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Gold During Recessions

A study about how gold can improve the performance of a portfolio during recessions

Bachelor Thesis in Business Administration

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Abstract

Problem: When choosing topic for this study the economy was on the brink of a recession. Many experts made varying statements regarding this fact, and further readings in this area led us to question: can an inclusion of gold enhance the performance in an index portfolio during recessions? And if so, how much should be allocated to gold?

Purpose: The purpose of this thesis is to look back at the historical price development of gold and DJIA during recessions in order to find out whether an inclusion of gold can improve a DJIA index portfolio held in today's recession. In addition, by analyzing the risks and possibilities with gold, the optimal allocation of gold in a DJIA portfolio will be investigated in.

Method: The methodological approach will be of a quantitative data analysis approach. By using historical data, new empirical findings will be found by using the deductive approach. This method has been chosen due to the nature of the purpose and in order to best give a general answer to our research questions.

Conclusion: The gold price is strongly influenced by uncertainty, and even though an optimal allocation of gold in each recession could be found, no general optimal allocation applicable in today's recession could be found. Gold has higher risk (higher variance) than DJIA, but is compensated with higher return as well.

Abbreviation Word List

DJIA = Dow Jones Industrial Average

GDP= Gross Domestic Product

OP = Optimal Portfolio

MVP = Mean Variance Portfolio

CML= Capital Market Line

OPEC = Organization of the Petroleum Exporting Countries

Today= 2008-2009

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1 Disposition

Chapter 3 *In this opening section, the background to the study will be presented where the specific field of interest will be included. Further, the problem discussion followed by the specific research questions, the purpose and the approach will be stated.*

Chapter 4 *In this section, the related economical and financial concepts and theories will be presented. The main parts concern Business Cycles, Supply and Demand for Gold, and the Modern Portfolio Theory. In addition some other important definitions and equations will be introduced.*

Chapter 5 *As this study is based on historical data, it is important to have knowledge about the related history. This part will present the reader with a brief introduction to DJIA and gold. After that, DJIA and gold development during each recession will be treated, together with graphical illustrations. Recession 2 and 3 are put together due to the close connection in time and possible shared causes and effects.*

Chapter 6 *In this part, our choice of the research method will be presented. Further on, our method for collecting and the manipulation of the data will be presented and the criticism against it, along with assumptions made for the analyses.*

Chapter 7 *This section presents the data collected and our findings. The data will be presented in forms of tables and figures in order to give the reader an easy way of interpreting the findings. Parallel to the findings, the data and theory will be analyzed. At the end, gold will be compared to other assets, to see how it performs in relation to them.*

Chapter 8 *In this conclusive section, the findings from the study will be summarized together with the research questions. Further recommendations for future studies will also be presented.*

2 Introduction

In this opening section, the background to the study will be presented where the specific field of interest will be included. Further, the problem discussion followed by the specific research questions, the purpose and the approach will be stated.

2.1 Background

George Santayana, a well-known philosopher, once expressed these words: “Those who cannot remember the past are condemned to repeat it.” (Reason in common sense)

As the quote above states, the history will repeat itself and it is therefore of vital importance to analyze the past in order to pursue hints for the future. In today’s (2008) financial turmoil, the market has changed dramatically during a short period of time. Starting with the sub-prime mortgage crisis with falling house prices in the US, the world market is today under pressure to recover. Seemingly, history will repeat itself because people with self-fulfilling goals drive the market. Investors have lost large shares of their portfolio investments and multinational companies and banks are struggling with their finances. The largest indexes all over the world have plummeted (see Figure 1-4) with 1-day record losses and the situation today is unstable, least to say.



Figure 1 Nikkei 225 Index, Nov 07 – Sep 08



Figure 2 DJIA, Nov 07 – Sep 08

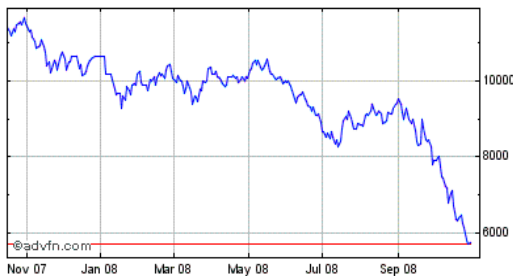


Figure 3 FTSE 250 Index, Nov 07 – Sep 08



Figure 4 Hang Seng Index, Nov 07 – Sep 08

The downfalls that many countries have experienced this year (2008) have caught our attention, and it has made us question what there is to do in order to hinder even further losses for private investors. Are there any assets that could decrease the losses and perhaps even improve the portfolio performance? Gold has long been considered a safe haven in these circumstances, and in an article written by BBC News (2008-01) earlier this year in January, the gold price was on its way up, driven by the weak dollar, strong oil prices and global inflationary fears. In general, people perceive gold and other precious metal commodities as lower risk investments, and with the fear of falling stock prices, people are now looking for various alternatives to safeguard their portfolios.

Later in October 2008, Feldman (2008) continued to argue that in today's insecure financial crisis, investors are still looking for safer forms of investments and that the gold rush is more intense than ever even though the gold prices have reached its peak and is slowly going down again. The reason being that the dollar has become more expensive and the oil prices are plummeting (cited in BBC News, 2008). In addition, the chief analyst Nicholas Brooks at ETF Securities in London is also promoting gold as a safer investment, though it should not be considered a risk-free investment because of its great fluctuations in price (Figure 5) (Dagens Industri, 2008).

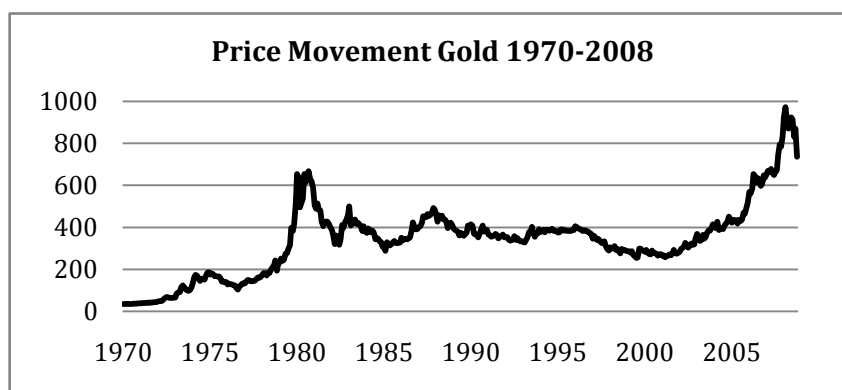


Figure 5 Price movement of gold 1970 - 2008

Is gold then the safe have that many believe it to be? In this academic paper, this issue will be looked into more deeply by linking these three main areas of studies: *Business Cycles, theories regarding Supply and Demand for Gold*, and *the Modern Portfolio Theory*.

The concept of Business Cycles explains how the economy moves over time with more or less regular fluctuations. It is a part of macroeconomics that explains how the different components of GDP are affecting the market, and how the components themselves are affected by peaks and troughs in an economy (Ralf, 2000).

Supply and Demand for gold is the principle mechanism that guides the price of gold, thus the value of gold. Since gold only falls back on its intrinsic value, it receives no interest or dividend payment, the price increase or decrease is what regulates the capital gain. (Levin & Wright 2006) The major determinants for gold prices are uncertainty, inflation, government auction policy and the supply and demand flow. (Abken, 1980)

Modern Portfolio Theory is based upon theories first introduced by Harry Markowitz, an American economist who was rewarded Nobel Prize in Economics 1990. One of the most important ideas introduced by Markowitz is the use of standard deviation and variance to measure risk. Markowitz also introduced the theory of optimal portfolio selection based on the assumption that investors are risk averse and wants to take as little risk as possible for a given rate of return (Horasanli & Neslihan, 2007).

With these three concepts, this study will aim to investigate if gold can be profitable during recessions when included in an index portfolio.

2.2 Problem discussion

One of the main reasons why this topic was chosen is because a new recession (2008) is threatening many countries all over the world. This makes diversifying investments an important measure to take for private investors. In order to understand these kinds of investments during recessions, one must comprehend the historical economic development

of the market. The US is of special interest because it has influenced the world economy and politics historically, and still today, it is the driving market that influences the global markets.

A returning topic within the fields of safer investments is gold, especially during uncertain times. Historically, gold has been considered a safe haven when other assets have plummeted due to the unstable situation in an economy. It is therefore of interest to look deeper into this comprehension of gold and its characteristics. Is it possible to look at the historical price movements of gold during recessions to draw the conclusion that an inclusion of gold in a portfolio in today's recession is profitable? In order to answer this question, numerous statistical measures must be taken.

Next step in this process was to find a measure that has represented the movement of the market historically, and is still used today. The Dow Jones Industrial Average (later referred to as DJIA) is one of the most established and renowned indices in the world, and the fact that the world economy is dependent on the US economy makes DJIA an attractive index to look at. By comparing the movement of DJIA, representing the market movement, to gold and its movement, it will be possible to find out whether gold has been the safe haven many proclaim it to be.

However, only having the knowledge about the correlated movement between gold and DJIA is insufficient for a private investor. It is in part helpful for an investor to know about the correlation, but without knowing the optimal allocation of gold, it is rather irrelevant. Therefore, it is critical to find the optimal portfolio where return to risk is maximized, or to find a minimum variance portfolio for a risk averse investor, where the risk is minimized. This will be found by using Markowitz's portfolio theory and the formulas and equations that are frequently used by the general crowd.

Further research within this field led the research to focus on to what extent gold is performing against DJIA from these three perspectives; first, the relative return and risk along with correlation between the two variables in recent recessions. Secondly, the allocation of the two assets an investor should hold and thirdly, if there are significant differences between the allocations for the different recessions.

From this discussion, the final research questions were developed, and these are presented in the subsequent section.

2.2.1 Research questions

The above reasoning led us to the following research questions:

- 1) Is it possible to conclude whether gold should be invested in when holding a DJIA index portfolio, in order to minimize risk or maximize return given risk, during recessions by looking at past performance of gold and DJIA during the last five recessions in the US?
- 2) If an investor who possesses a DJIA index portfolio chose to invest in gold during a recession, what should the allocation between DJIA and gold be in order to maximize return to risk and minimize risk?
- 3) Are there any significant differences between the weights and do they vary in different recessions?

What are possible causes behind the differences in weights in each recession?

2.3 Purpose

The purpose of this thesis is to look back at the historical price development of gold and DJIA during recessions in order to find out whether an inclusion of gold can improve a DJIA index portfolio held in today's recession. In addition, by analyzing the risks and possibilities with gold, the optimal allocation of gold in a DJIA portfolio will be investigated in.

2.4 Approach

The three areas of interest in this paper are the last recessions in the US, gold as an investment, and also the movement of DJIA. Since the study deals with how all these are interconnected, it is utterly important to get a deep understanding of these topics. Therefore the work of this study will start with investigating the background of all these topics. Thereafter, the Frame of Reference will be dealt with. We have chosen three concepts and theories that we will base our analysis upon. The recessions are explained by the concepts of business cycles. Gold as an investment will be investigated through the mechanism of supply and demand of the asset, and lastly, in order to tie all of these together we need a portfolio theory. This is because we are interested in not only whether gold can improve the performance of a portfolio in recessions, but also additionally how one should optimize the portfolio with optimal asset allocation. Therefore we are using the Modern Portfolio Theory in investigating how much an investor should allocate in gold and DJIA, in order to optimize the holdings. Even though DJIA has few flaws (presented later in a separate section), it is the most widely used index and also an excellent indicator of how the market is moving.

In the Result/Analysis, each recession will be analyzed with support from all the information about the three areas. The empirical findings and analysis for each part will be waved in together to give a more comprehensible view of the situation. Because the main focus of this paper is to investigate in whether gold can be used to increase the return to risk ratio or minimize the risk, it is relevant to compare the results of gold and DJIA with other commodities. This is not included as one of the research questions, however, this will give a more fair view of gold and its relative advantages (and disadvantages) compared to other commodities that are usually used as market indicators. Silver, oil and a commodity index (CCI) have been chosen to compare the gold data to. This will be presented at the end of the Results/Analysis and is mainly included in order to give an investor a well-reasoned investment recommendation. Then, a conclusive analysis will be made where the findings from the data collection and the analysis will be submitted.

3 Frame of Reference

In this section, the related economical and financial concepts and theories will be presented. The main parts concern Business Cycles, Supply and Demand for Gold, and the Modern Portfolio Theory. In addition some other important definitions and equations will be introduced.

3.1 Economical theories and concepts

3.1.1 Business Cycles

The concepts of business cycles explain how the economy moves over time with more or less regular fluctuations. Business cycles are a part of macroeconomics that explains how the different components of GDP are affecting the market, and how the components themselves are affected by peaks and troughs in an economy. These fluctuations are not affected by seasonal changes or single identifiable events, but are spread over longer time span and follow a systematic regular pattern. (Ralf, 2000)

The standard definition of a business cycle is presented by Burns and Mitchell (1946, p.56):

“Business cycles are a type of fluctuation found in the aggregate activity of nations that organize their work mainly in business enterprises: a cycle consists of expansions occurring at about the same time in many economic activities, followed by similarly general recessions, contractions and revivals which merge into the expansion phase of the next cycle; this sequence of changes is recurrent but not periodic; in duration business cycles vary from more than one year to ten or twelve years; they are not divisible into shorter cycles of similar character with amplitudes approximating their own.”

There are several kinds of business cycle theories trying to explain the occurrence of recessions and the ‘natural’ fluctuations. The truth of the matter is that recessions appear for many different reasons; intentionally (e.g. as a direct effect of Fed’s actions) and unintentionally (e.g. by natural disasters or terrorist attacks), expected and unexpected. However, until this point *no* theory has been able to fully explain, without undermining assumptions, why an economy suffers from an economic downturn. The different business cycle theories give varying approaches to the problem from various points of views. These theories will not be presented in this study, however, Knoop (2004) has stated six general traits on business cycles in general.

- i) *Business cycles are not cyclical* – looking back historically, the cycles have been anything else than cyclical. They have been unpredictable and irregular in both length and duration. The shortest recession in US history was in 1980 with only 6 months’ contraction, while the longest lasted 43 months between 1933 and 1937. In same fashion, the expansions in the economy have varied with the shortest expansion of 12 months to the longest of 121 months. With other words, the length or the depth and severity of a recession or expansion have in no ways given clues on how the next period would look like.
- ii) *Business cycles are not symmetrical* – in the US, a recession have lasted on average 14 months, while an expansion have lasted on average 43 months, more than three times the length of a recession. This clearly shows the asymmetry between expansions and recession, and this asymmetry seems to be true internationally as well. Recessions tend to affect the industrial output more than expansion, and

in general, there are shorter but sharper changes in GDP during a recession and a more gradual and slow changes during an expansion.

- iii) *Business cycles have not changed dramatically over time* – Experts often compare the economy by looking at the prewar period and postwar period. Up until ten years ago, economists believed that the postwar business cycles were shorter, less severe, and less frequent. However, with new data presented today, US economists instead mean that there only have been few moderations in the business cycles and the differences between prewar and postwar periods are smaller than earlier believed.
- iv) *The Great Depression and the World War II expansion dominate all other recessions and expansions* – Between 1929 and 1932, GDP fell by 50 % while unemployment rose to 25 % in 1933. To understand the serenity of the Great Depression, a comparison with the second largest recession in 1973 – 1975 can be made, with a GDP reduction of 4.2 % and unemployment level of 9 %. In the same way, the expansion that started in 1938 continued during the World War II and between 1941 and 1944, GDP increased with 64 %. This is obviously a result of intense mobility of resources and massive government purchases that took place during the war. No other expansions have even come close to the figures during this period.
- v) *The components of GDP exhibit much different behaviors than GDP itself* – GDP is a measure of following components: consumption, investments, net exports, and government spending. Durable consumption (e.g. appliances and automobiles) and investments are both more volatile than nondurable consumption (e.g. food and clothing), government purchases and net exports. Durable consumption and investments changes more than output over the business cycle in total (Figure 6).

<i>Component of GDP</i>	<i>Average share in GDP</i>	<i>Average share of fall in GDP during recessions</i>
Consumption		
Durables	8.4%	15.6%
Nondurables	25.8	11.2
Services	29.5	9.1
Investment		
New residential	4.7	20.9
Fixed nonresidential	10.7	11.7
Changes in inventories	0.7	40.6
Net exports	-0.4	-12.3
Government purchases	20.6	3.3

Source: Romer (2001)

Figure 6 Behavior of the components of GDP

Figure 6 shows the difference in how each of the components are affected by a fall in GDP, and also how much each component constitute in GDP. Nondurables and services both constitute a larger average proportion in GDP, than the average share of contribution when GDP is falling. This means that they are relatively more stable than the GDP as a whole, and are only mildly procyclical. Durables on the other hand are much more volatile than the GDP as a whole,

strongly pro cyclical, and a decline in durables can be used as an immediate indicator of peaks and troughs in GDP.

