme downturn for S&P 500 in the past two decades. The following graph presents S&P 500 and Gold movements after the IT bubble.
The graph shows that while S&P 500 went down from 1500 level to 800, gold price has actually inclined. Therefore, it is probable that gold acted as a safe haven during that period. However, this needs to be verified in the regression analysis. The following graph presents S&P 500 and Gold movements after the global financial crisis.
Graph 3-11 Gold against S&P 500 after financial crisis

It reveals that while S&P 500 went down from over 1500 level to below 700, gold price has actually inclined despite fluctuations. It means gold could have acted as a safe haven during that period.

3.7.2 Mathematical Model for Research Question Two

Similarly to research question one, a regression model is deployed. The independent variable is return of gold and the dependent variable is the return of S&P 500. In order to account for the extreme periods, two dummy variables are introduced as well, like in research question one. These periods are chosen subjectively by analysing S&P 500 graph.

D3: to represent the period 1/5/2000 to 31/3/2002

This variable is set to 1 for the above period and to 0 for the rest of the observation period.
D4: to represent 31/10/2007 to 31/3/2009

This variable is set to 1 for the above period and to 0 for the rest of the observation period.

The regression analysis is done by utilising the model below:

\[ Spr(t) = C + \beta_1 D3 + \beta_2 D4 + \beta_3 Goldr(t) + \beta_4 D3 \times Goldr(t) + \beta_5 D4 \times Goldr(t) + \epsilon \]

Equation 3-3 Regression model, Gold against S&P 500

Definition of the parameters is given in the table below:

<table>
<thead>
<tr>
<th>Name of the parameter</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spr</td>
<td>Return of S&amp;P 500</td>
</tr>
<tr>
<td>Goldr</td>
<td>Return of gold</td>
</tr>
<tr>
<td>D3</td>
<td>Dummy 1, representing period after IT Bubble</td>
</tr>
<tr>
<td>D4</td>
<td>Dummy 2, representing period after financial crisis</td>
</tr>
<tr>
<td>C</td>
<td>Intercept</td>
</tr>
<tr>
<td>( \beta_1 ) to ( \beta_5 )</td>
<td>Coefficients</td>
</tr>
<tr>
<td>( \epsilon )</td>
<td>Error term</td>
</tr>
</tbody>
</table>

Table 3-9 Definition of parameters for the research question two model.

The value of the coefficients, the independent variable and the P value for the coefficient is important here. If coefficient is significant and negative, it shows that gold acts as strong hedge or safe haven towards S&P 500 (Baur and Lucey, 2010). A significant positive coefficient would mean that gold acts as diversifier (Baur and Lucey, 2010).
The P value for the coefficient shows if the coefficient is significant or not. Similarly to the regression analysis in the research question one, null hypothesis is desirable, which shows the coefficient is significant. The result of the regression analysis is given in 4.2.

3.8 Data Analysing Methods, Research Question Three

Research question three is: “What is the optimal allocation of gold, S&P 500 and bond in a portfolio based on US market data? When, how and to what extent should we invest in gold?”

3.8.1 Three assets portfolio construction

According to Badkar (2013), four aspects are important while constructing a portfolio. These are: security valuation, asset allocation, portfolio optimisation and performance measurement. In this study, the focus is on asset allocation and portfolio optimisation. For this purpose, Modern Portfolio Theory, MPT, will be utilised, as described by Elton, Gruber, Brown and Goetzmann (2007), which is based on Markowitz theory. The concept is to maximise the portfolio return at certain risk level or minimise the portfolio risk at certain expected return. In this study, the Tangent Portfolio method will be used on a portfolio based on S&P 500, bonds and gold price. The variance of each security is calculated and the Efficiency Frontier curve and Capital Allocation Line defined (Elton et al., 2007). Once the Capital Allocation Line is tangent to the Efficiency Frontier, the optimal allocation is established (Elton et al., 2007).
The optimum point is achieved when the portfolio variance is minimised according to Shiller (2012). In a three assets’ portfolio the formula for portfolio variance is:

\[
\text{Var} = x_1^2 \text{var}(\text{return}_1) + x_2^2 \text{var}(\text{return}_2) + x_3^2 \text{var}(\text{return}_3) + 2x_1x_2 \text{cov}(\text{return}_1, \text{return}_2) + 2x_1x_3 \text{cov}(\text{return}_1, \text{return}_3) + 2x_2x_3 \text{cov}(\text{return}_2, \text{return}_3)
\]

(\text{where} \sum_{i=1}^{3} x_i = 1)

Equation 3-4 Variance of the portfolio

In the formula, \(x_i\) are the weight of the assets, whereas \(\text{return}_i\) are the return of each asset. “Var” stands for Variance and “cov” for Covariance. The other condition is that sum of assets weights must be equal to 1.

While finding the optimum weight for each asset, one constraint was added, that the weight of each asset cannot be less than 0. In reality, investors can short an asset (negative possession) in the portfolio, but this option is not considered in the portfolio analysis.
3.8.2 Selecting the appropriate periods for the tests

This analysis can be repeated for the different periods to find out the optimal allocation for long-term and short-term investors, during bullish and bearish market conditions. The issue is that during the severe down/up turns for gold or S&P 500 the portfolio is heavily skewed. For instance, during the financial crisis, the optimum portfolio comprises 0% of S&P 500 and during gold downturn after 2011, the optimum portfolio does not have any gold. Hence, it is more appropriate to select periods without (or with less) extreme events. Otherwise, the result can be predicted without any analysis, which is meaningless. Another aspect is to test periods with different length and characteristics. By this way, the suitable portfolio for different periods can be found, which could be of interest for investors. By considering these factors, four periods were subjectively chosen to represent different durations and characteristics of the market environment.

Test 1) Period: 1/1/2004 – 31/12/2005

In this test, a portfolio was constructed on the three assets Gold price, Bond and Stocks for the period of years 2004 and 2005. The reason this period was chosen was that neither gold price nor S&P 500 had any high level of volatility and up/downwards trends. This test will provide investors with ideas for investment during a relatively calm market environment and without surprises.


The second test was carried out over the last 10 years to find out which portfolio would have been the optimal one for investors. Investors normally do not keep any certain portfolio for a period of 10 years and normally alters the assets and the proportion of assets
several times in a year. However, it would be interesting to find out how a long-term three assets portfolio could perform compared to short-term portfolios.

Test 3) Period: 30/9/2013 – 30/9/2015

The third test was done on the last two years of the data collection, 1/10/2013 to 30/9/2015. This period includes an extreme price decline for gold. As gold dropped heavily during this period, it is expected that the optimal portfolio does not contain any gold. However, this test is interesting for investors to make the correct decision when one of the assets in the portfolio is on the way down. It is important to rebalance the portfolio in such events to maximise the profit and/or minimise the risks.


It is also interesting to find out if the portfolio analysis during the shorter periods provides more useful information for the investors. In fact, most of the investors are looking at portfolios from a short-term perspective, which is less than six months, and after that, they tend to reposition their assets.

In this test, 3 months period during 1/4/2014 to 31/6/2014 was chosen. This particular period was selected, as both gold and S&P 500 had positive returns. Data for 63 days were used in this test.

The results of the tests are presented in 4.3.

3.9 Data Analysing Methods, Research Question Four

Research question four is: “What was the cause(s) of the sharp decline in gold price during the period of 2011-2015?”

Gold enjoyed an extreme price hike period during 2009 until the third quarter of 2011, followed by a downturn after the end of 2011. The market analysts are divided about
whether the all-time-high was justified and gold will aim for that again, or if that level was a bubble and the gold price corrected to a reasonable level.

In this part of the research, the price movement of gold during 2009-2015 will be analysed to find out the reasons behind these extreme price movements.

For this part of the study, two methods were deployed. Firstly, the accumulated return for gold price in the past 20 years was calculated and compared to bonds and S&P 500.

Secondly, the gold price volatility based on gold fear factor variable GVZ was analysed.

3.9.1 Reason 1: Price Bubble

A method to explore whether gold was overpriced in 2011 is to calculate the accumulated return for Gold against Equities and Bonds in the 20 year period. In this method, the daily return for S&P 500, gold and bond is measured and accumulated. Put simply, it measures how much return is accumulated in the course of 20 years. For instance, if an investor puts 100 USD in each asset and collects a daily return (which can be positive or negative). The formula used for Accumulated return is

\[
Acc_{\text{Return}}(t) = \sum_{n=1}^{t} Return_{n}
\]

Equation 3-5 Accumulated return

The idea is to understand the level of gold’s return in the past 20 years and find out if the price level in 2011 was justified or if it was a bubble. If the accumulated return of gold is substantially higher than its historical return in 2011, the probability of a bubble exists. If the accumulated return of gold in 2015 is far below the expected level, then gold price may have experienced a crash after 2011 and the price level at 1900 USD in 2011 probably was not a bubble.
3.9.2 Reason 2: Volatility

Gold’s volatility index from 2008 was collected from Chicago Board Option Exchange, CBOE. The volatility index is measured by VIX methodology, as explained in chapter 2.8, which is related to the market's expectation of gold price volatility. This index is also called the ‘fear factor’ amongst the investors. A high fear factor is an indication that many investors are considering changing their position in gold from “buy” to “sell” or from “sell” to “buy”. Hence, higher GVZ shows higher expectation of volatility and price fluctuation upwards or downwards.

According to Mauldin Economics (2016), gold price always reacts 6 months after GVZ, if GVZ is higher than a level of 30 for a period of time. This reaction may lead to higher or lower prices. Hence, the periods with GVZ higher than 30 are filtered out in this study and analysed. As GVZ data is not available prior to 2008, this analysis is done from 2008 onwards.

The graph below shows the Gold’s Volatility Index against gold price after the financial crisis:
Graph 3-13 Gold price against the gold volatility index

In the graph above, the blue line shows the gold price and the red line is gold’s volatility factor, GVZ. By observing the graph, there are two tops in the volatility index which show high fear factor within investors –, two periods with GVZ higher than 30 also contain these two tops. These two periods indicate that investors are likely to reposition the level of gold in their portfolio by selling or buying.

**Top 1**: the very high volatility occurred at the end of the year 2008 when the gold price was at 700 USD level. Investors, after the financial crisis, were looking into alternative assets as safe haven. The high volatility index shows that investors feared that gold would rise in value and therefore they bought more gold. The investors’ buying increased the gold price
and eventually reduced the volatility factor. It shows that high volatility factor has reversed
the price development of the asset

**Top 2**: this top occurred when gold reached the highest price at 1900 USD level in 2011.
The fear factor rose as investors anticipated that gold may be overvalued and may go down.
The graph shows that as gold price went down from 1900 USD, the volatility index went
down as well. It means that the gold price reduction was in line with market expectation.
Investor’s selling reduced the gold price and, again it is seen that high volatility index
changed the trend of the price movement. As the volatility factor went down, gold price
was also reduced from 1900 to 1600 USD/ounce.
As explained in chapter 2.8, when GVZ is higher than 30 for a period, gold price will react
6 months later (Mauldin Economics, 2016). This statement is tested while analysing the
research question four. The relation of GVZ and gold price can be determined by a
regression analysis in a similar way to research questions one and two. The dependent
variable is gold return and the independent variable is GVZ. One more parameter to
consider is that GVZ impacts on the gold return 6 months later as per Mauldin Economics
(2016). As 6 calendar months translates approximately to 120 days with available financial
data, the price level of gold with 120 days shift against GVZ is used as the dependent
variable in the regression analysis.
In order to account for the two aforementioned periods, two dummy variables are
introduced and included to the regression model.

**D5**: To represent the period 5/9/2008 to 20/4/2009

This variable is set to 1 for the above period and to 0 for the rest of the observation period.
D6: to represent 8/10/2011 to 11/21/2011

This variable is set to 1 for the above period and to 0 for the rest of the observation period.

The regression analysis is done by utilising the model below:

\[
Goldr(t + 120) = C + \beta_1 D5 + \beta_2 D6 + \beta_3 GVZ(t) + \beta_4 D3 \times GVZ(t) + \beta_5 D4 \times GVZ(t) + \epsilon
\]

Equation 3-6 Regression model for the research question four

Definition of the parameters is given in the table below:

<table>
<thead>
<tr>
<th>Name of the parameter</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goldr(t+120)</td>
<td>Gold return with 120 days shift ahead</td>
</tr>
<tr>
<td>GVZ</td>
<td>Gold volatility index</td>
</tr>
<tr>
<td>D5</td>
<td>Dummy 1, representing period before gold price hike</td>
</tr>
<tr>
<td>D6</td>
<td>Dummy 2, representing the period before gold price downturn</td>
</tr>
<tr>
<td>C</td>
<td>Intercept</td>
</tr>
<tr>
<td>(\beta_1) to (\beta_5)</td>
<td>Coefficients</td>
</tr>
<tr>
<td>(\epsilon)</td>
<td>Error term</td>
</tr>
</tbody>
</table>

Table 3-10 Definition of parameters for the research question four.

The result of the regression analysis is provided in 4.4.
4 RESULTS AND DISCUSSIONS

4.1 Result of Research Question One – Price Determining Factors of Gold

4.1.1 Regression analysis result

A regression analysis was done utilizing the methods given in 3.6. The following table shows the result of the regression analysis for the research question one. The important parameters are the coefficients and their respective P-values which show the significance of the coefficients. Return of gold is the dependent variable and the coefficients of independent variables are given below:

Dependent Variable: GOLDR
Method: Least Squares

Sample (adjusted): 10/03/1995 9/30/2015
Included observations: 4965 after adjustments

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>0.000</td>
<td>0.000</td>
<td>0.834</td>
<td>0.404</td>
</tr>
<tr>
<td>D1</td>
<td>0.000</td>
<td>0.001</td>
<td>0.619</td>
<td>0.536</td>
</tr>
<tr>
<td>D2</td>
<td>0.000</td>
<td>0.000</td>
<td>-0.642</td>
<td>0.521</td>
</tr>
<tr>
<td>OILR</td>
<td>0.024</td>
<td>0.007</td>
<td>3.664</td>
<td>0.000***</td>
</tr>
<tr>
<td>D1*OILR</td>
<td>0.056</td>
<td>0.019</td>
<td>2.954</td>
<td>0.003**</td>
</tr>
</tbody>
</table>
Table 4-1 Result of regression analysis, research question one

The result above is obtained by utilising the model given in chapter 3.6.3. Definition of the variables is given in the table below:

<table>
<thead>
<tr>
<th>Name of the parameter</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goldr</td>
<td>Return of gold</td>
</tr>
<tr>
<td>Bondr</td>
<td>Return of bond</td>
</tr>
<tr>
<td>Interestr</td>
<td>Changes in the interest rate</td>
</tr>
<tr>
<td>Spr</td>
<td>Return of S&amp;P 500 market</td>
</tr>
</tbody>
</table>
Inflation | Daily inflation rate
---|---
Oilr | Return of oil
Usdr | Changes in the USD index
D1 | Dummy 1, representing 2009-2011
D2 | Dummy 2, representing 2012-2015
$\beta_1$ to $\beta_{20}$ | Coefficients

Table 4-2 Definition of variables for the model of research question one

The R-square at 0.154 indicates that the independent variables explain 15.4% of the movement in the dependent variable. Coefficients with p-values below 0.05 are significant in 95% confidence interval.