Investments are heavily pro cyclical and more volatile than GDP in total. In a recession, the investments are responsible for 70 % of the changes. Government purchases have 20.6 % of the shares in GDP, but during a recession, the purchases are relatively acyclical meaning that they are only slightly affected by the downturn.

Finally, the net export is a negative balance because the US has had a trade deficit since mid 1980s. This component is therefore not a reliable indicator of peaks and troughs.

- vi) *Business cycles are associated with big changes in the labor market* – Unemployment is a strongly countercyclical variable (moving in opposite direction) that changes significantly during a recession relatively to any other inputs for production. During recessions and expansions, unemployment counts for two thirds of the changes in GDP per capita, while production counts for remaining a third in GDP per capita. (Knoop, 2004)

3.1.2 Gold

Due to more stable economies the last 20 years, and together with the financial markets' "invention" of different hedging substitutes, the interest of gold as an investment has decreased. Due to this, the academic community has more or less ignored researching the possibility of gold as a diversifier. Even though mainstream economists no longer pay much attention to gold, a study conducted by Jonathan Phair (2004) showed that gold still has "great potential for investors".

The main difference between trading with gold and with regular financial assets such as stocks or bonds is that gold is traded from a "store-of-value" point of view, while financial assets are traded in order to secure future income. Consequently, the only gain you will have when investing in gold would be a possible future price increase since it does not yield a return except capital gain (Abken 1980).

As seen in Figure 7, the major supply side factors are recycled gold, mine production and central bank selling, while the demand side constitutes of jewelry, investment and industry demand. Price is the most important aspect considering supply and demand of gold, thus understanding the mechanism of price change will help to understand what drives supply and demand (Solt& Swanson, 1981).

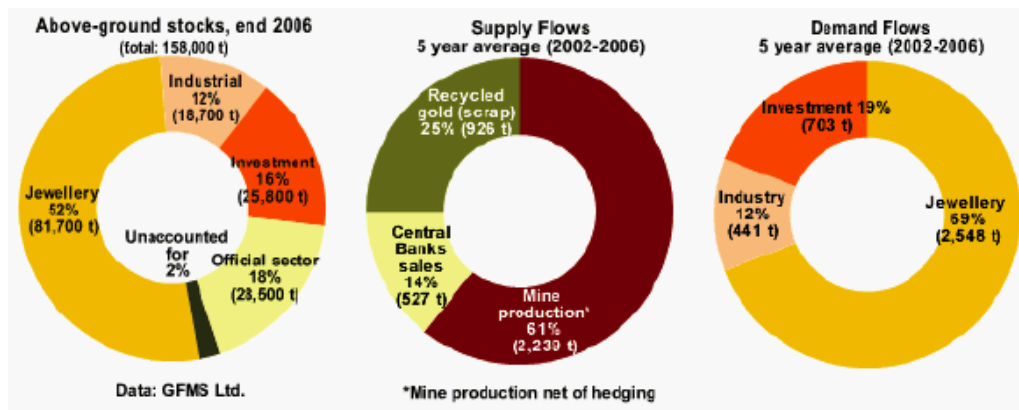


Figure 7 Demand and Supply of Gold (World Gold Council)

A more summarized analysis on the determinants of the price of gold was conducted by Abken (1980, p 6), where he located what he called the "probable causes of gold price movements" as: (i) extreme political and economic uncertainty, (ii) flow supply and demand for gold, (iii) inflation, and (iv) government auction policy.

- i) *Extreme political and economic uncertainty:* Since gold throughout history has had rather unique properties such as scarcity, divisibility, uniformity, liquidity, highly mobile, and almost indestructible. Therefore, it has for long time been highly demanded and together with the fact that the increasing above ground stock level (gold that has been extracted and is on the market) grows very slow (due to requirement in infra-structure, labor, and capital), gold has always been considered a relatively good store of wealth. This makes gold even more desirable in times of high uncertainty, compared to other assets, as people tend to flee to gold to secure their wealth.
- ii) *Flow of supply and demand for gold:* The demand for gold is on one hand the demand of the goods that was produced using gold in industrial production and also of the gold itself i.e. jewelry. While the supply of gold consists of gold ready for market consumption (above ground stocks). An important notice needs to be made, Abken (1980p 7) states that: "The salient characteristic of gold markets is that changes in flows, i.e., changes in the rate of commercial demand for gold or in gold's rate of production, affect the stock of gold insignificantly compared to changes in rates of production and consumption on the stocks of other storable commodities. For this reason flow supply and demand for gold have a relatively small impact on the price of gold." (This section will be treated in depth in section 4.1.2.1 and 4.1.2.2)
- iii) *The price of gold in terms of dollars* is a measurement of the demand of both gold and dollars, relatively. This depends on the believed future rate of return. If the dollar experiences increased inflation, meaning lower dollar value, the relative price of gold should increase by the same amount. For example would a five-percentage increase in inflation rate equal a five-percentage appreciation in gold price. As can be seen in Figure 8, the movement of inflation and gold are following a similar pattern.

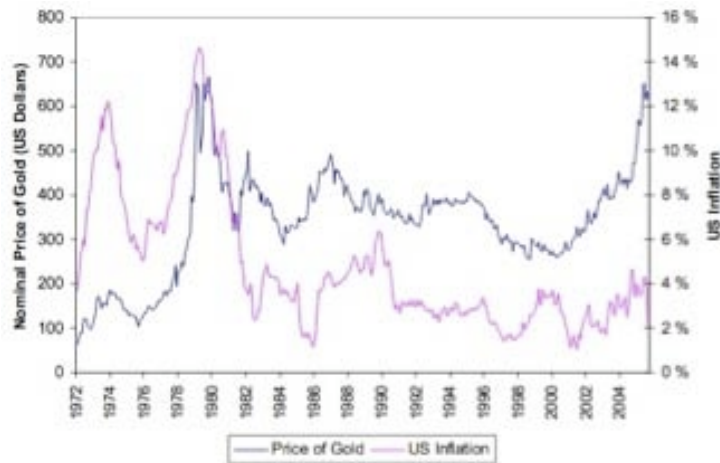


Figure 8 Movement of Price of Gold and US Inflation 1972 - 2004

- iv) *Government auction policy*: Central banks policies of buying and selling gold for their reserves has a big influence on the gold price. Central banks trade gold on special auctions and the market adjusts the price in relation to the announcement of these auctions. So the date of importance is the announcement day and not the exchange day. If a large quantity were sold out, the price would drop and vice versa. Figure 9 displays major world gold holdings 2006.

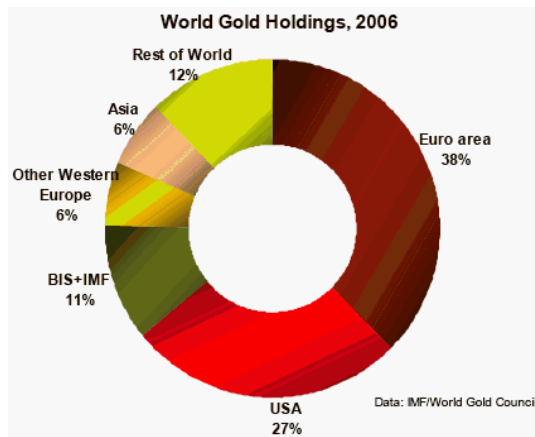


Figure 9 World Gold Holdings 2006

Now two sections of supply and demand of gold will be presented that elaborates on Abken's (1980) part ii), because this is of a more complex nature to understand, and has more variables. However, please note that the most significant impacts of gold price movements presented by Abken (1980) are: uncertainty, inflation and government auction policy.

3.1.2.1 Flow supply of gold

Levin & Wright (2006) stated that the short run supply and demand determinants of the price of gold are harder to predict and calculate than the long run since it contains more variables. They assume in their study that the short run price is determined by supply and demand, while long run price is expected to rise in line with inflation. This is because the long run price of gold is linked to the marginal (additional) extraction cost, and if this cost rises in the same pace as inflation, the price will rise in the same rate (this will be furthered discussed in 4.1.2.3).

The short run supply of gold has three main sources: mine production (or gold extraction), official sector sales, and recycled gold. Extraction constitutes about 70 % of the supply, but bear *no* relation to US or global GDP growth (Dempster 2008), figure 10 shows the total mine production in the world since 1980.

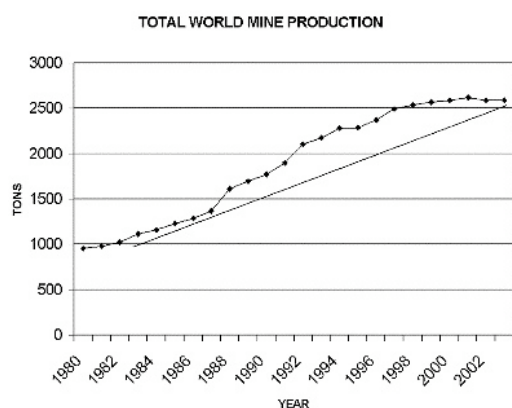


Figure 10 Total world mine production 1980 to 2004 Source: GFMS, Ltd.

What then drives the flow supply of gold?

Firstly, Levin & Wright (2006) concluded that the short run supply of gold mining depends positively on price of gold from earlier time periods since the mining industry experience a strong time lag. The price is negatively correlated to the amount of extracted gold that is used to pay off central banks, for the gold leased in earlier periods, and increased by an interest rate put on the repayment.

Miners lease gold in the first place in order to supply the market on short notice, in case gold demand rises sharply. In equilibrium the lease rate of gold from central banks equals the convenience yield plus the default risk (convenience yield is the benefit of holding gold in storage for safety). Thus, a fall in interest rate, rise in default risk or rise in convenience yield would reduce quantity of gold leased to the miners from the central banks. The previous period of quantity repaid to previous rate leased also plays a role on the price of gold, and this is affected by convenience yield and default risk of that same period.

Summing up the short run supply factors of gold from the mining production is current gold price, current and lagged values of physical interest rate, convenience yield and default risk premium. (Levin & Wright 2006)

Secondly, central bank policies to sell out gold are long term strategic and not heavily affected by economic cycle tendencies. Through various regulations the central banks have limitations both in size and time in their actions to sell of gold. There exist a time lag between decision, proposition, and actual sale (Dempster, 2008).

Lastly, the recycled gold is determined by many factors and is also heavily volatile in nature (Dempster, 2008). This part is hard to analyze and contributes to the notion made by Levin & Wright (2006), that short run supply is harder to predict than long run.

3.1.2.2 Demand of gold

The short-term demand is a function of the "usage demand" (i.e. jewelry, electrical components etc) and "asset demand" (i.e. dollar expectations, inflation expectations etc) (Levin & Wright 2006).

Dempster (2008, p.6) states, "Conventional wisdom argues that recessions are bad for commodity prices". Since consumer and business confidence falls, demand on goods falls, meaning that inputs in production decreases. Since many of these goods are commodities, the price of commodities falls. However, Dempster also notes that gold has some important characteristics that may turn conventional wisdom around. Gold demand for industry is relatively small, thus not relatively vulnerable to business cycles, while gold in electronics is expected to decrease during a recession, since fewer spends less on excess products. Gold in jewelry sector is also more vulnerable than industry demand, but in relation to other precious metals used in jewelries it stands *far better* in a recession.

The demand in total is based on many other factors, micro economic and macro economic factors, such as, dollar exchange rate factors, inflationary expectations, uncertainty in the economy and political turmoil, returns of other assets, and lack of correlation with other assets. Levin & Wright (2006) In addition to this Gotthelm (2005) argues that gold demand is subject to much uncertainty with the war on terror, the possibility that governments' return to gold as reserve backing the currencies, dump reserves, or illegalize trade with gold as in the 1930s.

3.1.2.3 Long Run

The long run supply and demand function presented by Levin & Wright (2006) is a function of inflation as mentioned earlier, thus making a good inflation hedge. Another important notification made by Levin and Wright (2006, p.23-24) is "surrounding the assertion that gold reduces portfolio volatility because the types of events that cause stock prices to collapse also tend to raise the price of gold. There is, however a disagreement about the claim that gold has a "negative correlation" because returns to holding gold have the opposite sign to the returns on a market portfolio".

Thus, as seen the factors constituting the price of gold, are highly various in both impact and variability, making gold behave differently from many assets. Some factors are common for others, like inflation, while others, like extraction costs, are solely affecting the gold price.

3.2 Financial theories

3.2.1 Uncertainty and Herd Behavior

In times of financial turmoil where uncertainty about the market increases, people tend to make more irrational decisions. It is reasonable to assume that investors are more willing to invest in safer forms of investments in fear of losing more money. The theory of herd behavior, derived from the field of psychology, explains how the human kind tends to be more attracted to the behavior of a group rather than an individual act. (Schiller, 1995)

In the financial area, investors put a lot of trust on analysts that are believed to have better knowledge than the average investor. Recommendations made by analysts that have had accurate forecasts are given more trust, and in future decisions, the chance that investors will follow that specific analyst's decision is more likely. In *The General Theory of employment, interest and money*, written by Keynes (1936), he expresses his concern for inef-

iciency on the market because of the influences of group psychology. Herd behavior *undermines* the information efficiency because the market is no longer driven purely by the information given. Analysts are reluctant to make recommendations in accordance with their beliefs and information if it contradicts with the general perception of the market. Instead they choose to give the same recommendation as the rest of the group, the herd. (Scharfstein & Stein, 1988)

In addition, Avery and Zemsky (1998) mean that the market is driven by 'animal spirits'. They argue that both market participants and financial economist believe that investors are widely affected by *imitative* behavior. They are no longer investing rationally; instead they take in influences that are more emotionally attachable.

There are researchers that strongly argue that people consider gold as a safe haven, a safe investment when the economic conditions are unstable and unpredictable. This can be explained by the perception of investors that metals, and in particular gold, is a good diversifier during uncertainty. When other investments are declining, gold usually goes up. Another reason to hold on to gold is because of its indestructible physical character; it does not corrode by acids like silver. It is also an asset that is easily traded in forms of jewelry or other physical form. (Gold.org, 2008)

Solt and Swanson (1981) conclude, on the contrary to the statements above in, their article that gold should not be seen as a traditional investment tool. Although in their research, gold had been performing "excellent returns over the last decade (read 1970s)"; there is a considerable risk with gold because of the fluctuations of the gold price. The gold has its own characteristics, and influences that affect the market in general does not apply to the development of gold.

3.2.2 Modern Portfolio Theory

In this study the Modern Portfolio Theory introduced by Harry Markowitz will be used in order to fulfill the purpose. This theory is divided into two parts, a *Financial statistical section* and a *Portfolio theory section*. The assumptions made in Modern Portfolio Theory are:

- Investors are rational in the sense that they evaluate the desirability of the assets in terms of expected return and risk.
- They are also assumed to prefer a higher level of return to given risk than lower return (Sharpe, 1964).
- Individual investors are price takers and can invest any portion in the risky assets.
- The financial market is free of transaction costs and taxes. (Lintner, 1965)

3.2.2.1 Financial Statistical Section

Return is according to the Oxford Dictionary of Finance and Banking (2005) defined as "the income from an investment frequently referred to as a percentage of its cost." This means the return of an asset can be calculated from the value of the end of the period minus the value in the beginning of the period, divided by the value in the beginning of the period (see Equation 1).

Equation 1 The return of an asset

$$R_t = \frac{V_2 - V_1}{V_1}$$

V_1 = Value of stock at beginning of the period

V_2 = Value at end of the period

As past performance often is used as a possible indicator for the future, expected return can be calculated by taking the average (mean value) of the historical returns. The mean values are obtained by taking the sum of all different historical returns, and then dividing the result by the number of different returns (see Equation 2).

Equation 2 Mean value of return

$$R_A = \frac{R_1 + R_2 + R_3}{3}$$

R_t = Return for period t.

Expected return for a portfolio is then the sum of the weighted averages of the returns for the assets included in the portfolio (see Equation 3) (Markowitz, 1959).

Equation 3 Expected return for a portfolio

$$r_p = \sum_{i=1}^n w_i \cdot E(r_i)$$

$$\sum_{i=1}^n w_i = 1$$

Example:

A portfolio consisting of 40% in stock A and 60% in stock B with the given returns of 20% for stock A and 10% for stock B yields a portfolio return (r_p) of

$$(0.4 \cdot 0.2) + (0.6 \cdot 0.1) = 0.14 \text{ or } 14\%.$$

The risk measurement is usually referred to as the volatility of an asset and is viewed as the degree an asset's return tends to vary around its average or expected return. For an individual asset, risk is measured by variance or standard deviation. Variance for an asset is calculated as the sum of the squared deviations between actual and average return divided by the number of observations (see Equation 4) and standard deviation is simply the square root of the variance (see Equation 5) (Markowitz, 1952). The variance statistic is just the tool used to get to standard deviation, which will be the de facto number. If one calculates the standard deviation from the data set immediately, one would end up with zero fluctuation, due to the cancelling out mechanism between values larger and smaller than the mean value. The variance squares all numbers in order to get the absolute values.