The coefficients for dummy variables D1 and D2 are not significant as the p-values are far over 0.05, which is presented in the table below:

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1</td>
<td>0.000</td>
<td>0.536</td>
</tr>
<tr>
<td>D2</td>
<td>0.000</td>
<td>0.521</td>
</tr>
</tbody>
</table>

Table 4-3 Significance of the dummy variables

Thus, the returns during the two periods represented by D1 and D2 are not higher (positive coefficients) or lower (negative coefficients).

### 4.1.2 Relation of oil to gold

The coefficients and p-values for return of oil to return of gold are given in the table below:

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oilr</td>
<td>0.024</td>
<td>0.000 ***</td>
</tr>
</tbody>
</table>
Oil return has got a p-value <0.05 for the entire period, as well as during D1 period, but not in the D2 period. The coefficients for the entire period and D1 period are positive, which means that oil return is positively correlated to gold return in those periods. For the entire period, if return of oil is changed by 1%, it corresponds to 0.024% at the same direction for return of gold. For the D1 period if return of oil is changed by 1%, it corresponds to 0.056% at the same direction for return of gold, which is higher than for the entire period. Both coefficients are considerably low which means that return of oil does not have a big impact on the return of gold, despite significance.

4.1.3 Relation of inflation to gold

The p-values for the coefficients of inflation are higher than 0.05, as it is shown in the table below:

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>INFLATION</td>
<td>1.113</td>
<td>0.447</td>
</tr>
<tr>
<td>D1*INFLATION</td>
<td>0.074</td>
<td>0.988</td>
</tr>
<tr>
<td>D2*INFLATION</td>
<td>-1.158</td>
<td>0.763</td>
</tr>
</tbody>
</table>

It is therefore concluded that inflation does not impact the return of gold in these periods. The majority of the studied literature advocate that gold and inflation are correlated positively in the long run. The main reason is that if inflation goes up, gold price has to increase as well. However, the strong gold price development from 2009 to 2011 followed...
by the steep price downturn from end of 2011 has changed the scenario. Hence, the positive correlation between gold and inflation has diminished. The result of this study is in line with Yousuf (2011) that inflation and gold are not following each other in the recent years.

4.1.4 Relation of interest rate to gold

The result of the relation between interest rate and return of gold is presented here. The p-values for the coefficients of interest rate are higher than 0.05, as it is shown in the table below:

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTERESTR</td>
<td>-19.270</td>
<td>0.583</td>
</tr>
<tr>
<td>D1*INTERESTR</td>
<td>65.952</td>
<td>0.950</td>
</tr>
<tr>
<td>D2*INTERESTR</td>
<td>719.619</td>
<td>0.516</td>
</tr>
</tbody>
</table>

Table 4-6 Coefficients and p-values for interest rate to return of gold

Hence, interest rate cannot significantly affect the return of gold for these periods according to the model.

A number of studied literature suggest that the US interest rate is negatively correlated to the gold price. Thus, as interest rate declines, gold price increase. This is not proven in this study due to the latest gold price development. After the end of 2011, gold price went down and the US interest rate stayed at low levels as it was shown in the chapter 3.3.1. Hence, the correlation between these variables has diminished which explains the result of this study.

4.1.5 Relation of bond to gold

The coefficients and p-values for return of bond is shown in the following table
<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>BONDR</td>
<td>0.811</td>
<td>0.508</td>
</tr>
<tr>
<td>D1*BONDR</td>
<td>-10.202</td>
<td>0.000 ***</td>
</tr>
<tr>
<td>D2*BONDR</td>
<td>-5.837</td>
<td>0.085</td>
</tr>
</tbody>
</table>

Table 4-7 Coefficients and p-values for return of bond to return of gold

The coefficient is not significant for the entire period, as the p-value is higher than 0.05. However, during the D1 period (gold price hike), the bond return coefficient is significant. The coefficient is negative for this period, which shows bond return and gold returns are negatively correlated during this period. If the return of bond is increased by 1%, return of gold is decreased by 10.202%. The result is quite logical, since during the gold price hike period, gold return was always highly positive. However, as this period occurred after financial crisis and interest rates were going down, the bond returns were therefore negatively affected. Therefore, it can be concluded that returns of bond and gold moved in different directions during the gold price hike period, 2009 to 2011.

During the D2 period (gold price crash), the coefficient is not significant with 95% confidence interval, but it is significant with 90% confidence interval, as the p-value is lower than 0.1. There is a negative relationship between return of bond and return of gold during this period as well. If the return of bond is increased by 1%, return of gold is decreased by 5.837%. During this period, the return from gold price was negative, whereas the return from bonds was steady. This result matches the findings from quite a few of the reviewed researches, among others, Baur and McDermott (2010).
4.1.6 Relation of S&P 500 to gold

The S&P 500 variable has a p-value <0.05 for the entire period, as well as during D1 period, as it is shown in the table below:

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPR</td>
<td>-0.066</td>
<td>0.000 ***</td>
</tr>
<tr>
<td>D1*SPR</td>
<td>-0.103</td>
<td>0.004 **</td>
</tr>
<tr>
<td>D2*SPR</td>
<td>-0.003</td>
<td>0.957</td>
</tr>
</tbody>
</table>

Table 4-8 Coefficients and p-values for return of S&P 500 to return of gold

As the coefficient is slightly negative, it means that returns of the S&P 500 have a weak but negative impact on the return of gold in these periods. For the entire period, the coefficient is -0.066, which means that 1% changes in the return of S&P 500 will result in -0.066% changes in the return of gold. The coefficient was -0.103 during the D1 period. Thus, during the gold price hike, returns of the S&P 500 have a more negative impact on the returns of gold. This is reasonable, as lower S&P 500 returns encourage more investment in gold, which occurred after the financial crisis. The obtained results are coherent with the findings of Baur and Lucey (2010) and Baur and McDermott (2010).

4.1.7 Relation of USD Index to Gold

The USD index is negatively related to gold returns given by significant coefficients, as presented in the following table:

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>USDR</td>
<td>-1.359</td>
<td>0.000 ***</td>
</tr>
<tr>
<td>D1*USDR</td>
<td>0.180</td>
<td>0.180</td>
</tr>
<tr>
<td>D2*USDR</td>
<td>-0.396</td>
<td>0.017 *</td>
</tr>
</tbody>
</table>

Table 4-9 Coefficients and p-values for USD Index to return of gold

As gold is denominated in USD, this result is logical that weaker USD tends to increase the gold price and vice versa. This is supported by many studies, such as Wang (2012) and Dooley et al. (1995). For the entire period and D2 period (after the gold price crash) the coefficients are significant with p-values below 0.05. For the entire period, 1% changes in the USD index corresponds to 1.359% changes in return of gold and in the opposite direction. The coefficient presents that an increase in the USD index negatively impacts gold returns. After gold price downturn (D2 period), the coefficient is -0.396, which means that 1% increase in the USD index corresponds to 0.359% decline in return of gold.