Equation 4 Variance for an individual asset

$$\sigma^2 = \frac{\sum_{t=1}^n (r_t - R)^2}{n}$$

r_t = return for the specific time period (e.g. weekly, monthly, yearly)

R = average return for the entire period

n = nr of observations, if a sample is used n should be replaced by $n-1$. In finance n usually is the nr of time period measured, e.g. $n=5$ if the analysis covers 5 weeks.

σ^2 = the variance

Equation 5 Standard deviation for an individual asset

$$\sigma = \sqrt{\sigma^2}$$

Example:

A portfolio consisting of an asset that has an average return of 10%, shows during three periods, respective returns of 7%, 11%, and 15%. The variance of the asset would be:

$$((7-10)^2 + (11-10)^2 + (15-10)^2)/3 = (9 + 1 + 25)/3 = 11.67.$$

The standard deviation is correspondingly: $\sqrt{11.67} = 3.42$. If one has multiple assets, the variances or standard deviations are summed up.

To compare two assets with different variances (risks), two different statistics called covariance and correlation coefficient can be used. The covariance tells you weather two assets' prices move in the same direction or not (see Equation 6). The overall risk for a portfolio can be decreased if assets with negative covariances are included, as the returns will offset each other. Correlation between assets can be calculated in many ways, in this thesis *Pearson product-moment correlation coefficient* will be used as it is one of the most widely used correlation measures. A correlation coefficient (see Equation 7) scales the covariance between -1 and +1 and tells you in what degree two assets are related to each other. The assets' returns are more connected the closer the correlation is to -1 or +1. A correlation of +1 means the exact same percentage price movement can be expected for the two assets. A correlation of -1 means exact opposite price movements of the same percentage can be expected. A correlation of 0 means the percentage price movements for the two assets are not related at all and are moving without any relation to each other.

Equation 6 Covariance between two returns; R_A and R_B

$$Cov(R_A, R_B) = \frac{\sum_{t=1}^n (R_{A,t} - \bar{R}_A)(R_{B,t} - \bar{R}_B)}{n}$$

n = nr of observations (periods).

$R_{A,t}$ = the return of asset A in period t

\bar{R}_A = mean return for asset A

Equation 7 Correlation coefficient between two assets

$$\rho_{A,B} = \frac{COV(R_A, R_B)}{\sigma_A \cdot \sigma_B}$$

$COV(R_A, R_B)$ = Covariance between asset A and B.

s = variance for the individual assets

The risk for a portfolio of assets is measured by the portfolio variance (as mentioned earlier) (Markowitz, 1959).

3.2.2.2 Portfolio Theory Section

When constructing a portfolio the investment decision process can be conducted in a top-down process. The first implication of the investment decision should be the capital allocation, between risk-free and risky assets. Secondly, the asset allocation should be made, deciding the relative quantities between the different risky asset classes, the area in which this study will be conducted. Last, one should conduct security selection, thus deciding between the different securities within each asset class. (Bodie, Kane and Marcus, 2008)

Firstly, the portfolio variance (see Equation 8) can be found by combining all the variances of the individual assets in the portfolio with all the covariances between the very same assets weighted by their market weights. The portfolio variance can be lowered if assets not perfectly correlated to any other assets in the portfolio are added to the portfolio (Markowitz, 1959).

Equation 8 Variance of a portfolio

$$VAR(p) = \sum_{i=1}^n w_i^2 \sigma_i^2 + \sum_{i=1}^n \sum_{j=1}^n w_i w_j COV(R_A, R_B)$$

w= asset weight in the portfolio

σ_i^2 =variance for the individual asset

COV(R_A, R_B)= Covariance between asset A and B.

When having two risky assets (i.e. gold and DJIA), experimenting with the weights of the assets produces different expected returns and risk combinations to each corresponding weight. All combinations of portfolios that can be created from a set of assets are usually referred to as the opportunity set (see Figure 11). Each dot inside the opportunity set is a possible set of portfolios, and the point at the far left in the middle represents the Minimum Variance Portfolio, where the standard deviation is the lowest. The number of portfolios that can be created depends on the correlation coefficient between the assets in the portfolio; the more positive the correlation between the assets is, the less portfolio combinations can be utilized. (Sharpe, 1964) (see Figure 12).

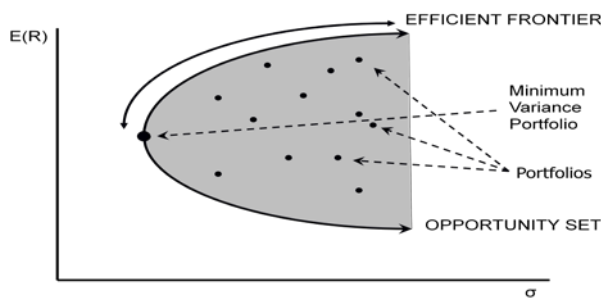


Figure 11 Opportunity set of a portfolio

Even though combining different weights of assets can create a big number of possible portfolios, most of them will likely be inefficient, located on the "inside" of the opportunity set. "If a portfolio is inefficient, there is either some other portfolio with more average return and no more standard deviation, or else some portfolio with less standard deviation and no less average return. In the case of most inefficient portfolios there are portfolios which have both more average return and less standard deviation." (Markowitz, 1959).

The graph below shows possible combinations of two assets (assets A and B) with different correlation (the vertical axis describes return and the horizontal axis the risk). As can be seen, when having a correlation value of +1, there is a straight line between A and B. As the correlation decreases, this line concaves to the left indicating a lower risk for the same return.

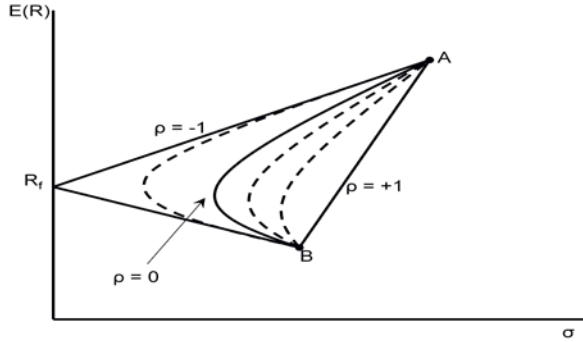


Figure 12 Return to risk ratio with different correlations

Investors should according to Markowitz (1959) E-V (Expected return – Variance) theory, only construct portfolios where assets are weighted in a way that either gives maximum return for a *given level of risk* or *minimum risk for a given level of return*. These portfolios are called efficient portfolios and form a curve called the efficient frontier (see Figure 12) when plotted in a graph. When a portfolio is located on the curve, it is called efficient. "If a portfolio is "efficient", it is impossible to obtain a greater average return without incurring greater standard deviation; it is impossible to obtain smaller standard deviation without giving up return on the average." (Markowitz, 1959, p. 22).

To the left of the efficient frontier return-risk levels are unattainable with the current asset allocations, if one does not include risk-free rate (Markowitz, 1952).

Two portfolios that always can be found on the efficient frontier and ease the search for other efficient portfolios are the minimum variance portfolio and the optimal risky portfolio. The minimum variance portfolio (see Equation 9) is the portfolio with the lowest risk (variance) on the efficient frontier and the optimal portfolio (see Equation 10) is the portfolio with the highest return to risk ratio on an efficient frontier. These portfolios can be found both mathematically and graphically.

The weights for the minimum variance portfolio for a portfolio consisting of two risky assets can be found by this formula:

Equation 9 Weights for the minimum variance portfolio (MVP)

$$W_A = \frac{\sigma_B^2 - Cov(A,B)}{\sigma_A^2 + \sigma_B^2 - 2Cov(A,B)}$$

$$W_B = 1 - W_A$$

The weights for the optimal portfolio for two risky assets can be found by this formula:

Equation 10 Weights for the optimal portfolio (OP)

$$W_A = \frac{[E(R_A) - R_f]\sigma_B^2 - [E(R_B) - R_f]Cov(R_A, R_B)}{[E(R_A) - R_f]\sigma_B^2 + [E(R_B) - R_f]\sigma_A^2 - [E(R_A) - R_f + E(R_B) - R_f]Cov(R_A, R_B)}$$

$$W_B = 1 - W_A$$

In order to find the optimal portfolio graphically the Capital Market Line (CML) first has to be found. The CML is the line that gives the relationship between risk and return, including the risk-free rate. To find the CML, a portfolio must first be constructed, based on the assumptions that investors invest a certain amount in a risk free asset (x) and the rest in the market portfolio e.g. DJIA ($1-x$).

The return for the constructed portfolio (see Equation 11) can be calculated by this formula:

Equation 11 Return for the constructed portfolio

$$R_p = (1-x)R_m + xR_f$$

The variance for the portfolio (see Equation 12) can be calculated by this formula:

Equation 12 Variance for the constructed portfolio

$$\sigma_p^2 = (1-x)^2 \sigma_m^2 + x^2 \sigma_f^2 + 2x(1-x)\sigma_{mf}$$

What is left of the portfolio variance (see Equation 13) is the squared weight of the market portfolio times the market portfolio variance.

Equation 13 Variance for the constructed portfolio

$$\sigma_p^2 = (1-x)^2 \sigma_m^2$$

The standard deviation can be found by this formula:

Equation 14 Standard deviation for the constructed portfolio

$$\sigma_p = (1-x) \sigma_m$$

After the portfolio is created, the CML can be found by combining the variance and return for the constructed portfolio. The intercept for the line will then be the risk free rate, and the slope is referred to as the market's *reward to variability ratio*. This ratio tells you, which return you can expect for a certain risk and vice versa for the market portfolio, (see Equation 15) (Sharpe, 1964). As the two assets' weights must sum up to 1, the CML must be a straight line. If one include a risk-free asset, one get a superior return to risk ratio of this combination to all efficient portfolios, since the risk-free rate has return for zero risk.

Equation 15 Capital market line

$$E(r_p) = R_f + \left(\frac{E(r_m) - R_f}{\sigma_m} \right) \sigma_p$$

The intercept for the line is R_f (the risk free rate), the slope for the line is:

Equation 16 Slope of capital market line

$$\frac{E(r_m) - R_f}{\sigma_m}$$

The portfolio with the highest return to risk ratio (Sharpe ratio) on an efficient frontier, as mentioned earlier, is the optimal risky portfolio. The mathematical approach has already been discussed. The optimal portfolio can be found graphically at the tangency point of the

efficient frontier with the CML. When doing that, the CML will meet the efficient frontier at one point and that point is where the optimal portfolio (OP) can be found see Figure 13, (Sharpe, 1964).

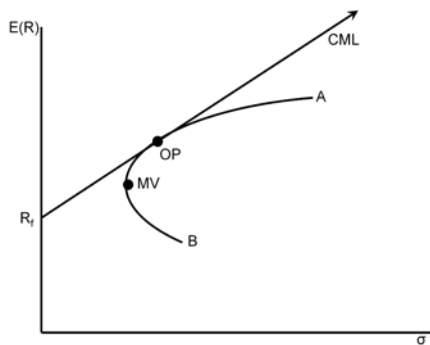


Figure 13 Efficient frontier, CML and the location of optimal portfolio

This graph shows the efficient frontier for a combination of the two risky assets A and B. The point A shows the expected return and risk when putting all money in A, and B shows the expected return and risk when putting all money in B. MVP shows the minimum variance portfolio, i.e. the portfolio with the lowest risk for the combinations of the risky assets A and B. It will *always* be located at the furthest left point at the efficient frontier. OP shows the optimal risky portfolio i.e. the portfolio that *tangents* the CML and has the highest return to risk ratio (Bodie, Kane, Marcus, 2008).

4 Historical Background

As this study is based on historical data, it is important to have knowledge about the related history. This part will present the reader with a brief introduction to DJIA and gold. After that, DJIA and gold development during each recession will be treated, together with graphical illustrations. Recession 2 and 3 are put together due to the close connection in time and possible shared causes and effects.

4.1 Dow Jones Industrial Average

The Dow Jones Industrial Average (DJIA), originally named Dow, Jones & Company, was established in 1882 by Charles Dow, Edward Jones and Charles Bergstresser on 15 Wall Street in New York (Dowjones.com, 2008). At first, only nine industrial stocks were included, but today, it is an index for the 30 largest so-called Mega Cap world-known companies such as Proctor & Gamble, Coca Cola Company, and Microsoft (see Appendix).

DJIA is a price-weighted index, meaning that the price of the stocks is divided by the amount of stocks regardless of the relative size. This in turn means that the most influential stocks are those with the highest prices, and if an investor wants to compare the returns on stocks, he would need to buy the same amount of stocks with heavily varied prices. This is not optimal and rational way of investing and it is one of the weaknesses with DJIA. Another disadvantage is that the index only contains 30 US based companies, and industrial firms represent most of them, which leave many of the companies in the information technology industry outside. However, DJIA is the oldest and first index in US and when people are referring to about how 'the market' is doing, DJIA is the most commonly used index. (The Motley Fool, 2008)

It is not unusual to question the accuracy of DJIA because it is a price weighed index instead of a market value weighted index. But when the movement of DJIA was compared to S&P500, which contains 500 companies from Large Cap in the US, the correlation was 0.9487 in the long run and 0.9661 in the short run. (See Figure 14 for short run development). The high rates indicate the accuracy and are significant, which means that the DJIA is a trustworthy index that reflects the average movement of the stock market just as well as S&P500.

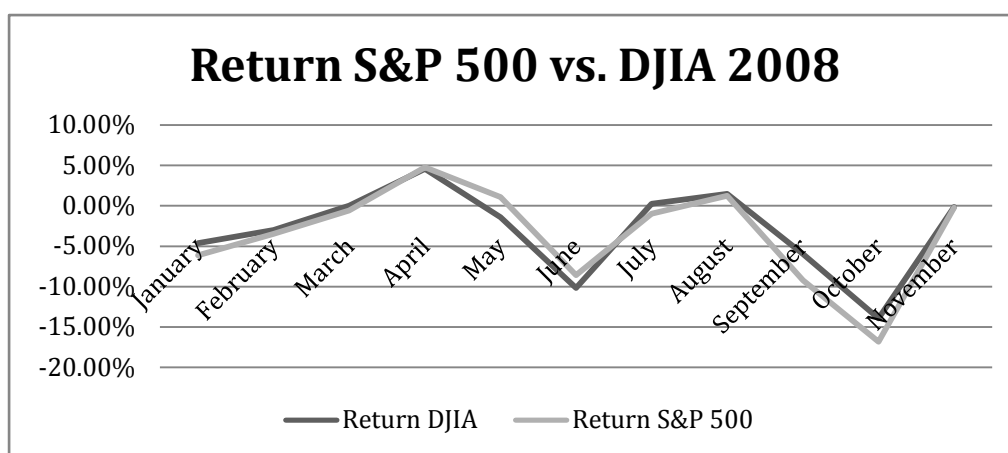


Figure 14 Correlation between S&P500 and DJIA 2008

4.2 Recessions

The National Bureau of Economic Research (later referred to as NBER) is the official organization that announces when a recession starts and ends in the US, and makes other important statistics for the US economy. NBER's (2008) own definition is:

“The NBER does not define a recession in terms of two consecutive quarters of decline in real GDP. Rather, a recession is a significant decline in economic activity spread across the economy, lasting more than a few months, normally visible in real GDP, real income, employment, industrial production, and wholesale-retail sales.”

The reasons why a recession occurs can differ from time to time. As mentioned earlier, there are several theories, which explain business cycle occurrences from an external and internal point of view. It can start as a reaction to exterior causes such as natural disasters, terrorist attacks or collapse of larger institutions. Internally, the inflation, interest rate and monetary policies can also cause a downturn in the economy. In most cases however, the Fed are trying to protect against an increasing inflation rate, by tightening the money supply, which in turn affects the components of GDP; consumption, investments, net export and government purchases.