4.1.8 Overall findings for research question one

Bond return and gold return are negatively correlated during the gold price hike period (D1), 2009-2011 and also the gold price decline period (D2) in 2012-2015. The negative correlation was bigger during the D1 period. Return of the S&P 500 has got a weak negative correlation to gold returns for the entire 20 year period and during 2009-2011. Return of oil has got a weak and positive correlation to return of gold during the entire 20 year period and also gold price hike (D1). USD Index is significantly affecting return of gold for the entire period. As gold is denominated in USD, it is evident that stronger USD should lead to a weaker gold price and vice versa. USD index is also negatively correlated to the return of gold during the D2 period. The relation between inflation and gold return was not evident and likewise the relation between the US interest rate and gold return. This was justified by the gold price development in the recent years.
4.2 Result of Research Question Two, Gold’s Hedging Characteristics

In this research question, gold’s characteristics as hedge, safe haven or diversifier to S&P 500 were analysed. A regression analysis was performed to test the relationship between gold price and the S&P 500, as per the model presented in 3.7. The result of the regression analysis is given in the table below:

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>0.000</td>
<td>0.000</td>
<td>2.318</td>
<td>0.021 **</td>
</tr>
<tr>
<td>GOLDR</td>
<td>0.002</td>
<td>0.019</td>
<td>0.081</td>
<td>0.935</td>
</tr>
<tr>
<td>D3</td>
<td>-0.001</td>
<td>0.001</td>
<td>-1.662</td>
<td>0.097</td>
</tr>
<tr>
<td>D4</td>
<td>-0.003</td>
<td>0.001</td>
<td>-3.754</td>
<td>0.000 ***</td>
</tr>
<tr>
<td>D3*GOLDR</td>
<td>-0.187</td>
<td>0.070</td>
<td>-2.658</td>
<td>0.008 **</td>
</tr>
<tr>
<td>D4*GOLDR</td>
<td>-0.104</td>
<td>0.039</td>
<td>-2.658</td>
<td>0.008 **</td>
</tr>
</tbody>
</table>

Table 4-10 Result of regression analysis for the research question two

The result above is obtained by utilising the model given in chapter 3.7.2. The definition of the variables and parameters are presented in the following table:

<table>
<thead>
<tr>
<th>Name of the parameter</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spr</td>
<td>Return of S&amp;P 500 market</td>
</tr>
<tr>
<td>Goldr</td>
<td>Return of gold</td>
</tr>
<tr>
<td>D3</td>
<td>Dummy 1, representing period after IT Bubble</td>
</tr>
<tr>
<td>D4</td>
<td>Dummy2, representing period after financial crisis</td>
</tr>
<tr>
<td>β₁ to β₅</td>
<td>Coefficients</td>
</tr>
</tbody>
</table>
Table 4-11 Definition of parameters for the research question two

The returns of the S&P 500 are the dependent variable and the returns of gold are the independent variable. The coefficients and the p-values for the dummy variables are given below:

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>D3</td>
<td>-0.001</td>
<td>0.097</td>
</tr>
<tr>
<td>D4</td>
<td>-0.003</td>
<td>0.000 ***</td>
</tr>
</tbody>
</table>

Table 4-12 Coefficients and p-values for dummy variables

The coefficient for D4 which corresponds to world financial crisis period is significant. As the coefficient is -0.003, it shows that the return of S&P during the period represented by D4, after financial crisis, is (slightly) lower.

The coefficient for return of gold for the entire period is not significant, as it is shown in the table below:

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>GOLDR</td>
<td>0.002</td>
<td>0.935</td>
</tr>
<tr>
<td>D3*GOLDR</td>
<td>-0.187</td>
<td>0.008 **</td>
</tr>
<tr>
<td>D4*GOLDR</td>
<td>-0.104</td>
<td>0.008 **</td>
</tr>
</tbody>
</table>

Table 4-13 Coefficients and p-values for return of gold to return of S&P

However, the coefficients during the market downturns after IT bubble and after the financial crisis are significant. As the coefficients are negative, it shows that the returns of the S&P 500 and returns of gold are negatively correlated during the market turmoil. After the IT bubble, the coefficient is -0.187 which means that 1% increase in the gold return
corresponds to -0.187% decrease in the return of S&P 500. After the financial crisis, 1% increase in the gold return corresponds to -0.104% decrease in the return of S&P 500.

The main finding in the research question two is that gold acts as safe haven or weak safe haven during the S&P 500 downturns. The reason is that return of gold is negatively correlated to return of S&P 500 during market downturns, as explained by Baur and Lucey (2010). As the return of gold’s coefficient in the long-run is not significant, any long-term correlation between return of gold and return of S&P 500 cannot be proven. Hence, in the long-run, return of gold is uncorrelated to the return of S&P 500. Therefore, gold is not a hedge, but a diversifier, as per definition by Baur and Lucey (2010).

4.3 Result of Research Question Three, Portfolio Analysis

In this research question, a three-asset portfolio was constructed comprising Bond, Gold and S&P 500. The idea was to find out which proportion of each asset will optimise the portfolio.

As it is explained in the chapter 3.8, a minimum variance portfolio will be designed. Firstly, the average and standard deviation of each asset are calculated. Then the variance-covariance matrix is made. By setting weights for each asset, the expected return and the standard deviation of the portfolio are calculated. The standard deviation is related to the risk of the portfolio. The optimum portfolio can be found by estimating the efficient frontier line. The higher the standard deviation, the higher the risk is taken by the investor. This procedure was done during four different periods, as defined in 3.8. The periods were chosen to cover both extreme conditions like S&P crash and also during the normal
conditions with small fluctuations. The idea is to have portfolios for different market characteristics.

4.3.1 Portfolio analysis 1/1/2004 – 31/12/2005 daily data

In this test, a portfolio was constructed on the three assets, gold, bonds and S&P 500 for the period of years 2004 and 2005. The reason this period was chosen was that neither gold nor S&P 500 had any high level of volatility and up/downwards trends. This market characteristic is what investors are typically facing. The table below shows the average of return and standard deviation and the Correlation Matrix, which were obtained from the analysis.

<table>
<thead>
<tr>
<th></th>
<th>Bond</th>
<th>Gold</th>
<th>S&amp;P 500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average return</td>
<td>0.017</td>
<td>0.038</td>
<td>0.021</td>
</tr>
<tr>
<td>Stdev</td>
<td>0.001</td>
<td>0.876</td>
<td>0.680</td>
</tr>
<tr>
<td>Correlation Matrix</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bond</td>
<td>1.000</td>
<td>-0.050</td>
<td>0.000</td>
</tr>
<tr>
<td>Gold</td>
<td>-0.050</td>
<td>1.000</td>
<td>0.040</td>
</tr>
<tr>
<td>S&amp;P 500</td>
<td>0.000</td>
<td>0.040</td>
<td>1.000</td>
</tr>
</tbody>
</table>

Table 4-14 Correlation matrix portfolio analysis 1/1/2004 – 31/12/2005

The result from the correlation matrix presents that there is no correlation between S&P 500 and Bond in this period (0.000). Gold is negatively correlated to Bond (-0.050) and positively correlated to S&P (0.040) in this period.
Portfolios were formed by varying the weights for each asset. The weights were set partly random to see how the portfolio behaves with changes in each asset. In this case, the aim is to minimise the risk (standard deviation) or maximise the expected return. 19 portfolios were made, which is shown in the table below:

<table>
<thead>
<tr>
<th>Portfolio</th>
<th>X axis = SD</th>
<th>Y axis = E[r]</th>
<th>Weight Bond</th>
<th>Weight Gold</th>
<th>Weight S&amp;P 500</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.00</td>
<td>6.23</td>
<td>100.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>Lowest risk and return</td>
</tr>
<tr>
<td>2</td>
<td>0.11</td>
<td>7.12</td>
<td>80.00%</td>
<td>10.00%</td>
<td>10.00%</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>0.19</td>
<td>7.87</td>
<td>70.00%</td>
<td>20.00%</td>
<td>10.00%</td>
<td>Optimum portfolio</td>
</tr>
<tr>
<td>4</td>
<td>0.19</td>
<td>7.87</td>
<td>70.00%</td>
<td>20.00%</td>
<td>10.00%</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>0.49</td>
<td>7.92</td>
<td>20.00%</td>
<td>10.00%</td>
<td>70.00%</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>0.23</td>
<td>8.01</td>
<td>60.00%</td>
<td>20.00%</td>
<td>20.00%</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>0.55</td>
<td>8.05</td>
<td>10.00%</td>
<td>10.00%</td>
<td>80.00%</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>0.27</td>
<td>8.14</td>
<td>50.00%</td>
<td>20.00%</td>
<td>30.00%</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>0.39</td>
<td>8.41</td>
<td>30.00%</td>
<td>20.00%</td>
<td>50.00%</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>0.26</td>
<td>8.50</td>
<td>64.15%</td>
<td>28.83%</td>
<td>7.02%</td>
<td>Optimum portfolio</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>0.45</td>
<td>8.54</td>
<td>20.00%</td>
<td>20.00%</td>
<td>60.00%</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>0.32</td>
<td>9.00</td>
<td>56.27%</td>
<td>35.17%</td>
<td>8.57%</td>
<td>Optimum portfolio</td>
</tr>
<tr>
<td>13</td>
<td>0.44</td>
<td>9.16</td>
<td>20.00%</td>
<td>30.00%</td>
<td>50.00%</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>0.38</td>
<td>9.19</td>
<td>33.33%</td>
<td>33.33%</td>
<td>33.33%</td>
<td>Equal weight</td>
</tr>
<tr>
<td>15</td>
<td>0.37</td>
<td>9.50</td>
<td>48.38%</td>
<td>41.50%</td>
<td>10.11%</td>
<td>Optimum portfolio</td>
</tr>
<tr>
<td>16</td>
<td>0.38</td>
<td>9.52</td>
<td>40.00%</td>
<td>40.00%</td>
<td>20.00%</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>0.43</td>
<td>10.00</td>
<td>40.50%</td>
<td>47.84%</td>
<td>11.66%</td>
<td>Optimum portfolio</td>
</tr>
<tr>
<td>18</td>
<td>0.49</td>
<td>10.50</td>
<td>32.62%</td>
<td>54.18%</td>
<td>13.20%</td>
<td>Optimum portfolio</td>
</tr>
<tr>
<td>19</td>
<td>0.54</td>
<td>11.00</td>
<td>24.73%</td>
<td>60.52%</td>
<td>14.75%</td>
<td>Highest return and risk</td>
</tr>
</tbody>
</table>

Table 4-15 Constructed portfolios, 1/1/2004 – 31/12/2005

The table is sorted out based on expected return ascending. The points in the graph below represent the portfolios. The x-axis presents the risk level and the y-axis shows the expected annual return in percentage.
Graph 4-1 Efficient frontier portfolio analysis 1/1/2004 – 31/12/2005

The tangent line in blue and efficient frontier curve in red are drawn in a way that it is a tangent to the most efficient portfolio and other portfolios fall underneath of the tangent line. By observing the line, it is discovered that actually eight portfolios are on the line and the curve. They can be considered as efficient portfolios. Hence, all portfolios in the table below are optimum.

<table>
<thead>
<tr>
<th>Portfolio</th>
<th>X axis = SD</th>
<th>Y axis = E[r]</th>
<th>Weights</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>St.Dev</td>
<td>E[r]</td>
<td>Bond</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>0</td>
<td>100.00%</td>
</tr>
<tr>
<td>Portfolio</td>
<td>Bond</td>
<td>Gold</td>
<td>S&amp;P 500</td>
</tr>
<tr>
<td>-----------</td>
<td>------</td>
<td>------</td>
<td>---------</td>
</tr>
<tr>
<td>4</td>
<td>0.19</td>
<td>7.87</td>
<td>70.00%</td>
</tr>
<tr>
<td>10</td>
<td>0.26</td>
<td>8.50</td>
<td>64.15%</td>
</tr>
<tr>
<td>12</td>
<td>0.32</td>
<td>9.00</td>
<td>56.27%</td>
</tr>
<tr>
<td>15</td>
<td>0.37</td>
<td>9.50</td>
<td>48.38%</td>
</tr>
<tr>
<td>17</td>
<td>0.43</td>
<td>10.00</td>
<td>40.50%</td>
</tr>
<tr>
<td>18</td>
<td>0.49</td>
<td>10.50</td>
<td>32.62%</td>
</tr>
<tr>
<td>19</td>
<td>0.54</td>
<td>11.00</td>
<td>24.73%</td>
</tr>
</tbody>
</table>

Table 4-16 Optimum portfolios for 1/1/2004 – 31/12/2005

It is basically up to the investors to choose one of these portfolios based on their targets for return and risk. The investor with most risk willingness would choose portfolio number 19 which includes 24.73% bonds, 60.52% gold and 14.52% S&P 500. These investors could expect 11% annual return on the portfolio. The investor with lowest risk willingness, opt for portfolio number 1 that includes only bonds. In that case, expected return is 6.23% per annum.

4.3.2 Portfolio analysis 1/10/2005 – 30/9/2015

The second test was carried out over the last 10 years to find out which portfolio would have been the most optimal one for investors.

The same procedure was done as the previous test and the result of analysis is given below:

<table>
<thead>
<tr>
<th>Average return</th>
<th>Bond</th>
<th>Gold</th>
<th>S&amp;P 500</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.017</td>
<td>0.026</td>
<td>0.009</td>
</tr>
</tbody>
</table>
The correlation matrix unveils that gold was positively related to bond (0.020) and negatively to S&P 500 (-0.020) for the period. S&P 500 is negatively correlated bond (-0.010). In the same manner as the previous test, random weights were used to create the portfolios and the result is presented in the table below:

<table>
<thead>
<tr>
<th>Portfolio</th>
<th>X axis = SD</th>
<th>Y axis = E[r]</th>
<th>Weights</th>
<th>S&amp;P 500</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>St.Dev</td>
<td>E[r]</td>
<td>Bond</td>
<td>Gold</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1.06</td>
<td>4.09</td>
<td>0.10</td>
<td>0.10</td>
<td>0.80</td>
</tr>
<tr>
<td>2</td>
<td>0.93</td>
<td>4.37</td>
<td>0.20</td>
<td>0.10</td>
<td>0.70</td>
</tr>
<tr>
<td>3</td>
<td>0.83</td>
<td>4.98</td>
<td>0.20</td>
<td>0.20</td>
<td>0.60</td>
</tr>
<tr>
<td>4</td>
<td>0.70</td>
<td>5.26</td>
<td>0.30</td>
<td>0.20</td>
<td>0.50</td>
</tr>
<tr>
<td>5</td>
<td>0.47</td>
<td>5.81</td>
<td>0.50</td>
<td>0.20</td>
<td>0.30</td>
</tr>
<tr>
<td>6</td>
<td>0.65</td>
<td>5.87</td>
<td>0.30</td>
<td>0.30</td>
<td>0.40</td>
</tr>
<tr>
<td>7</td>
<td>0.00</td>
<td>5.95</td>
<td>1.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>8</td>
<td>0.18</td>
<td>6.02</td>
<td>0.80</td>
<td>0.10</td>
<td>0.10</td>
</tr>
<tr>
<td>9</td>
<td>0.37</td>
<td>6.08</td>
<td>0.60</td>
<td>0.20</td>
<td>0.20</td>
</tr>
<tr>
<td>10</td>
<td>0.29</td>
<td>6.36</td>
<td>0.70</td>
<td>0.20</td>
<td>0.10</td>
</tr>
<tr>
<td>11</td>
<td>0.21</td>
<td>6.50</td>
<td>0.84</td>
<td>0.16</td>
<td>0.00</td>
</tr>
<tr>
<td>12</td>
<td>0.58</td>
<td>6.76</td>
<td>0.40</td>
<td>0.40</td>
<td>0.20</td>
</tr>
<tr>
<td>13</td>
<td>0.47</td>
<td>6.91</td>
<td>0.56</td>
<td>0.35</td>
<td>0.09</td>
</tr>
<tr>
<td>14</td>
<td>0.47</td>
<td>6.91</td>
<td>0.56</td>
<td>0.35</td>
<td>0.09</td>
</tr>
<tr>
<td>15</td>
<td>0.40</td>
<td>7.00</td>
<td>0.69</td>
<td>0.31</td>
<td>0.00</td>
</tr>
<tr>
<td>16</td>
<td>0.49</td>
<td>7.25</td>
<td>0.62</td>
<td>0.38</td>
<td>0.00</td>
</tr>
<tr>
<td>17</td>
<td>0.59</td>
<td>7.50</td>
<td>0.54</td>
<td>0.46</td>
<td>0.00</td>
</tr>
<tr>
<td>18</td>
<td>0.78</td>
<td>8.00</td>
<td>0.40</td>
<td>0.60</td>
<td>0.00</td>
</tr>
<tr>
<td>19</td>
<td>0.87</td>
<td>8.25</td>
<td>0.32</td>
<td>0.68</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Table 4-18 Constructed portfolios for 1/10/2005 – 30/9/2015