4.2.1 Recession 1 1973-11 – 1975-03

The recession that started in 1973 was the second largest downfall in the US economy since the Great Depression in the 30's. The economy was unstable in the 1970's, mainly due to the largest corporate collapse in the US history, the Penn Central Railroads that shook the financial markets. The Fed tried to ease the crisis by increasing the money supply, and up to 1973, the effect of the increased liquidity boosted the economic activity. However, even though inflation rose, Nixon (President at the time), was not able to carry out wage and price control and instead he decided to continue supply with money to the economy. (Knoop, 2004)

Another important reason to the high inflation was the abandonment of the Bretton Woods system, where other exchange rates were fixed to the American dollar. In 1971, the US removed the convertibility for gold into dollar, and in 1973 the dollar was floating and enabled even more money growth. The inflation peaked at 5.9 % in 1973 and the real GDP growth was at 5.3 %. However, the main shock to the economy came when OPEC (The Organization of Arab Petroleum Exporting Countries) imposed oil embargo in October same year. The embargo made the oil price rise 300%, from \$3 - \$12, which in turn started to spin off a chain of negative effects (see Figure 15). Firstly, it reduced real income, which in turn resulted in reduced aggregate demand. Second, and more importantly, it decreased the aggregate supply in two ways; one, it made existing technology and capital stocks too expensive to use; two, it increased the marginal costs for industries where oil was a crucial input. (Knoop, 2004)

In 1975, the inflation turned into stagflation (a status in which the economy experiences both high inflation and unemployment) with a rate that had ran up to 12.1% and unemployment had increased from 4.8% to 8.9% from 1973. This recession was the worst since 1930's and classical economic models on business cycles were discredited, mainly because they could not explain the stagflation phenomenon. In 1975, the oil embargo loosened, and the price of oil and inflation dropped significantly. The economy started to recover with help from the Fed that increased the money supply again. (Knoop, 2004)

4.2.1.1 Price movement of Gold Recession 1

The 15th of August 1971, president Nixon closed the gold window, suspending all further convertibility of USD to gold at 35 USD, in order to strengthen the dollar and stimulate the economy. This had the effect that gold price started to rise, since it was artificially kept at a low rate. As the Soviet Union and South Africa stopped selling gold, decreasing the supply, price soared 14 % in about two weeks. Later the gold price peaked when the European Community countries' stated that they would use a higher rate than earlier decided (38 USD instead of 35 USD), when valuating the official reserves. (World Gold Council, 2008)

In 1973, the US trade deficit generated speculation against the dollar, and together with the devaluation of the dollar, and the liberalization of the Japan gold market, the gold price reached all time high of 127 USD. 1973 was overall a turbulent year; first, because of the collapse of the Penn Central Railroads and its after affects, secondly, because OPEC halted exports of oil to nations supporting Israel, leading to four time increase of oil price as mentioned earlier (see Figure 15). This hit the aggregate supply in the US economy. Though, this only generated a marginal change upwards in the gold price at that time. (World Gold Council, 2008)

In the beginning of 1974, gold prices soared as a political turmoil broke out in France. In July the same year monetary policy around the globe was rigid and sale out of gold hoardings were done in order to boost liquidity, and therefore the price of gold was lowered to 129 USD from 180 USD (see Figure 15). The oil price increase caused by OPEC, pushed global inflation (with US inflation at 11 %), again increasing demand of gold. (World Gold Council, 2008)

In 1975 US held its first auction of the gold holdings, meaning that citizens were allowed to exchange and own gold and the next year the IMF held its first auction. Now this auction was not well received in the face of stagflation, as mentioned earlier, since people had less money to spend. (World Gold Council, 2008)

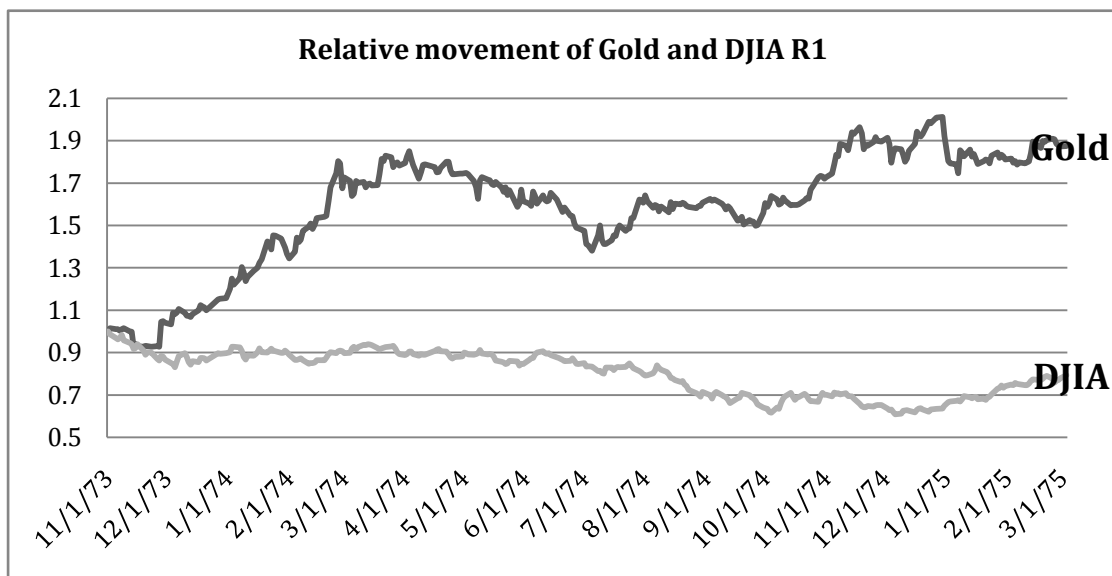


Figure 15 DJIA and Gold development during Recession 1

4.2.2 Recession 2 1980-01 – 1980-07 and Recession 3 1981-07 – 1982-11

The recession of 1980 was the shortest recession in US economic history with only six months of steady downturn. With very little growth in the end of 1979, almost all macroeconomic data slowed down in the beginning of 1980. The real GNP growth fell 9.9% indicating a strong cyclical contraction and a serious recession. The Fed imposed stronger credit restraint that made the private borrowing drop 51% in second quarter of 1980 (see Figure 16), and at the same time, the interest rates peaked at 20%. In the third quarter, the interest fell abruptly to 7%. Later this year, the Fed loosened the credit control, and the private borrowing increased again, spiraling in decreased consumer prices, and stable interest rates together with a positive consumer expectations and attitude (see Figure 16). (Zarnowitz & Moore, 2008)

Shortly after the recession in 1980, the most severe economic contraction since the Great Depression was taking place in 1981 – 1982. Like earlier in US economic history, the Fed feared accelerating inflation rate, and in order to hinder the increase, the money supply was severely contracted. According to a study made by Romer and Romer (1994) the industrial growth dropped by 4% a year during years of recessions (cited in Knoop, 2004). They argued further that this would not have been the case if the Fed had not worried about the inflation to a great extent. Rudy Dornbusch (1997, p. 171), an MIT economist, took a step further and argued that “None of the U.S. expansions of the past 40 years died in bed of old age; everyone was murdered by the Federal Reserve”.

4.2.2.1 Price movement of Gold Recession 2 – Recession 3

In 1979, the revolution in Iran broke out, leading to heavy US sanctions of the country. In addition the Soviet Union invaded Afghanistan in the end of the year, yielding a strong increase in the price of gold, because of the global turmoil (see p. 12). This had a great effect on gold, which responded to the political uncertainty, leading to gold peaks at 850 USD (see Figure 16), an all time high after the Soviet invasion. At this time, jewelry demand decreased sharply during the recession while the official sector became a net buyer. In March 1980, gold price had dropped 43% in two months (see Figure 16). In May, IMF completed the four-year sales plan, and conducted its fifth auction for 1980. Later the same year, the first Gulf War broke out in September, leading to higher oil price and inflation. (World Gold Council, 2008)

After soaring gold prices in 1979 and 1980, the prices fell almost 200 USD in 1981 (see Figure 17) after record high interest rates, where the Fed Funds rate was 19% in June 1981 (this in order to hinder the accelerating inflation). Thus, in this recession gold price decreased as more people put their wealth in interest bearing bills. In addition as the Fed intervened in the market in 1982, the confidence in the American dollar was restored and inflation decreased, which lowered demand for gold (see Figure 17) (see 4.1.2) (World Gold Council, 2008).

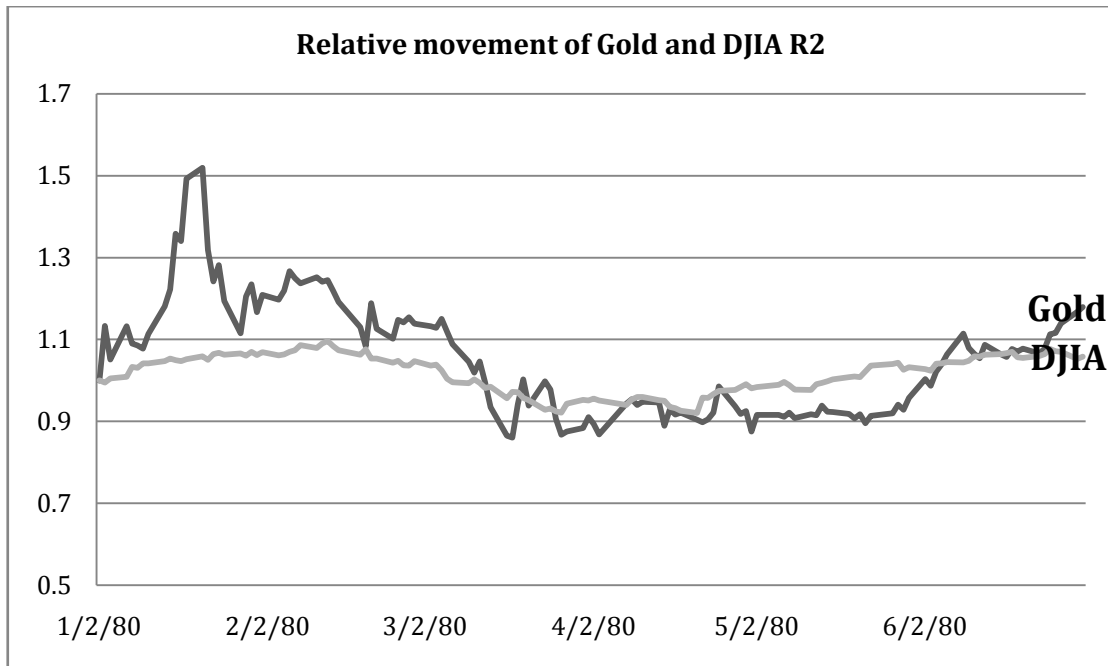


Figure 16 DJIA and Gold development during recession 2

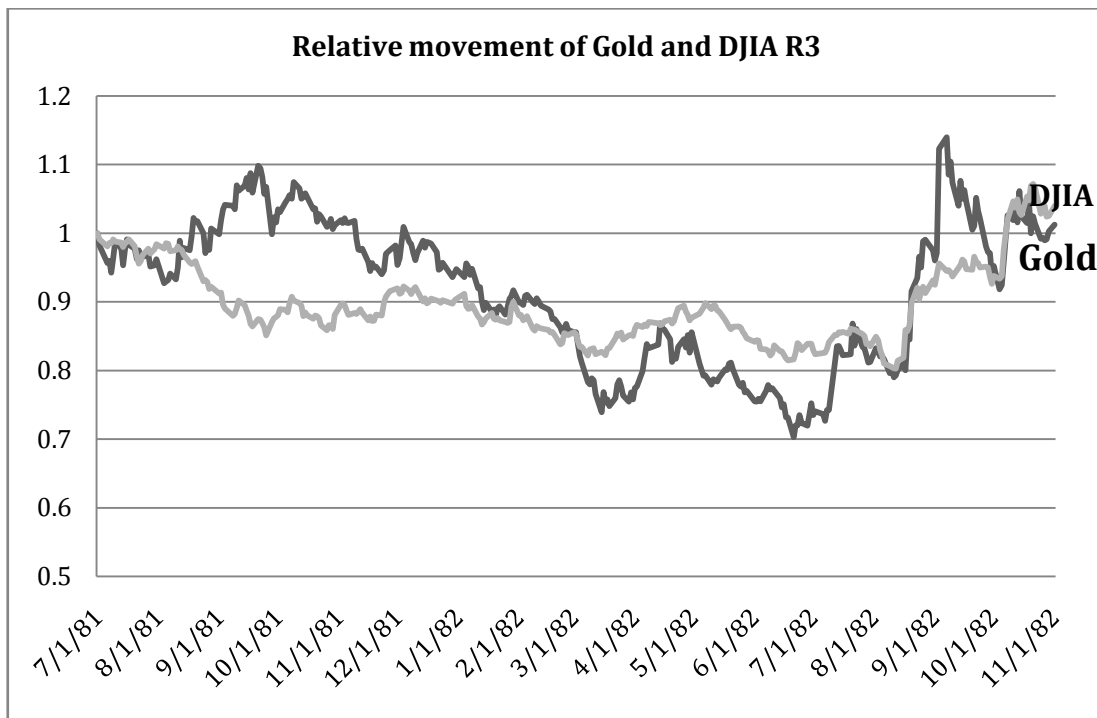


Figure 17 DJIA and Gold development during Recession 3

4.2.3 Recession 4 1990-07 – 1991-03

There are several theories on why the recession during this period actually occurred. In July 1990, the US economy had experienced the longest post wartime expansion in the economic history. The downturn has been explained by shifting consumer preferences, the oil price shock caused by Iraq's invasion in Kuwait and once again, the Fed's attempt to hinder the inflation by monetary policies. The inflation had risen from 1.2% in 1986 to 4.4% in

1989. But already in 1986, the Fed had sensed that inflation could be a possible outcome, and in order to reach zero-inflation (which was argued by experts to spur average real economic growth) they imposed a contraction policy. However, in early 1989, the aggregate spending factors turned down sharply and eventually put the slowly growing economy into recession. (Walsh, 1993)

According to Poole (2007), the 75% oil price increase caused the main downturn in the economy. The oil shock began in August 1990, and in October the same year the inflation was at 6.4%. Hamilton and Herrera (cited in Poole, 2007) meant that there was a correlation between increasing oil prices and down turning economies. The price increases in 1973, 1979 and 1990 all led to a recession within a year in the US economy. However, Poole (2007) wanted to point out that even though the oil prices (an external factors) could trigger a recession, it would not be possible to create a recession if the economy already was not over heated (Siegel 2007).

4.2.3.1 Price movement of Gold Recession 4

In first nine months of 1989 gold prices moves downward due to forward sales in Australia and still high interest rates, but gold recovered in the end because of speculative buying at the height of the Tiananmen Square protest in Beijing, adding uncertainty in the global community. The price again moved down shortly after to a three-year low of 355 USD, and changed direction up to 400 USD again after speculative buying. (World Gold Council, 2008)

The gold price started very volatile in the 90's, first down under mistrust against covert selling from Soviet, and further down in March when a major bank in the Middle East liquidated large amount of its holdings (read section 4.1.2 for further information). Although gold price soared shortly when Iraq went into Kuwait in August, the ending rate was as the beginning of the year (see Figure 18). The price increased to 403 USD when the Allies went into Iraq in January 1991, but went quickly down again due to overall global stability before the end of Soviet Union. When the Soviet Union was dissolved, gold investments went down since the political tension was remarkably decreased. (World Gold Council, 2008)

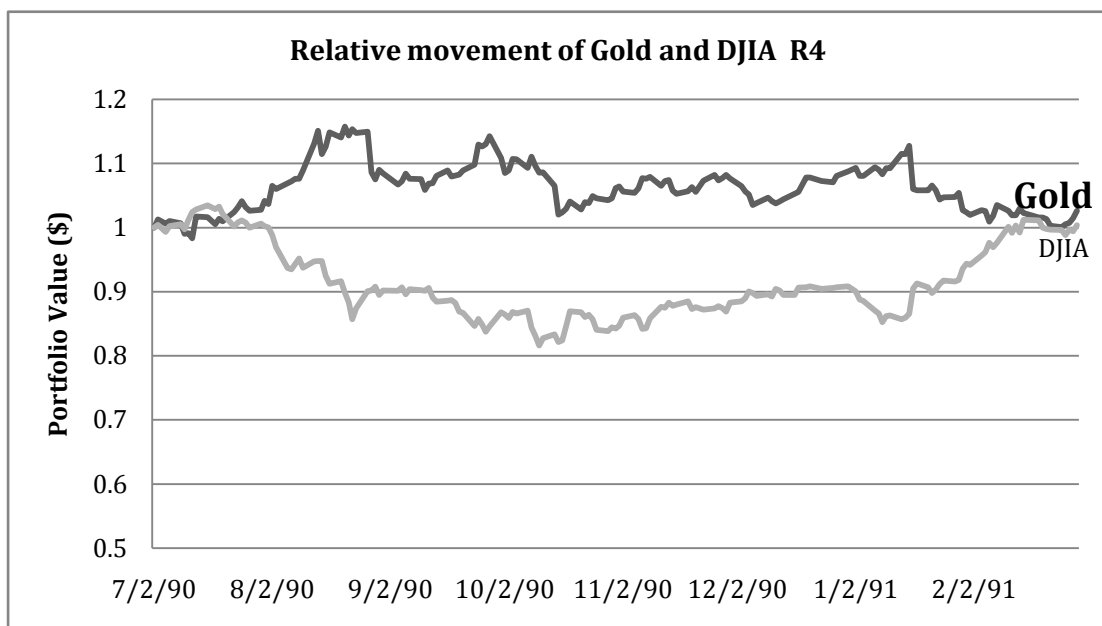


Figure 18 DJIA and Gold development during recession 4

4.2.4 Recession 5 2001-03 – 2001-11

In the recession in 2001, the market was over heated after a new record of longest consecutive expansion in US history of exactly ten years. The length of the recession was slightly shorter than the average in the postwar economy. The impact of the World Trade Center attack cannot be exactly measured, but it is argued that the incident might have slowed down the recovery from the GDP fall of 1.6 % in the second and third quarter of the year. Right after the attack, the DJIA experienced the largest one-day drop, and the following week was the worst one-week drop in history (see Figure 19). (Lin & Schmidt, 2002)

Since the air transport industry only constitutes 0.8 % of the national output, the US economy was still able to grow again after the trough in November. However, the national spending on defense and the societies' fear was probably reflected in the aftermath in the economy. (Lin & Schmidt, 2002)

The industry that was hit hardest by the recession was the production and high-tech investment industry. Three quarters before the recession, aggregate industrial production and non-residential investment started to decline in a fast pace. By the first quarter of 2002, production had been reduced 5.8 % and investments 11.4 %, which was far worse than the total GDP decline. The high-tech industry that had had an amazing growth starting in the mid 90's, crashed during the so called 'dot.com bubble' and the recession was a difficult obstacle to overcome. (Lin & Schmidt, 2002)

Consumption, constituting more than 60 % of GDP, at this time was relatively stable compared to earlier recessions. It did not decline, but the annual rate of 4.0 % that had started two years before the recession was put on hold during the first three quarters in 2001, and started to grow again the following two quarters with an average of 3.8 % annual growth. In this sense, this recession has been described as a shallow recession. (Lin & Schmidt, 2002)

4.2.4.1 Price movement of Gold Recession 5

The market had gone through a fundamental difference in the beginning of the 21st century; now investors were net sellers of gold too. As the dollar strengthened, the Fed conducted sales of gold together with an economic slowdown, the price of gold was under a lot of pressure, and ended 2000 at 274 USD, a yearly difference of only 7 USD compared to the start price of the year. (World Gold Council, 2008)

In 2001, the gold price went into a bull market after long time of side tracking. This was because of stronger investment demand under strong market forces such as the collapse of Australian company Centaur Mining in May (see how this affects gold price in 4.1.2). This made the price rally from 265 USD to 291 USD since rumors spread that the company's hedge book would be repurchased. Price again rallied 20 USD in September due to the 9/11 attacks (see Figure 19)(see how this affects gold price in 4.1.2). (World Gold Council, 2008)

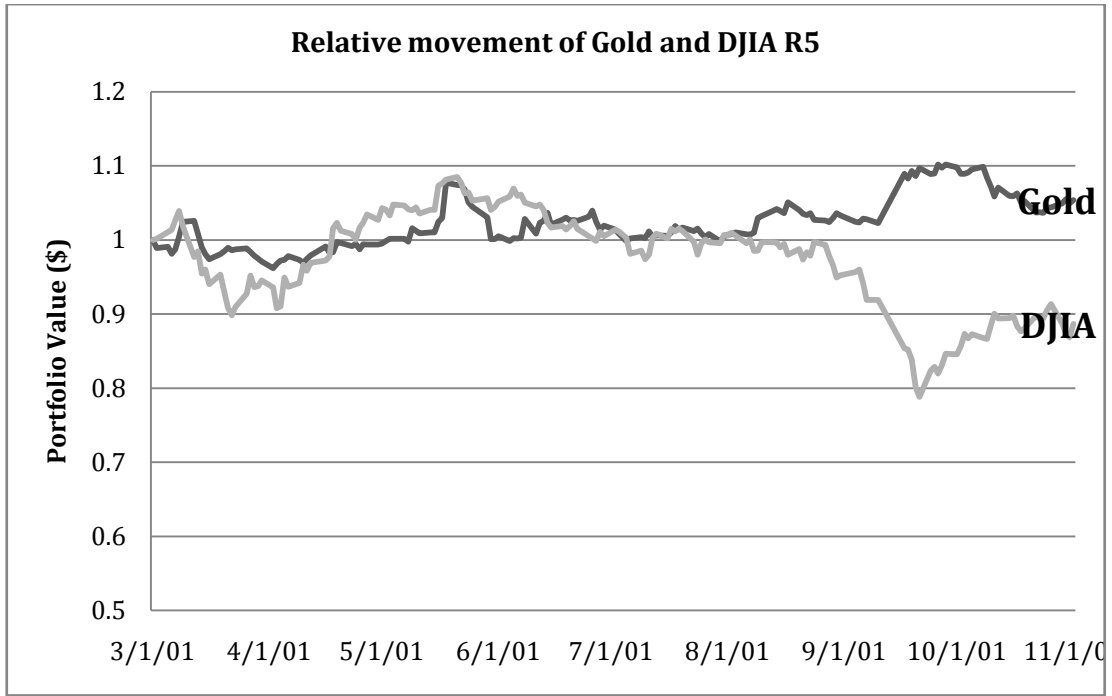


Figure 19 DJIA and Gold development during recession 5

5 Method

In this part, our choice of research method will be presented. Further on, our method for collecting and the manipulation of the data will be presented and the criticism against it, along with assumptions made for the analysis.

5.1 Quantitative data collection

In an academic research, there are two main methods of collecting data; through qualitative or quantitative data. According to Fred Kerlinger (1994, p. 40) “There’s no such thing as qualitative data. Everything is either 1 or 0.” In this sense, Kerlinger questioned the validity of qualitative research and instead promoted the quantitative data collection method. With this, we would like to continue argue for our choice of conducting quantitative data collection.

Firstly, quantitative research assumes that facts have an objective reality, variables can be identified, and their relationships measured. A quite understandable point as quantitative data is all about numbers. The purpose with this approach is to generalize facts and understandings, and not to think too much about the individual case, but instead what it means for the science in general, (Glesne & Peshkin, 1992).

As mentioned earlier, quantitative data can be described as research in which the focus lies on numbers, statistics and facts. Quantitative data can be obtained from surveys or data already collected and presented by others (referred to as secondary data, which is handled in subsection 6.3). As the name refers to, the quantity or mass of data handled should be substantial and essential. In general, quantitative data gives a broad, general answer to the problem, while qualitative data lets you get deep into the question and understand why and how things are as they are (Jacobsen, 2002).

According to Creswell (2008), quantitative researches relies on empirical data, objectivism and in general tries to verify theories and use standards of validity and reliability. The quantitative method is therefore more appropriate for our purpose because we needed to rely our study on objective historical data. We did not conduct any surveys or questionnaires by ourselves, instead we used secondary data to reach to our empirical findings. Because we are looking for a general answer to our problem, this method was chosen as the most suitable.

In depicting the main difference between quantitative and qualitative data, Strauss (1987) says: “(qualitative researchers) have quite different investigatory styles, let alone different talents and gifts, so that a standardization of methods ... would only constrain and even stifle social researchers’ best efforts” (cited in Coffey & Atkinson, 1996).

5.2 Deductive approach

The deductive research approach is a logical pathway in thinking how to derive knowledge through scientific methods. The deductive approach refers to determining a theory of reality and then testing it to confirm it. The researcher has an idea of reality in beforehand, and investigates the problem in order to see whether it holds or not. Thus, the researcher starts at the desktop to formulate ideas about how the world works, and then goes out and test the theory. This method is also known as a “top-down” approach; the researcher develops a theory, sets up hypotheses for the specific research question, collects and analyzes data, and finally sees whether one can reject or not reject the hypotheses (see Figure 20). (Zikmund, 2000)

The general comprehension of gold and its advantages during a down turning economy is something we have looked specifically into. We have started the research process by reading theories concerning price movement of gold, recessions, and portfolio theories; everything needed for us to be able to answer our research questions. We have chosen not to set up a specific hypothesis since we are not only looking at one particular question where we can either accept or not accept a result.

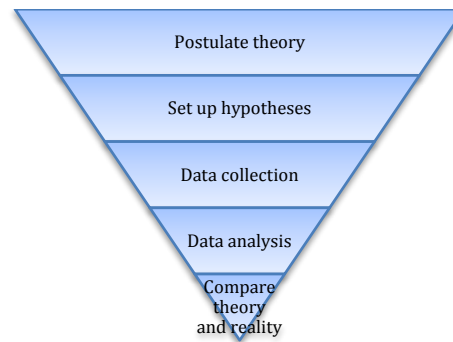


Figure 20 Deductive approach

5.3 Secondary data

Secondary data is data that has previously been gathered by other researchers for other purposes and is reused of the current researcher. Secondary data includes for example statistics from government, private institutions, and scientific research. It is vital to check if the data used from other sources have been gathered in a scientific way, is not subject to constraints from special interest groups, and is biased. (Befring, 1992)

An advantage of secondary data is that other researchers already have gathered the data needed. This decreases the time spent of gathering preliminary data, in addition when it is already gathered; it has probably been scrutinized prior to the research at hand. This generally leads to more correct input data with fewer errors. However, because secondary data was collected for another purpose by the original authors, it is important to bear in mind that the data can be insufficient for the new authors. (Saunders, Lewis & Thornhill, 2003)

For this research, all data and information was taken from secondary sources. We collected data from databases where historical data was stored. For the historical background, where the information about the recessions and gold was presented, we tried to use as many different sources as possible in order to escape from author's biases and special interests.

5.4 Research process

In the Problem Discussion (section 3.2), we discussed how we arrived to the conclusion of selecting the research questions. We discussed and philosophically derived the problems of the paper. In the Approach (section 3.4) we laid out the “map” of the study, an outline of how we were about to answer the questions with support of the theories and concepts chosen.

In this chapter we specify how we actually went about to answer the questions stated in a more definite manner. For this study, previous research within the field of gold as an investment in general, as a diversifier and as a commodity was investigated. Articles, journals,

research, books, e-books and newspapers within the field were used, in order to improve the understanding of the topic, and to be able to analyze the data collected.

It was vital for us to enhance the understanding of the topic. Course literature was used with caution mainly when trying to define certain terms that are general within economics and finance. Even though course books are not recommended to use in an academic paper, they were not ruled out entirely, since they contain valuable information with more easily interpreted explanations. In most cases we turned to course books in the first hand to get an overview of the theories and then extended this knowledge with the original sources where we found more specific and more professional input for the subject in matter.

The World Gold Council (www.gold.org) provided us with valuable information concerning gold and its usage, and since it is constantly updated with new research within gold and its usage, we believed it was a reliable source. It is a web site made by the world's largest gold mining companies, and there are publications made by researches where they are arguing both for and against gold. However, this information was used with caution since the researchers probably had some subjective biases.

Due to the nature of our purpose and research questions, we chose not to conduct any own interviews or surveys (qualitative data collection). First, because this would give a somewhat biased view of the responders' own "clouds" and beliefs. Secondly, since our purpose has a strict statistical nature, and the appropriate way was to use a quantitative approach. Thirdly, we felt that it was more important for the study to find more general answers to our stated problems, than to know how a specific company or hedge fund were working.

5.5 Collection of data

Before we decided to focus on US data, we did a pilot study where we calculated the correlation between gold and FTSE on the London Stock Exchange. Unfortunately, it was challenging to find adequate information and data for the recessions in the UK, and also to find data from the stock market that went sufficiently far back in time. We were however still interested in investigating in gold and its diversifying possibilities, and therefore we changed the focus to DJIA and the economic history of the US. The data availability was far more accessible and there were many useful websites on the Internet where earlier researches and papers were presented within the field for the US.

To fulfill our purpose we needed to acquire historical data for gold, DJIA and US treasury bills. Data for US treasury bills was needed in order to calculate the capital market line and the optimal risky portfolio. For the calculations in each recession, *daily* historical data for gold and DJIA was collected in order to cover all the fluctuations within that time span. However, for the long time analysis, 1970 – 2008, we used *monthly* data instead as we reasoned it would give a sufficient picture of how the movement of gold and DJIA had been.

Historical data for DJIA and for US treasury bills could easily be found on various web sites like Yahoo Finance and Google Finance. These sites provided compiled data in forms of Excel sheets, and made the process of collecting data efficient for us. When deciding which US Treasury bill to chose, we decided to use the 13-week T-bill mainly because in the original Modern Portfolio Theory by Markowitz, it was stated that this would yield more appropriate results. More about this will be presented in our assumptions in section 6.7.1.

The data for gold on the other hand was much harder to find. We were not able to find daily data for gold online and had to look at other places. With advice from a librarian at Jönköping International Business School, a computer program called EcoWin was used to gather all relevant historical data for gold, silver, oil and the Reuters-CRB Index (later referred to as CCI, a commodity index) and DJIA. Data for DJIA was collected once again from EcoWin to obtain more consequent data even though data was obtained earlier from Yahoo Finance. Thus all data, except for US treasury bills, were obtained from EcoWin to simplify our data collection. The data for silver, oil and the commodity index was collected for comparing purposes, and will be presented after the results and analysis of gold and DJIA to present more interpretative result.

Furthermore, the data for oil could not be fairly interpreted in all recessions. The price of oil was in the first three recessions periodically static, and therefore we chose to exclude this from our findings. Instead, only the data for oil for the two latest recessions will be displayed and compared to gold in the analysis. Despite the fact that there are data missing to fulfill the findings, oil was chosen because it is an important commodity for the industrial world, and has a great impact on the world economy.

5.6 Use of Data

By applying the modern portfolio formulas to our data in Microsoft Excel, we were able to directly find out the expected return, total return, standard deviation, covariance and correlation for gold, DJIA and the other assets. When these variables were calculated, we were able to draw some conclusions whether an inclusion of gold could improve the performance of an index portfolio or not. But these variables did not give us any ideas about *how much* gold one should own to minimize risk or get the highest return to risk.

To find these allocations we had to apply the formulas for minimum variance portfolio and optimal risky portfolio. Both formulas could directly be applied to our data in Microsoft Excel, however the formula for the optimal risky portfolio gave a somewhat misleading result as it allowed negative allocations i.e. -150% in Gold and +250% in DJIA (accepting short selling alternatives, which we do not want to look at). Due to this, we had to use another method to find out the optimal portfolios. With experience from earlier projects, we used the Solver tool in Excel for this task. This tool helped us find the minimum variance portfolio and the optimal risky portfolio given that one excluded the possibility of negative allocations.

Before using Solver, in order to find the optimal portfolio, the formula for the Sharpe ratio needed to be implemented in Microsoft Excel because it represents the slope of the CML (Capital Market Line). For the Sharpe ratio the daily compounded T-bill rate was needed, since it shows where the CML intercept the Y-axis. As the T-bill rate usually is compounded yearly we had to convert it to daily compounding before using it in the Sharpe ratio equation.

When the Sharpe ratio formula was implemented in Microsoft Excel the optimal risky portfolio could finally be calculated. The Solver tool then changed the weights automatically until the Sharpe ratio was maximized and the constraints that each weight must be more or equal to 0% and the sum of the weights must equal 100% fulfilled.

After both the minimum variance portfolio and the optimal portfolio had been calculated, we were able to find the CML and the Efficient Frontier. In this stage we knew two points on the CML, the starting point at the Y-axis, which is the risk free rate, and one other

point, that is the optimal risky portfolio. To find additional points on the CML we used the formula for a straight line where the Sharpe ratio is the slope, and the intercept the risk free rate (13-week T-bill).

All detailed calculation can be found in an Excel workbook on the Appendix CD.

5.7 Criticism and Delimitations

As with any choices made, there are both positive and negative outcomes involved. One cannot always take all the effects into consideration, but it is important to bear this in mind when choosing or deciding to follow a certain path of choice. For this paper we have encountered these limitations:

The first limitation is the scope of this project. By only focusing on quantitative data and no qualitative data, the whole paper is only focusing on secondary data that has been collected before by other researchers for other purposes. Even though this gives a more general picture of a problem, there is a chance that we have missed valuable qualitative data. As stated, we wanted to avoid personal opinions, and biases from people as much as possible, but at the same time, it is possible that we have lost some insight to the problem.

A second negative aspect is that our sample set is limited. The span of the study consists of the US market between 1970 and 2008. Of course a longer period would be appealing but would not yield any usable results since gold price was not allowed to fluctuate freely before 1970's. Therefore, the sample could be considered to be too limited to be able to draw general conclusions.

The third limitations is that we have not looked deeply enough into the reasons behind the recessions and the gold price movement. Due to the nature of our research questions, we decided that we needed to limit the information and instead focus on the statistical data. Because of this, we might have discarded information that could have changed the character to the study, but on the other hand, it would be impossible to cover historical happening during a 38-year time span.

As mentioned in the Collection of Data part (6.5), we have only used one source for the gold background presented in each recession period. We are aware of this draw back, but we believe the information is valid enough to be used for this study and its purpose.