The efficient frontier line is drawn in a way that it is a tangent to the most efficient portfolio and other portfolios fall underneath of this line. The x-axis presents the risk level and the y-axis shows the expected annual return in percentage.
Graph 4-2 Efficient frontier for 1/10/2005 – 30/9/2015

By observing the tangent line, it is found that four portfolios are actually on the line and can be considered as efficient portfolios. Hence all portfolios in the table below are optimum.

<table>
<thead>
<tr>
<th>Portfolio</th>
<th>X axis = SD</th>
<th>Y axis = E[r]</th>
<th>Weights</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>St.Dev</td>
<td>E[r]</td>
<td>Bond</td>
</tr>
<tr>
<td>7</td>
<td>0</td>
<td>4.92</td>
<td>100%</td>
</tr>
<tr>
<td>11</td>
<td>0.21</td>
<td>6.50</td>
<td>84%</td>
</tr>
<tr>
<td>18</td>
<td>0.78</td>
<td>8.00</td>
<td>40%</td>
</tr>
</tbody>
</table>
Investors could choose their preferred portfolio based on their targets for return. The optimum portfolio, number 19, with 8.25% return contains 32% of bond and 68% of gold without any allocation of equities. As S&P 500 took a heavy decline during the financial crisis, this result is expected. The lowest risk is achieved if the investors have only bonds in the portfolio (number 7) which will yield 4.92% annually. As table above reveals, the higher bond allocation in the portfolio decreases the yield and reduces the risk whereas higher gold allocation (up to 68%) increases the portfolio return but at the price of a higher risk.

### 4.3.3 Portfolio analysis, 1/10/2013 to 30/9/2015

The third test was done in the last two years, 1/10/2013 to 30/9/2015. As gold price dropped sharply during this period, it is expected that the optimal portfolio does not contain any gold. The same procedure as previous tests, is run here.

<table>
<thead>
<tr>
<th></th>
<th>Bond</th>
<th>Gold</th>
<th>S&amp;P 500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>0.014</td>
<td>-0.039</td>
<td>0.023</td>
</tr>
<tr>
<td>return</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stdev</td>
<td>0.001</td>
<td>0.907</td>
<td>0.827</td>
</tr>
<tr>
<td>Correlation Matrix</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4-19 Optimum portfolios for 1/10/2005 – 30/9/2015
Table 4-20 Correlation matrix for 1/10/2013 to 30/9/2015

As it is shown in the table above, the average return of gold is negative and it shows that any percentage of gold in the portfolio will have a negative impact on the portfolio return. The correlation between gold and S&P 500 is negative (-0.150) and likewise the correlation between gold and bond (-0.040). S&P 500 and bond are positively correlated (0.030).

By setting the weights, the portfolios which are shown in the table below, are constructed.

<table>
<thead>
<tr>
<th>Portfolio no</th>
<th>X axis = SD</th>
<th>Y axis = E[r]</th>
<th>Weights</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bond</td>
<td>Gold</td>
<td>S&amp;P 500</td>
</tr>
<tr>
<td>1</td>
<td>0.19</td>
<td>1.47</td>
<td>70.0%</td>
</tr>
<tr>
<td>2</td>
<td>0.23</td>
<td>1.81</td>
<td>60.0%</td>
</tr>
<tr>
<td>3</td>
<td>0.28</td>
<td>2.15</td>
<td>50.0%</td>
</tr>
<tr>
<td>4</td>
<td>0.43</td>
<td>2.83</td>
<td>30.0%</td>
</tr>
<tr>
<td>5</td>
<td>0.50</td>
<td>3.17</td>
<td>20.0%</td>
</tr>
<tr>
<td>6</td>
<td>0.11</td>
<td>3.36</td>
<td>80.0%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>7</td>
<td>0.11</td>
<td>3.36</td>
<td>80.0%</td>
</tr>
<tr>
<td>8</td>
<td>0.41</td>
<td>4.72</td>
<td>40.0%</td>
</tr>
<tr>
<td>9</td>
<td>0.00</td>
<td>4.92</td>
<td>100.0%</td>
</tr>
<tr>
<td>10</td>
<td>0.57</td>
<td>5.40</td>
<td>20.0%</td>
</tr>
<tr>
<td>11</td>
<td>0.65</td>
<td>5.75</td>
<td>10.0%</td>
</tr>
<tr>
<td>12</td>
<td>0.26</td>
<td>6.00</td>
<td>68.3%</td>
</tr>
<tr>
<td>13</td>
<td>0.32</td>
<td>6.25</td>
<td>60.9%</td>
</tr>
<tr>
<td>14</td>
<td>0.38</td>
<td>6.50</td>
<td>53.6%</td>
</tr>
<tr>
<td>15</td>
<td>0.44</td>
<td>6.75</td>
<td>46.2%</td>
</tr>
<tr>
<td>16</td>
<td>0.50</td>
<td>6.98</td>
<td>39.5%</td>
</tr>
<tr>
<td>17</td>
<td>0.63</td>
<td>7.50</td>
<td>24.2%</td>
</tr>
<tr>
<td>18</td>
<td>0.75</td>
<td>8.00</td>
<td>9.5%</td>
</tr>
<tr>
<td>19</td>
<td>0.83</td>
<td>8.32</td>
<td>0.0%</td>
</tr>
</tbody>
</table>
Table 4-21 Constructed portfolios for 1/10/2013 to 30/9/2015

And the resulting graph is given below, which shows that the two portfolios with highest return are actually optimal portfolios. These portfolios have predominantly S&P 500 shares and no gold at all.

Graph 4-3 Efficient frontier for 1/10/2013 to 30/9/2015

The two optimal portfolios are given below:

<table>
<thead>
<tr>
<th>X axis = SD</th>
<th>Y axis = E[r]</th>
<th>Weights</th>
</tr>
</thead>
<tbody>
<tr>
<td>St.Dev</td>
<td>E[r]</td>
<td>Bond</td>
</tr>
<tr>
<td>18</td>
<td>0.75</td>
<td>8</td>
</tr>
</tbody>
</table>
The finding is that during the period of 1/10/2013 to 30/9/2015, the best portfolio had predominantly S&P 500 shares and no gold at all. This is due to the fact that gold’s return was negative in this period. The highest return portfolio (number 19) includes 100% of S&P 500 shares and 0% of the other two assets. But the portfolio risk is high as well. In that case, 8.32% annual return is expected. However, if 9.5% of portfolio is bonds and the rest S&P 500 (portfolio number 18), the risk will be lower and the yield is slightly lower at 8%. As investors prefer to have more than one type of asset in their portfolio, the case with both bonds and S&P 500 is more appealing.