Finally, we have decided to only look at two variables, gold and DJIA. This is because we wanted to do a proper analysis with strong foundation and evidence from the data collected. However, we have briefly compared the results from the analysis with other assets to give the results a relative value. These will be presented at the end of the analysis.

5.7.1 Assumptions

There are certain assumptions that will be made in order to be able to use the data and method of choice in a representative manner. Many variables have been disregarded from the empirical findings in order to present useful and applicable results.

The first assumption is that historical data from the price movements of DJIA is a market indicator for the status of the economy. It is assumed that it reflects the true movement of the economy and market during recessions, thus no other variables representing the market movement will be used.

Secondly, it is assumed that Markowitz Portfolio Theory is a well-known, established and used measure of portfolio allocation in the market. If many different methods of portfolio allocations would be used, the outcome of one problem could have many possible solutions. Markowitz's theory is therefore used as the standard, and no other measure will be presented in this paper.

Thirdly, there will be assumptions that the transaction costs for gold and stocks are equal concerning taxes, fees and other related costs. This means that there are no advantages for purchasing one over the other. *If* an investor faces the same price and possible future yield of the assets, s/he would be indifferent to the choice of investment.

Fourthly, it is assumed that the 13-week T-bill is the correct risk free asset to use because it is stated in Markowitz's original work. There are varying time periods for the risk free rate in the US, but this 13-week T-bill is chosen for this purpose.

Finally, the causes to the recessions and gold that are stated in the Historical Background are assumed to be the true reason behind the movements. There are naturally different ways and perspectives to analyze one event, but the references and sources have been chosen after its credibility and reliability and hopefully, they are stating the objective truth.

6 Results and Analysis

This section presents the data collected and our findings. The data will be presented in forms of tables and figures in order to give the reader an easy way of interpreting the findings. Parallel to the findings, the data and theory will be analyzed. At the end, gold will be compared to other assets, to see how it performs in relation to them.

The results and analysis will be conducted in three main parts. The first part will consider the whole span of years in the study, from 1970 to 2008 in order to present an alternative to invest in gold during a larger time span without reallocation. The second part will go deeper into each recession where the allocation possibilities will be presented. We have chosen to present both long-term and short-term portfolios to see if there are any differences. In the third part, the results for gold in the second part will be compared to other commodities in order to present comparative results. Lastly, a conclusive analysis will summarize our findings from this section.

6.1 All time (1970 – 2008)

Table 1 shows the total return, expected return, standard deviation and correlation for gold and DJIA from 1970 – 2008, based on monthly data. During this period, the gold yielded a total return of 2002 %, compared to 1133 % for DJIA. The monthly expected return for gold and DJIA per month was 0.82% and 0.64% respectively. With the higher expected return, the standard deviation was also higher for gold with 5.8893% compared to the standard deviation for DJIA with 4.4294%.

Table 1 All time data between 1970 – 2008, based on monthly data

	All Time
Total Return Gold	2002.0292%
Total Return DJIA	1133.8642%
Monthly Expected Return Gold	0.8245%
Monthly Expected Return DJIA	0.6412%
Monthly Standard Deviation Gold	5.8893%
Monthly Standard Deviation DJIA	4.4294%
Correlation Gold vs DJIA	-0.0439
Monthly Risk Free Rate	0.4689%
Sharpe Ratio	2.0219

Both the standard deviation and expected return for gold during this 38-year period has been greater than the corresponding results for DJIA. This is not a coincidence since it is widely known in the financial community that as an investor is accepting a higher rate of risk, s/he must be compensated with a higher return. The conclusion for this extensive time period of investment horizon is that a less risk-averse person should invest more in gold than in DJIA.

By common sense, when two return-to-risk-ratios are compared, the asset with the highest ratio should be the dominant asset in an optimal portfolio consisting of the two assets. This reasoning usually holds as long as there is a big difference between the two ratios. When the ratios are close to each other, other variables, such as the correlation between assets play an important role for the optimal portfolio weight determination. Therefore the asset with the highest return to risk ratio does not have to have the highest allocation in an Optimal Portfolio (OP).

When looking at the ratios for gold and DJIA from Table 1, in the long run the return to risk ratio (Return/Risk) for gold was 0.1400 and 0.1448 for DJIA. As the ratios were very close to each other it is hard to determine whether an optimal portfolio should be allocated more towards gold or DJIA in the long run.

1. $0.8245\% / 5.8893\% = 0.1400$ (Gold)
2. $0.6412\% / 4.4294\% = 0.1448$ (DJIA)

The long-term correlation is approximately -0.04, significantly close to 0. The noteworthy value of -0.04 confirms that the causes of changes in price of gold are different from what determines DJIA movements. As mentioned earlier, any correlation that is smaller than +1.00, can be used as a diversifier, i.e. gold can be used as a diversifier in the long run. Having this in mind, the investor would as a next step be interested in knowing how much gold should be allocated to the portfolio in order to receive the lowest risk (Minimum Variance Portfolio) or maximum return to risk (Optimal Portfolio). Expected return and standard deviations for different combinations of gold and DJIA can be found in the Table 2 below.

Table 2 Allocations for Gold and DJIA with MVP and OP, 1970 - 2008

Gold	DJIA	Expected Return	Std Dev	
0.00%	100.00%	0.6412%	4.4294%	
10.00%	90.00%	0.6595%	4.0041%	
20.00%	80.00%	0.6779%	3.6848%	
30.00%	70.00%	0.6962%	3.5007%	
36.69%	63.31%	0.7084%	3.4643%	MVP
40.00%	60.00%	0.7145%	3.4732%	
52.91%	47.09%	0.7382%	3.6729%	OP
60.00%	40.00%	0.7512%	3.8828%	
70.00%	30.00%	0.7695%	4.2756%	
80.00%	20.00%	0.7878%	4.7557%	
90.00%	10.00%	0.8061%	5.2995%	
100.00%	0.00%	0.8245%	5.8893%	

When looking at the weights in Table 2, it can be seen that if an investor wants to hold a long time portfolio (1970 – 2008) and want to minimize risk, the optimal choice is to invest in the Minimum Variance Portfolio (MVP) (see Figure 21). If an investor's goal is to optimize the return to risk ratio, the OP is the best alternative. In the long run, this portfolio will yield highest return given risk. An interesting fact is that OP has an allocation of almost 50/50 between gold and DJIA (see Figure 22), just slightly more money should be invested in gold than DJIA (52.91% in gold and 47.09 in DJIA) to get an optimal return to risk (further in this paper, this long term OP will be referred to as the 50/50 portfolio).

These facts make gold a significant investment alternative; risk and return can change dramatically if it is included in a portfolio, which is in line with the diversification theories explained in the modern portfolio theory section (see Figure 12). If an investor would only hold on to a 100% DJIA portfolio, the risk would be higher and the return lower, compared to the OP. The risk could be lowered though, with any kind of asset, however, the great amount of gold that is included in an OP shows that in the long run, gold can act as a

good investment. This is in line with Jonathan Phair's (2004) conclusion that gold has great potential in investments (see section 4.1.2.).

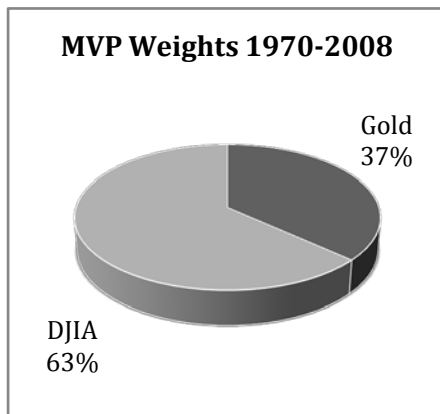


Figure 21 MVP weights 1970 -2008

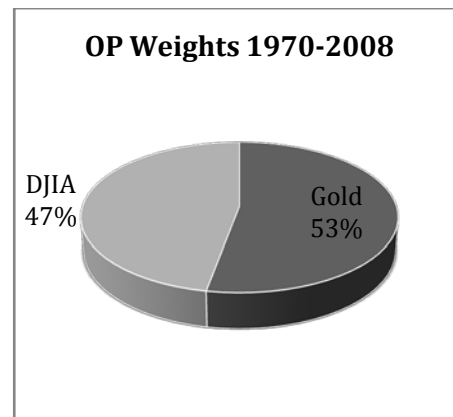


Figure 22 OP weights 1970 - 2008

Figure 23 shows the whole movement of gold, DJIA and the OP with a 50/50 allocation. It illustrates the price development if 1 USD investment in each of the categories from 1970 to 2008 was made. In order to have the most stable portfolio, the best choice is to invest in the OP that works as an average of gold and DJIA. As can be seen in the graph, gold and DJIA are moving in rather different perpendicular directions.

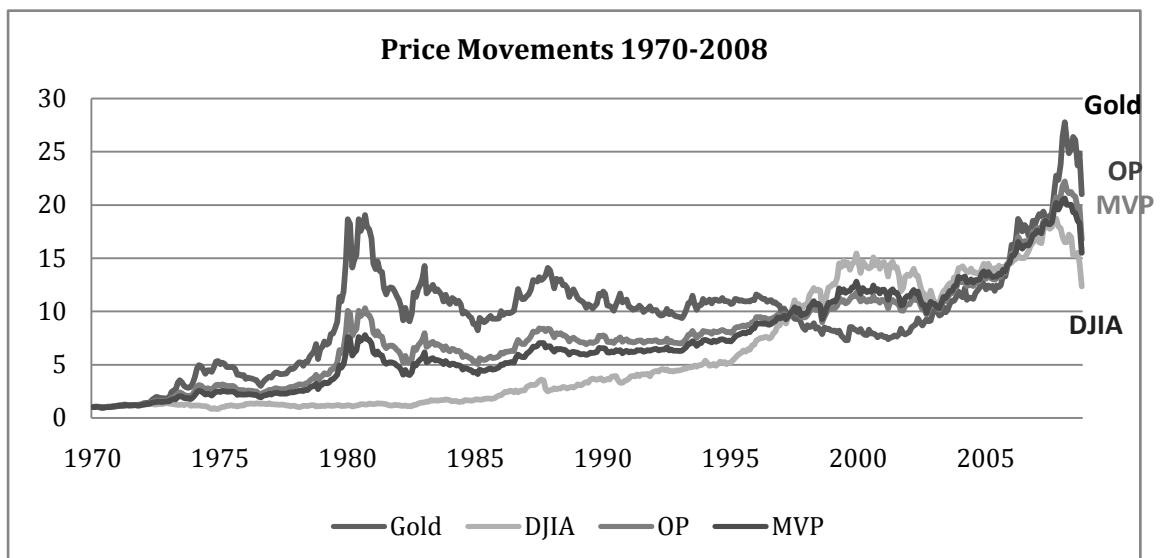


Figure 23 Movement of DJIA, Gold and Optimal Portfolio, 1970 - 2008

Another graphical illustration of the MVP and OP allocations can be seen in Figure 24. This graph shows the efficient frontier and the CML from different combinations of gold and DJIA for the period 1970-2008. The point where the CML intersects the Y-axis is the risk free rate (r_f)(13-week T-bill). The point marked as MVP is the minimum standard deviation portfolio, the point on the efficient frontier that tangent the CML is the optimal risky portfolio, here marked as OP. Every point on the efficient frontier represents a 10% difference in the weights between the assets. This means that the smaller and closely related the points are on the curve, the less are the differences for each 10% change.

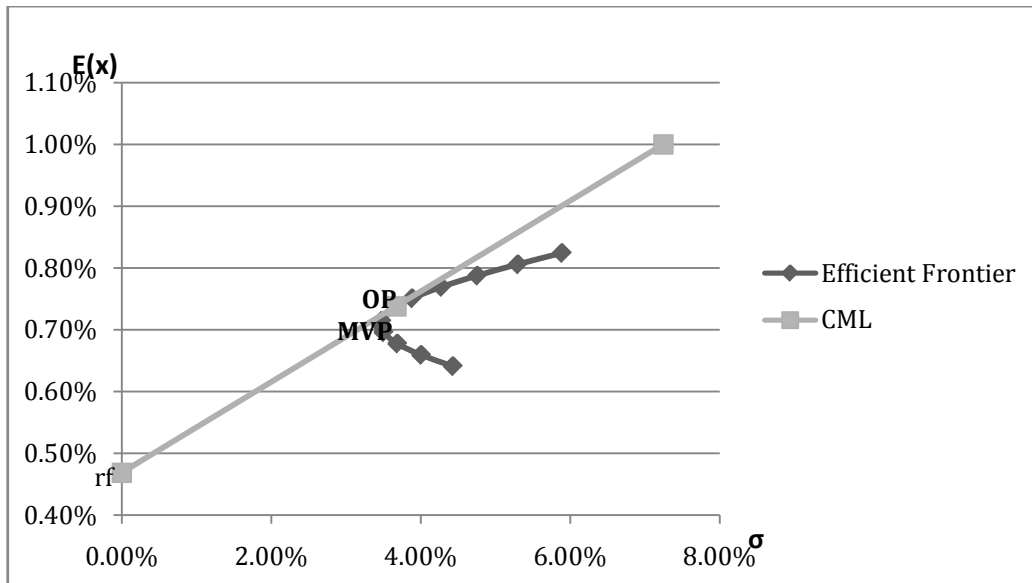


Figure 24 OP and MVP for Gold and DJIA on the Efficient Frontier 1970 – 2008

6.2 Recessions

When analyzing the results for the different recessions it is important to keep in mind the important role the Fed has in the economy. Business cycles are natural events in any economy, but as the Fed intervenes, they can both bring the economy into a recession by imposing restrictions but also ‘save’ the economy from recessions with deliberating measures. However, the Fed’s action can only be efficient to a certain extent. If the general market, including private investors and households, has been critically affected by the down turn in the economy, it will be challenging for the Fed to revitalize the economy.

Even though many events can be stated as causes to different recessions, Fed always plays an important role to shaping the recession. Fed’s policies to the economy is treated here as exogenous factors, because the immense impact the decisions have on the economy cannot be exactly traced and measured.

With this stated, the data for the different recessions (referred to as R1...R5) can now be presented and analyzed. Table 3 shows that the daily-expected return for each recession was positive for gold, while DJIA only had positive expected returns in R2, R3 and R4. Even though the returns varied more for different recessions for DJIA than Gold, DJIA had a lower standard deviation than gold for all recessions except for R5 where gold was slightly more volatile. In R2, the standard deviation for gold was significantly higher than any other standard deviations. The reasons for this will be presented in the section for Recession 2 further down.

Table 3 Overview of the Recessions

	R1	R2	R3	R4	R5
Total Return Gold	87.4742%	17.9625%	1.2441%	2.6573%	6.1524%
Total Return DJIA	-20.6254%	5.7848%	3.9311%	0.3670%	-13.2918%
Daily Expected Return Gold	0.2138%	0.2207%	0.0270%	0.0244%	0.0364%
Daily Expected Return DJIA	-0.0594%	0.0502%	0.0168%	0.0094%	-0.0611%
Daily Standard Deviation Gold	2.1075%	4.1979%	2.1778%	1.2967%	1.0038%
Daily Standard Deviation DJIA	1.4861%	0.9859%	1.0134%	1.2011%	1.4829%
Correlation Gold vs DJIA	0.0492	-0.0045	0.2085	-0.2259	-0.2385
Daily Risk Free Rate	0.0203%	0.0300%	0.0314%	0.0187%	0.0092%

The correlation between Gold and DJIA was close to zero for all five recessions, the highest positive correlation was found in R3 (0.2085) and the highest negative correlation was found in R4 (-0.2259) and R5 (-0.2385). The 13-week T-bill rate (daily compounded) varied from 0.009 to 0.03 percentage points.

Despite the fact that gold had a higher standard deviation than DJIA for most recessions, gold could still act as a diversifier i.e. the risk could be lowered for all recessions by adding a certain portion of gold to the portfolio. However an optimal portfolio made upon a *combination* of gold and DJIA could only be found in R2. For R3 the daily risky rate was higher than the expected return of both gold and DJIA, which made the optimal investing decision to invest 100% in the risk free rate (13-week T-bill). In R1, R4 and R5, gold had a considerable higher return to risk ratio than DJIA, and therefore the OP's were allocated 100% to gold in all three recessions.

6.2.1 Results and Analysis, Recession 1 (1973 – 1975)

In Recession 1 (Table 4), the total return of gold was significantly higher than the other four later recessions (see section 5.2.1.1). This led to an unusually high daily standard deviation of gold due to the big price jumps. Meanwhile, DJIA saw a strong decrease in total return during the recession.

Table 4 Data for Recession 1

	R1
Total Return Gold	87.4742%
Total Return DJIA	-20.6254%
Daily Expected Return Gold	0.2138%
Daily Expected Return DJIA	-0.0594%
Daily Standard Deviation Gold	2.1075%
Daily Standard Deviation DJIA	1.4861%
Correlation Gold vs DJIA	0.0492
Risk free rate (13 week T-bill)	0.0203%

The total return of gold was 87.47%, which was an extremely high return, thus the natural explanation for the high daily-expected return. There were several reasons behind this high value, and it has already been explained earlier in the section 5.2.1.1.

In this specific recession, the inflation rate was the primary reason for the rising gold prices. Because the correlation was negative, when the dollar went up, the gold price went

down and vice versa, as Abken (1980) stated in section 4.1.2. Since the inflation was high, the value of dollars decreased, resulting in more expensive gold.

The total return for DJIA was strongly negative with a value of -20.63%. This can be explained by the largest corporate bankruptcy by Penn Central Railroads that shocked the financial market markedly. The Fed intervened in the market in order to restore the losses by increasing money supply. As the dollar lost its value, and inflation increased, the gold prices were pushed up to its all time high in 1973.

The reason why the gold prices were affected so much more than the prices for DJIA could be the simple fact that DJIA was a supervised financial institution in the US, while gold was and a commodity that could be traded all over the world. It is possible to try to hinder abnormal fluctuations in a stock market, however it is much harder to limit the trade of gold. There were more influences outside US that affected the price movement of gold compared to the movement of DJIA, which increased the probability to more volatile standard deviations.

The daily expected return for gold in Recession 1 was 0.2138% compared to -0.0594% for DJIA, and the standard deviations were 2.1075% and 1.4861% respectively (Table 4). The return to risk ratio for gold was 0.1014 and for DJIA the ratio was -0.0400. As the ratio was negative for DJIA and positive for gold it was likely that the portfolio combination with the highest return to risk ratio was more allocated towards gold than DJIA.

Table 5 below shows different portfolio combinations for Recession 1. The daily average T-bill rate was 0.0203% for Recession 1, which is slightly smaller than the return of the MVP and much smaller than the expected return for the OP. This made investing in 13-week T-bills unattractive.

Table 5 MVP and OP for Recession 1

Gold	DJIA	Expected Return	StdDev	
0.00%	100.00%	-0.0594%	1.4861%	
10.00%	90.00%	-0.0321%	1.3642%	
20.00%	80.00%	-0.0048%	1.2808%	
32.39%	67.61%	0.0291%	1.2422%	MVP
40.00%	60.00%	0.0499%	1.2569%	
50.00%	50.00%	0.0772%	1.3189%	
60.00%	40.00%	0.1045%	1.4235%	
70.00%	30.00%	0.1318%	1.5620%	
80.00%	20.00%	0.1591%	1.7264%	
90.00%	10.00%	0.1865%	1.9099%	
100.00%	0.00%	0.2138%	2.1075%	OP

Table 5 shows the MVP and OP for Recession 1. The lowest risk was found for MVP where the allocation between gold and DJIA was 32% and 68% respectively, as presented in Figure 25. If instead, an OP was desired, all assets should have been put in gold (Figure 26). Notice that putting all the money in DJIA yielded lower risk than doing the corresponding for gold.

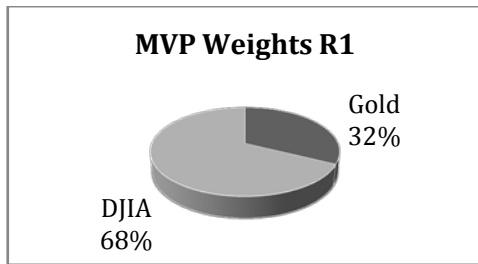


Figure 25 MVP in Recession 1

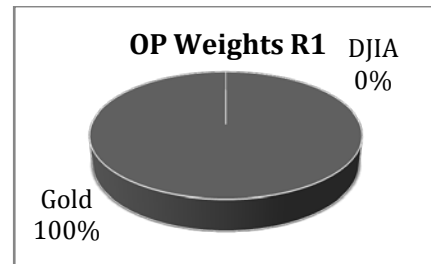


Figure 26 OP Recession 1

The risk would always be reduced as long as 10 – 32% of the portfolio was allocated to gold, compared to 100% allocation to DJIA. This is evident by looking at table above; where standard deviation for each 10% increase is lower than 1.4861% (100% in DJIA). Because gold and DJIA were not perfectly correlated, some movements would offset each other which in turn would have led to lower risk.

The reason why DJIA constituted the majority in MVP is because the standard deviation for DJIA was significantly lower than the standard deviation for Gold. For the OP on the other hand, Gold had the majority in the portfolio. This was because the return to risk ratio for gold was much higher than the ratio for DJIA. However, “putting all eggs in one basket” has always been considered riskier choice of investment.

The time during Recession 1 was very uncertain because the USD was about to become devaluated, and the news about the high national debt caused more people to increase their shares in gold.

Figure 27 shows the efficient frontier and the CML from different combinations of gold and DJIA for Recession 1. The point where the CML intersects the Y-axis is the risk free rate (rf)(13-week T-bill). As can be seen, the Efficient Frontier curve here is more ‘open’ than the one in All Time. This is explained by the larger return to risk ratio. To remind the reader, the lowest and highest point on the Efficient Frontier represent 100% allocation in each of the assets respectively, thus a 100% allocation in DJIA would give a 0.0594% negative return per day with a 1.4861% standard deviation.

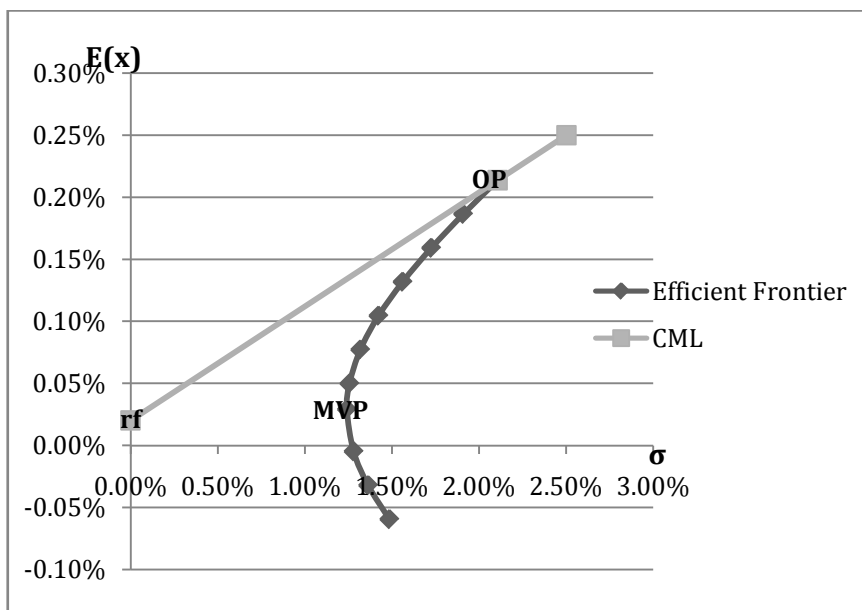


Figure 27 OP and MVP for Gold and DJIA on the Efficient Frontier R1, 1973 – 1975

In Figure 28 we have decided to show the development of three different movements (Gold, MVP and DJIA). In the remainder of the recessions, four different movements will be shown, if possible. As the OP was made up of solely gold in Recession 1, the OP and gold shows the same movement. Gold is the most volatile and MVP is the flattest with least deviations, as expected.

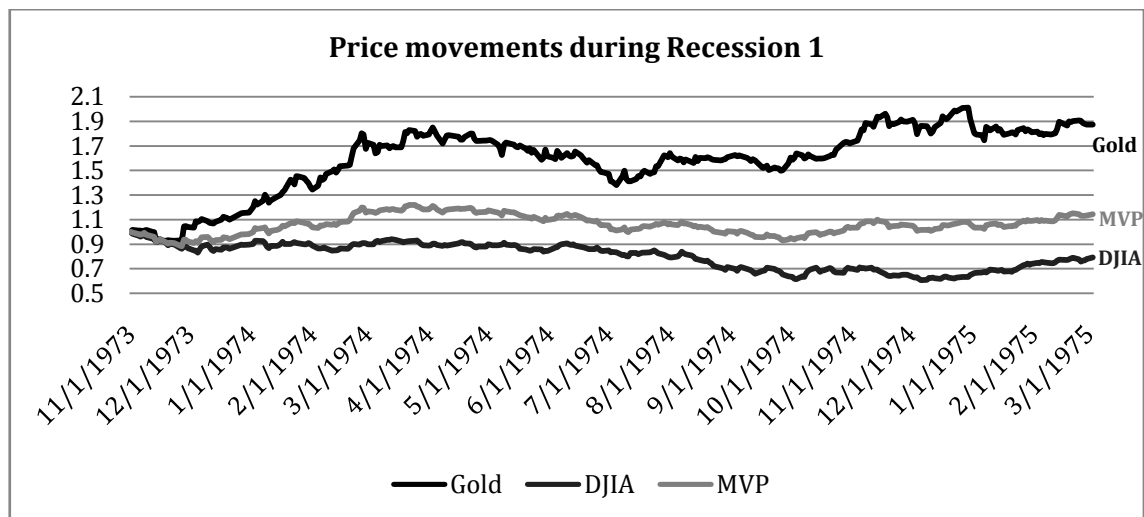


Figure 28 Movements of Gold, OP, MVP and DJIA

6.2.2 Results and Analysis Recession 2 (1980 – 1980)

Recession 2 was a little bit special in its character. As mentioned in the Historical Background, this recession was the shortest in American history.

Table 6 Data for Recession 2

	R2
Total Return Gold	17.9625%
Total Return DJIA	5.7848%
Daily Expected Return Gold	0.2207%
Daily Expected Return DJIA	0.0502%
Daily Standard Deviation Gold	4.1979%
Daily Standard Deviation DJIA	0.9859%
Correlation Gold vs DJIA	-0.0045
Risk free rate (13 week T-bill)	0.0300%

The daily expected return for gold in Recession 2 was 0.2207% compared to 0.0502% for DJIA, and the standard deviations were 4.1979% and 0.9859% respectively (Table 6). Thus, both expected return and risk was approximately four times higher for gold than DJIA. The return to risk ratio for gold was 0.0526 and for DJIA the ratio was 0.0519. As these ratios were very close to each other they could not be used to determine whether gold or DJIA should hold the majority in the optimal portfolio for Recession 2.

Further, as seen in Table 6, the standard deviation for gold during this period, 4.1979%, was considerably higher than for any other recessions. This was because the gold price rose dramatically during a short period of time, and even set an all-time high, again (see section

5.2.2.1). Remarkable here is that even though the standard deviation was so high, the total return for gold was not only positive, but also relatively high.

The return for DJIA during Recession 2 was relatively high while the standard deviation was the lowest out of the five recessions. Perhaps could the short time recession along with the cyclical behavior at that time explain this outcome? DJIA, on the other hand did not change too much, maybe due to the short period of time. Because the financial market is pro cyclical in its nature, reflecting the changes in information immediately, the downfall in DJIA could have been visible before the recession itself was a fact.

Table 7 MVP and OP for Recession 2

Gold	DJIA	Expected Return	Std Dev	
0.00%	100.00%	0.0502%	0.9859%	
5.32%	94.68%	0.0593%	0.9588%	MVP
10.00%	90.00%	0.0673%	0.9799%	
20.00%	80.00%	0.0843%	1.1493%	
34.05%	65.95%	0.1083%	1.5675%	OP
40.00%	60.00%	0.1184%	1.7778%	
50.00%	50.00%	0.1355%	2.1539%	
60.00%	40.00%	0.1525%	2.5476%	
70.00%	30.00%	0.1696%	2.9520%	
80.00%	20.00%	0.1866%	3.3632%	
90.00%	10.00%	0.2037%	3.7789%	
100.00%	0.00%	0.2207%	4.1979%	

Looking at Table 7, in Recession 2, the MVP and OP were both higher up on the allocation alternatives; gold was not a big part of the portfolio in either MVP but had about one third in the OP. The OP in Recession 2 had approximately the same weights as the MVP in Recession 1. Logically, as the weight in DJIA is decreased, both return and risk heavily increases, but it is optimal only to decrease it to a certain extent, until the negative effects outweighs the positive. Looking at Figure 29 for MVP and Figure 30 for OP, it is clearly stated that DJIA constitutes the majority of the portfolio.

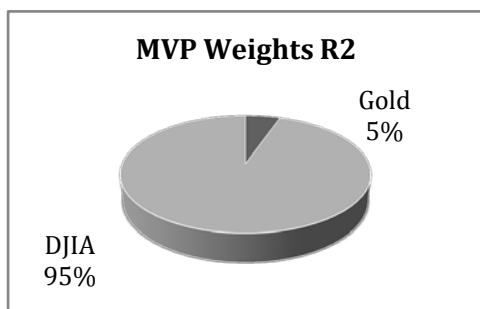


Figure 29 MVP in Recession 2

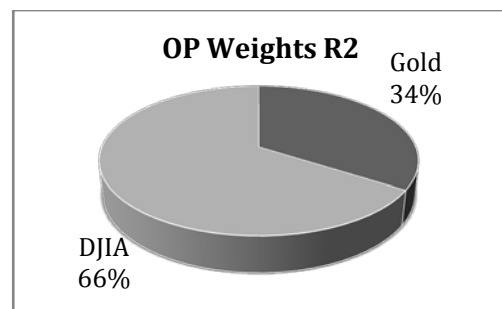


Figure 30 OP in Recession 2

Figure 31 shows the MVP and OP on the Efficient Frontier for Recession 2. The comparably straight Efficient Frontier in this figure is explained by the rough linear relationship between expected return and risk for every 10% increase. From the portfolio containing 40% of gold, every time the weights change and the allocation of gold increases, the overall portfolio return and risk linearly increases approximately 0.017% and 0.4% respectively (Table 7). It is also easy to see, that on the bottom on the efficient frontier, a small change in weights gives a big change in return relative to risk.

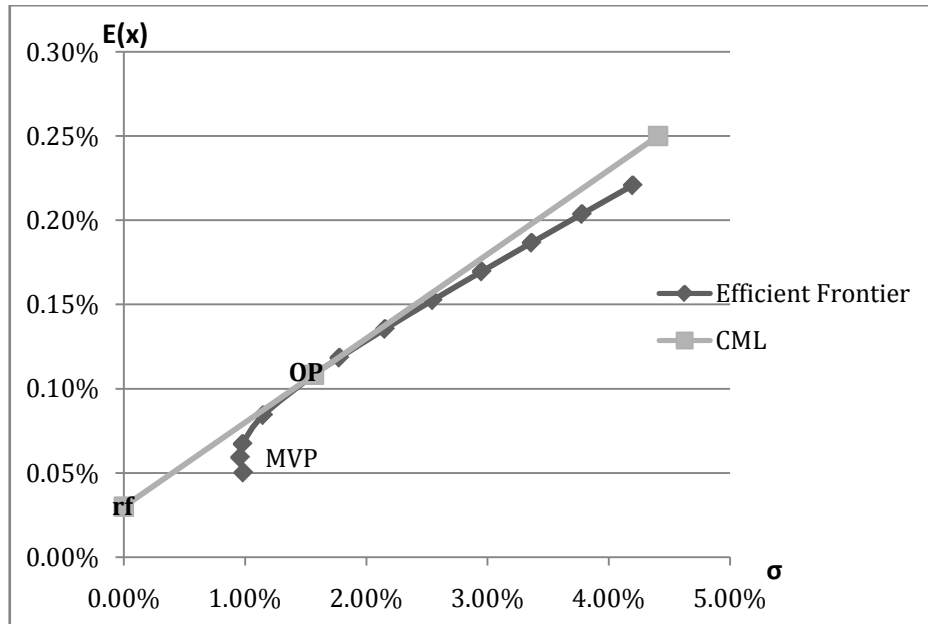


Figure 31 OP and MVP for Gold and DJIA on the Efficient Frontier R2, 1980 - 1980

In Figure 32, we can see that gold had a fad in the beginning of 1980. Throughout the recession, gold also tended to be more volatile than DJIA, which had low standard deviation and therefore had a rather 'smooth' development. During a large part of this time period, gold performed with a higher return than all other portfolio combinations, to switch and perform less than all others. This was the effect of the high standard deviation already mentioned. Additionally, the OP and MVP performed almost in perfect correlation with DJIA, which resulted in a significant portion of gold in the portfolio.