4.3.4 Portfolio analysis, 1/4/2014 to 31/6/2014, 3 months

It is also interesting to find out if the portfolio analysis during the shorter periods provides more useful information for the investors.

In this test, a three month period during 1/4/2014 to 31/6/2014 was chosen. This particular period was selected, as both gold and S&P 500 had positive returns. Data for 63 days was used in this test. The correlation matrix is made and presented in the table below:

<table>
<thead>
<tr>
<th></th>
<th>Bond</th>
<th>Gold</th>
<th>S&amp;P 500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average return</td>
<td>0.013</td>
<td>0.026</td>
<td>0.071</td>
</tr>
<tr>
<td>Stdev</td>
<td>0.000</td>
<td>0.731</td>
<td>0.594</td>
</tr>
<tr>
<td>Correlation</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Table 4-23 Correlation matrix for 1/4/2014 to 31/6/2014

The result of the correlation matrix reveals that gold is positively correlated to bond (0.148) but negatively correlated to S&P 500 (-0.327). S&P 500 is positively correlated to bond (0.019).

The portfolios were constructed, similar to the previous tests, by utilising weights and as a result, 17 portfolios were totally generated.

<table>
<thead>
<tr>
<th>Portfolio no</th>
<th>X axis = SD</th>
<th>Y axis = E[r]</th>
<th>Weights</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>St. Dev.</td>
<td>E[r]</td>
<td>Bond</td>
</tr>
<tr>
<td>1</td>
<td>0.00</td>
<td>4.82</td>
<td>1.00</td>
</tr>
<tr>
<td>2</td>
<td>0.08</td>
<td>7.34</td>
<td>0.80</td>
</tr>
<tr>
<td>3</td>
<td>0.19</td>
<td>11.41</td>
<td>0.68</td>
</tr>
<tr>
<td>4</td>
<td>0.19</td>
<td>11.93</td>
<td>0.50</td>
</tr>
<tr>
<td>5</td>
<td>0.26</td>
<td>14.45</td>
<td>0.30</td>
</tr>
<tr>
<td>6</td>
<td>0.25</td>
<td>15.00</td>
<td>0.37</td>
</tr>
</tbody>
</table>

Matrix

<table>
<thead>
<tr>
<th></th>
<th>Bond</th>
<th>Gold</th>
<th>S&amp;P 500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bond</td>
<td>1.000</td>
<td>0.148</td>
<td>0.019</td>
</tr>
<tr>
<td>Gold</td>
<td>0.148</td>
<td>1.000</td>
<td>-0.327</td>
</tr>
<tr>
<td>S&amp;P 500</td>
<td>0.019</td>
<td>-0.327</td>
<td>1.000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>7</td>
<td>0.28</td>
<td>15.64</td>
<td>0.40</td>
</tr>
<tr>
<td>8</td>
<td>0.28</td>
<td>16.09</td>
<td>0.30</td>
</tr>
<tr>
<td>9</td>
<td>0.34</td>
<td>16.97</td>
<td>0.10</td>
</tr>
<tr>
<td>10</td>
<td>0.30</td>
<td>17.00</td>
<td>0.25</td>
</tr>
<tr>
<td>11</td>
<td>0.33</td>
<td>18.16</td>
<td>0.20</td>
</tr>
<tr>
<td>12</td>
<td>0.35</td>
<td>19.00</td>
<td>0.12</td>
</tr>
<tr>
<td>13</td>
<td>0.39</td>
<td>19.80</td>
<td>0.20</td>
</tr>
<tr>
<td>14</td>
<td>0.38</td>
<td>20.00</td>
<td>0.06</td>
</tr>
<tr>
<td>15</td>
<td>0.40</td>
<td>21.00</td>
<td>0.00</td>
</tr>
<tr>
<td>16</td>
<td>0.45</td>
<td>21.87</td>
<td>0.10</td>
</tr>
<tr>
<td>17</td>
<td>0.53</td>
<td>23.51</td>
<td>0.10</td>
</tr>
</tbody>
</table>

Table 4-24 Constructed portfolios for 1/4/2014 to 31/6/2014

As S&P 500 had a great run during 1/4/2014 to 31/6/2014, the portfolio provided high
return as well. The graph below shows the tangent line, efficient frontier and optimal portfolios.
The following three portfolios were optimal and on the efficient frontier with high return.

<table>
<thead>
<tr>
<th>Portfolio no</th>
<th>X axis = SD</th>
<th>Y axis = E[r]</th>
<th>Weights</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>St.Dev</td>
<td>E[r]</td>
<td>Bond</td>
</tr>
<tr>
<td>15</td>
<td>0.40</td>
<td>21.00</td>
<td>0.00</td>
</tr>
<tr>
<td>16</td>
<td>0.45</td>
<td>21.87</td>
<td>0.10</td>
</tr>
<tr>
<td>17</td>
<td>0.53</td>
<td>23.51</td>
<td>0.10</td>
</tr>
</tbody>
</table>
Table 4-25 Optimum portfolios for 1/4/2014 to 31/6/2014

By allocating 10% on bond, 10% on gold and 80% on S&P 500, investors could fetch an annual return of 21.87% during Q2 2014. In case, the lowest risk is desired, a portfolio of 28% gold and 72% S&P 500 will achieve that and provides 21% annual return. The highest return is, however, obtained by 10% bonds and 90% S&P 500. In this three months period, the standard deviation of bonds was higher than the other two assets. Hence, investing in bonds increased the risks. This phenomena is observed if portfolio analysis is done over a short period.

4.3.5 Findings regarding research question three

The main findings after testing four periods are summarised below:

Portfolio analysis during the unstable market with high volatility will not give any proper result. Thus, the weight of each asset alters by a great deal. For instance, after the financial crisis, the optimal portfolio would have no holding in S&P 500 and during the gold price plunge, without any holding in gold.

Portfolio analysis on the shorter periods (stable periods) gives a more reasonable result. The result from the 10 year period showed S&P 500 shares should not be included in the portfolio. However, for the last two years of that period, S&P 500 shares performed much better than gold, hence the optimal portfolio contained no gold. The second quarter of 2014 showed another optimal portfolio with very high S&P 500 shares and a low level of gold and bond. Therefore, portfolio optimisation is suitable for shorter periods.

The result from this research question unveils that investors cannot make high returns without repositioning. The portfolios which are unchanged in the long-term, provide less
return. This was shown, as the return for the portfolios in the shorter periods gave a higher return than the longer periods.

As per findings, investors make the best profit by allocating a certain part of investments in bonds and then invest the rest on the riskier assets.

### 4.4 Result of Research Question Four, why did gold crash after 2011?

#### 4.4.1 Analysing accumulated return for Gold, Bond and S&P 500

The accumulated returns were determined as per the model given in 3.9.1. The returns from bond, S&P 500 and gold since twenty years ago were obtained and accumulated. The result is presented in the graph below.
Graph 4-5 Accumulated returns of Gold, Bond and S&P 500 in the past twenty years

As expected the bond return is constant during the period with the accumulated return steadily rising. The S&P 500 return however, goes through two periods of steep decline after the year 2000 IT bubble and after the year 2008 financial crisis. Gold’s accumulated return is negative in the beginning of the period and it only breaks even after 2003. Interestingly, after twenty years, the return of gold is almost at the same level of S&P 500. This result hints that gold’s pricing level in 2011 may have been a bubble.

4.4.2 Analysing gold fear factor, GVZ, against gold price

A regression analysis is done to examine the relationship between the gold volatility index, GVZ, and the gold price according to the model in the chapter 3.9. The result of the regression analysis is given in the table below:

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>1169.197</td>
<td>13.972</td>
<td>83.680</td>
<td>0.000 ***</td>
</tr>
<tr>
<td>GVZ</td>
<td>-17.443</td>
<td>1.277</td>
<td>-13.660</td>
<td>0.000 ***</td>
</tr>
<tr>
<td>D5</td>
<td>-192.225</td>
<td>32.728</td>
<td>-5.873</td>
<td>0.000 ***</td>
</tr>
<tr>
<td>D6</td>
<td>516.583</td>
<td>28.397</td>
<td>18.191</td>
<td>0.000 ***</td>
</tr>
<tr>
<td>GVZ*D5</td>
<td>14.495</td>
<td>2.364</td>
<td>6.132</td>
<td>0.000 ***</td>
</tr>
<tr>
<td>GVZ*D6</td>
<td>18.741</td>
<td>6.547</td>
<td>2.863</td>
<td>0.004 **</td>
</tr>
</tbody>
</table>

Table 4-26 Result of regression analysis for the research question four

Definition of the parameters is given in the table below:

<table>
<thead>
<tr>
<th>Name of the parameter</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gold(t+120)</td>
<td>Gold price with 120 days shift ahead</td>
</tr>
<tr>
<td>GVZ</td>
<td>Gold volatility index</td>
</tr>
</tbody>
</table>
D5 | Dummy 1, representing period before gold price hike
---|---
D6 | Dummy 2, representing the period before gold price downturn
\(\beta_1\) to \(\beta_5\) | Coefficients

Table 4-27 Definition of parameters for the research question four

The dependent variable is Gold price with 120 days shift forward. The independent variable is GVZ. Two dummy variables represents periods with high volatility (GVZ > 30). All coefficients are significant as the P-values are lower than 0.05.

For the entire period, the coefficient is -17.443 with a p-value at 0.000. This result shows that GVZ impacts the gold price \(t + 6\text{mth}\) negatively. For the period September 2008 to April 2009, the coefficient is -192.225 with p-value at 0.000. In this period investors feared that the gold price was low and the high volatility increased the gold price and reduced the GVZ. Hence the coefficient for D5 period is negative. In the next period, D6, which covers August to November 2011, the coefficient is 516.583 with p-value at 0.000. During this period, investors feared that gold price was too high. Then after 6 months, gold price declined and GVZ was reduced as the fear factor was less. Hence the positive coefficient for D6 is justified.

From 2012, except few days, there has not been any period with GVZ higher than 30. It means that the fear factor has been considerably lower since 2011. Thus, investors have had less “fear” with gold price at current levels. As fear factor has been low since the gold price went down after 2011, it indicates that investors consider the current price level as
reasonable. Therefore the probability that gold price at 1900 USD in 2011 was actually a bubble is quite high.

4.4.3 Main findings with regards to research question four

Considering the historical return and risk levels, there was not much support for the gold level at 1900 USD/ounce in 2011. Therefore investors expected that gold would adjust to the same level based on the historical return levels. This supports the volatility index analysis as well. In both methods, it is evident that there is more support for gold price at the current levels than at 1900 USD/ounce in 2011. Hence, the finding is that gold price at 2011 was overvalued. Thus, the gold price decline after end of 2011 was a market reaction to the bubble.
5 CONCLUSIONS

The findings in this study are based on the empirical research that covered the four research questions and also the extensive literature review.

According to the literature review, gold cannot be treated as a commodity but rather, as currency. The physical gold never diminishes but the total amount of physical gold is always on the incline due to the new mining outputs. Hence, the supply and demand factors that are applicable for other commodities, are not relevant for gold. The impact of sectors such as the mining industry, jewellery industry and central banks on the gold price is not evident. This is due to the fact that the supply and demand of physical gold is negligible compared to the existing available gold.

The result of analysis for research question one shows that movements in oil price and S&P 500 correlate with the gold price. Oil price is positively correlated and S&P 500 is negatively correlated. Bonds are not correlated with gold during the 20-year period of analysis in this study. However, the analysis showed that bond returns were negatively correlated to gold return after the financial crisis in 2009. After the financial crisis, gold price started to hike and bond returns were decreased, which explains the negative correlation. Bond returns have been steady since 2011 while the gold price went down from 2011 onwards. Hence, the negative correlation continued, which was shown in the analysis of this study. Regression analysis showed that USD index was negatively correlated towards the return of gold. It is apparent that a stronger USD would repel investors as gold is denominated in that currency. A weaker USD, on the other hand, encourages investors to buy more of
the precious metal. Therefore, the negative correlation between USD index and gold return is justified, which was shown by the analysis of this study.

The analysis regarding research question two which is about hedge, safe haven and diversification properties of gold, revealed that gold is not a hedge against S&P 500 as the long-term correlation does not exist. As returns of gold and S&P 500 are not correlated in the long-term, gold can be considered a diversifier against S&P 500 in a portfolio. However, the result showed that gold is a (weak) safe haven against S&P 500 during market turndowns. The analysis exhibited a negative relation between gold return and the return of the S&P 500 index during the market turmoil in 2000-2002 (after the IT bubble) and after the financial crisis in 2008. This finding is important for investors as they seek safe investments when the equity market crashes. During market turmoil, investors can prohibit losses and gain profit by retreating to gold as it is presented by this study.

In research question three, a portfolio based on three assets gold, bond and S&P 500 was constructed. The objective was to find the optimised portfolio for different periods. The periods were chosen to cover both volatile and normal periods to provide different strategies for investors. The finding was that the optimised portfolio depends on the investors’ risk taking appetite. Investors have the opportunity to choose between high return or low risk or a mix of both. The preferred portfolios for each period were presented in this study. During the volatile market, bonds seem to be best of these three assets. This is due to stable return and low risk. By investing in gold and S&P 500 shares and reducing bonds, players
increase their potential return by accepting more risks. This study exhibited that the expected return for the portfolios constructed over shorter period was higher. According to the result, an optimised portfolio over three months had an expected return of over 20% annually, whereas another optimised portfolio which was constructed over 2 years returned approximately 7% annually at the same risk level. The probability that assets like equities and gold face downturns and upturns over longer periods is higher than in shorter periods. Hence, investors need to rebalance their portfolios by shifting between assets frequently.

Another finding was that optimum portfolios are skewed towards one or two assets during volatile periods as one of the assets is continuously declining. As investors reposition their portfolio to less gold, the price drops. In the past 20 years, gold has had an average return of 6-7%. Hence, a long-term investment in gold, compared to bonds, is not justified, considering the volatility and risks. Hence, a portfolio with gold as an asset has to be rebalanced periodically to exit from gold once the profit target is achieved.

In research question four, it was found that the gold price was in a state of bubble at the end of 2011. Market perception was that gold was overpriced at 1900 USD. This factor drove up the fear factor within investors and increased volatility. The interesting finding of this research was that high gold volatility factor will impact the gold price after 6 months, which was in line with the findings in the literature review. As per the statement from gold analysts, high GVZ will impact gold price. Hence, by analysing the GVZ index, investors can find opportunities to enter and exit gold positions at the right moment.
There are many ways to invest in gold, such as buying physical gold, ETF’s, shares of mining companies and future contracts. In this study, the advantages and disadvantages for each of these investment methods are discussed. Based on the literature review in this study, trading with gold ETF’s is the most convenient and hassle free way to invest in gold.
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