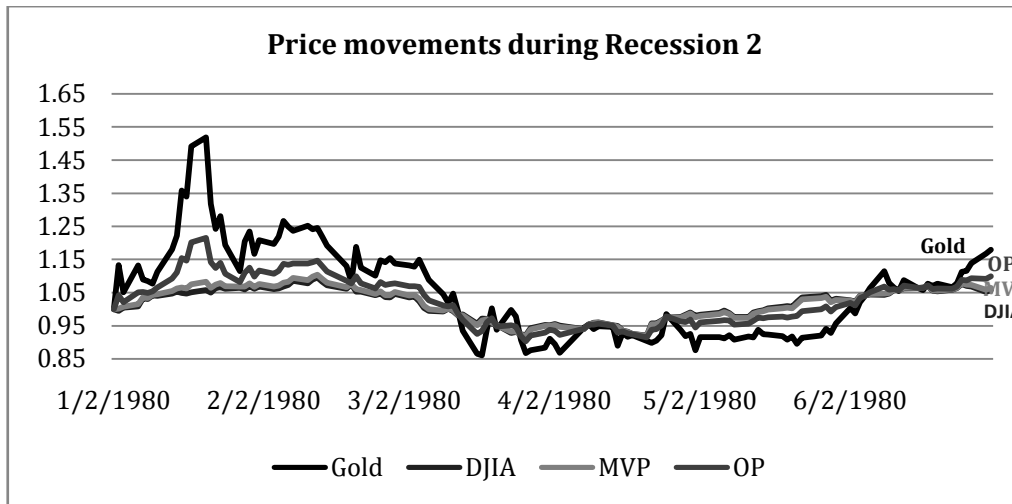


Figure 32 Movements of Gold, OP, MVP and DJIA 1980 - 1980

Comparing Figure 32 to Table 6, the graph shows that all combinations move in close proximity to each other with deviations only in the beginning. The standard deviation in Table 6 showed a higher value for gold than DJIA, and in this specific recession, one can say that gold moves “around” DJIA. The natural supply and demand flows might be the reason to the small movements of gold around DJIA. In the same way, the big fad can be explained by the global turmoil after the Soviet invasion of Afghanistan. If only total returns were to be compared, there are big differences, but because total return only is a measure for the difference for the first and last day of trade, it is not a reliable value unless there are large differences. Instead, the expected value gives a more valid forecasting. In Recession 2, the total return for gold was high because the price skyrocketed in the end of the period.

6.2.3 Results and Analysis, Recession 3 (1981 – 1982)

The third recession was the most severe since the Great Depression, with stagflation threatening the economy. In order to hinder the higher inflation rate, the Federal Reserve contracted money supply, which led to an increase in the interest rate.

Table 8 Data for Recession 3

	R3
Total Return Gold	1.2441%
Total Return DJIA	3.9311%
Daily Expected Return Gold	0.0270%
Daily Expected Return DJIA	0.0168%
Daily Standard Deviation Gold	2.1778%
Daily Standard Deviation DJIA	1.0134%
Correlation Gold vs DJIA	0.2085
Risk free rate (13 week T-bill)	0.0314%

The daily expected return for gold in Recession 3 was 0.0270% compared to 0.0168% for DJIA, and the standard deviations were 2.1778% and 1.0134% respectively (Table 8). The return to risk ratio for gold was 0.0124 and for DJIA the ratio was 0.0166. As the ratio was higher for DJIA than gold it was likely that the portfolio combination with the highest return to risk ratio was more allocated towards DJIA than gold.

For the first time, the index was performing better than gold in total return. If we look at the ratio for total return, 3:1, it can be interpreted as a significant number, however, in real numbers the change was only 1.2441% and 3.9311% for gold and DJIA respectively during a twelve months' period. Therefore, we look again at the daily-expected return for each asset.

Unlike the values from total return where DJIA was better than gold, the expected value for gold was 0.0270% and 0.0168% for DJIA, which was a turnaround in performance. This was only possible because the values for total returns were significantly low, which in turn means that if the gold price and the DJIA price had closed differently on the last closing day, the values could possibly have been totally different. If these numbers instead had been very much higher, the best performer would have had both the highest total return and expected return.

This supports the reasoning that the total return is only reflecting the difference in price for gold and DJIA between the start date of the recession and the end date, while the expected return is an average of the daily returns.

The standard deviation in this period is almost five times higher for gold. As mentioned earlier, this is in line with the general idea that with higher return comes higher risk.

The correlation was 0.2085, which is significantly higher than the previous recessions showing that gold and DJIA moved in the same direction. This had a negative impact on the diversification possibilities in the portfolio.

Table 9 MVP for Recession 3

Gold	DJIA	Expected Return	Std Dev	
0.00%	100.00%	0.0168%	1.0134%	
11.69%	88.31%	0.0180%	0.9802%	MVP
20.00%	80.00%	0.0189%	0.9971%	
30.00%	70.00%	0.0199%	1.0599%	
40.00%	60.00%	0.0209%	1.1617%	
50.00%	50.00%	0.0219%	1.2933%	
60.00%	40.00%	0.0229%	1.4466%	
70.00%	30.00%	0.0240%	1.6155%	
80.00%	20.00%	0.0250%	1.7955%	
90.00%	10.00%	0.0260%	1.9836%	
100.00%	0.00%	0.0270%	2.1778%	

An OP for this period was not to be seen due to the high T-bill rate 0.0314% that was higher than any values of expected return for gold (Table 9). In this recession, the MVP had the allocation according to Figure 33 where DJIA held the majority of the portfolio. The average daily rate for a 13-week T-bill was 0.0314%, which was higher than both the expected return for gold (0.0217%) and DJIA (0.0168%) for the recession. The T-bill was higher than both the expected return for the two assets, hence no creation of an OP, and only a MVP (Figure 34).

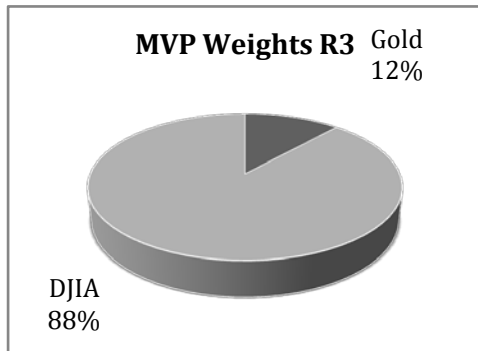


Figure 33 MVP in Recession 3

The high risk-free rate indicated a fight against inflationary pressures by the Fed. This was a common act taken by central banks when the country was experiencing threats for high inflation. The money supply was controlled and this caused higher interest rates to contract the spending of money.

A reason why the gold price did not follow the inflation in this particular recession could be that the inflation was higher *before* the recession, not during it. When the Fed imposed measures to hinder even higher inflation, the high interest rate could have pushed the economy into recession before the effects of the measures were seen. This means that the data we covered only measured the high interest rate, not the high inflation, thus making gold not as attractive as in earlier recessions.

Unlike the previous portfolio allocation figures, Recession 3 only had an Efficient Frontier, without a CML due to reasons mentioned above (Figure 34). Consequently, there was no OP in the figure. The T-bill rate was above the highest value on the Y-axis, and was therefore not of relevance in this case. An OP was possible to create if the T-bill value was disregarded; however in order to be subsequent with earlier results and to be able to compare the findings, we decided not to create an OP.

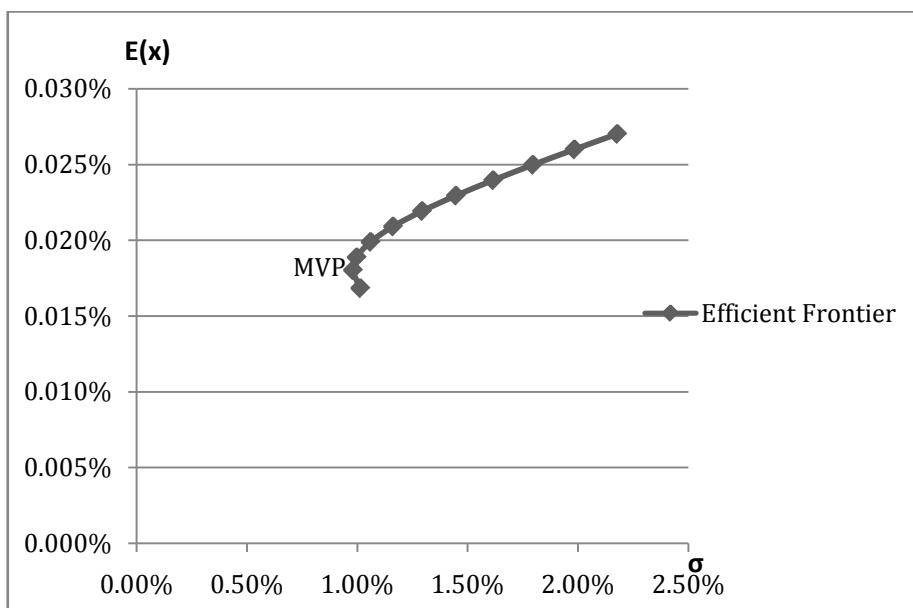


Figure 34 MVP for Gold and DJIA on the Efficient Frontier R3, 1981 – 1982

As for the corresponding figure for Recession 2, Figure 35 illustrates a similar pattern with movements that are closely linked to each other. This may have to do with the fact that the time between the end of Recession 2 and start of Recession 3 only lasted twelve months. Also visible here is the movement of gold, which is more volatile and moves more than DJIA. The first period of this recession shows a strong negative correlation, but since gold and DJIA moves in somewhat same pattern the rest of the recession, the total correlation during this period ends up at 0.2085%.

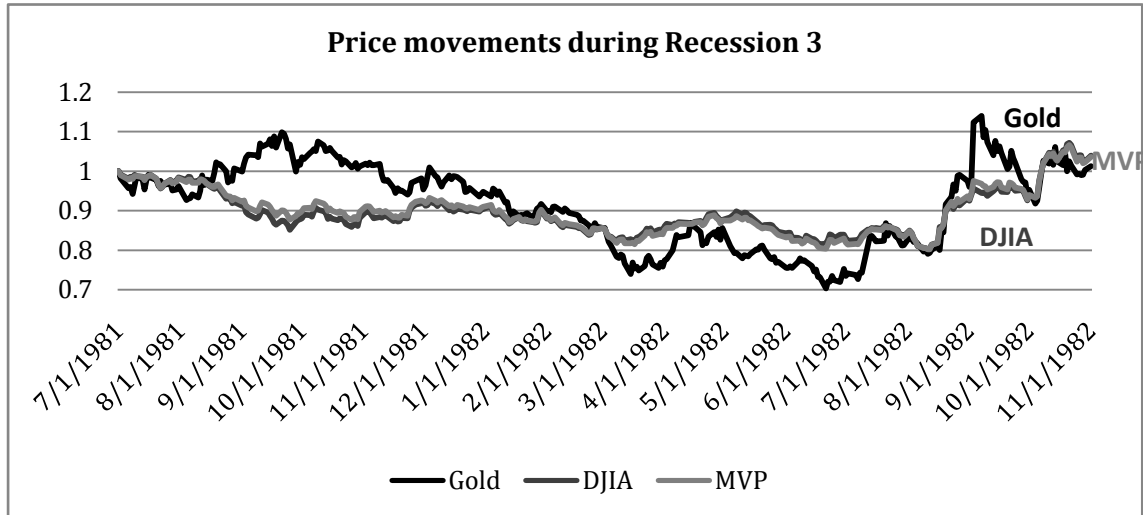


Figure 35 Movement of Gold, MVP and DJIA 1981 – 1982

6.2.4 Results and Analysis Recession 4 (1990 – 1991)

Compared to Recession 3, the Fed had a less apparent role in the economy during Recession 4. Instead, the increase of the oil price due to the invasion of Iraq in Kuwait was the main reason for the down turn (see section 5.2.3). This caused big uncertainty on the market, which in turn led to an increased price for gold.

Table 10 Data from Recession 4

	R4
Total Return Gold	2.6573%
Total Return DJIA	0.3670%
Daily Expected Return Gold	0.0244%
Daily Expected Return DJIA	0.0094%
Daily Standard deviation Gold	1.2967%
Daily Standard deviation DJIA	1.2011%
Correlation Gold vs DJIA	-0.2259
Daily Risk Free Rate	0.0187%

With Poole's (2007) theory (section 5.2.3.) that oil price shocks affects causes large uncertainty on the market, the results of Recession 4 will be analyzed.

The expected return for gold in Recession 4 was 0.0244%, compared to 0.0094% for DJIA, and the standard deviations were 1.2967% and 1.2011% respectively (Table 10). The return to risk ratio for gold was 0.0188 and for DJIA the ratio was 0.0078 which means that gold had the best reward for given risk and should hold the majority in the optimal portfolio for Recession 4.

Table 11 MVP for Recession 4

Gold	DJIA	Expected Return	Std Dev	
0.00%	100.00%	0.0094%	1.2011%	
10.00%	90.00%	0.0109%	1.0593%	
20.00%	80.00%	0.0124%	0.9370%	
30.00%	70.00%	0.0139%	0.8429%	
40.00%	60.00%	0.0154%	0.7871%	
46.88%	53.12%	0.0164%	0.7755%	MVP
60.00%	40.00%	0.0184%	0.8168%	
70.00%	30.00%	0.0199%	0.8978%	
80.00%	20.00%	0.0214%	1.0106%	
90.00%	10.00%	0.0229%	1.1459%	
100.00%	0.00%	0.0244%	1.2967%	OP

Elaborating further, Table 11 shows the allocation between gold and DJIA for both MVP and OP. Because the return to risk ratio was essentially higher for gold in this period, the OP will only consisted of gold, see Figure 37. For MVP, the allocation was as Figure 36 shows. Even though the standard deviation for gold was not significantly higher than for DJIA, the negative correlation offset the risk. Consequently, a portfolio with both gold and DJIA would help to reduce the total risk.

The table shows that the risk could be lowered if more than 0% but less or equal to 90% was invested in gold (the standard deviation for DJIA was 1.2011% for Recession 4). The lowest possible risk was achieved if 46.88% of the assets were allocated to gold and the rest to DJIA.

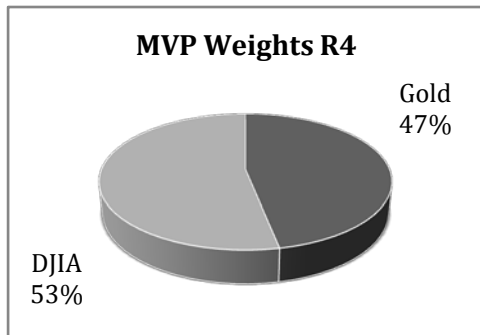


Figure 36 MVP in Recession 4

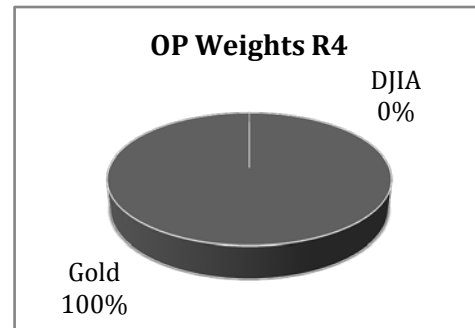


Figure 37 OP in Recession 4

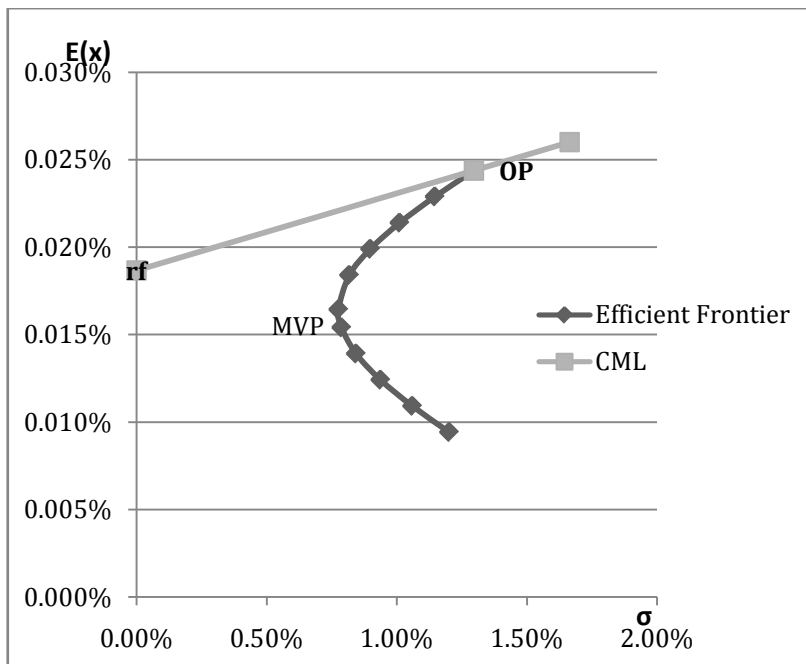


Figure 38 OP and MVP for Gold and DJIA on the Efficient Frontier R4, 1990 - 1991

This graphical illustration of Table 11 in Figure 38 is not a surprise. OP is located on the upper end of the Efficient Frontier, in other words, 100% in gold. The risk for gold and DJIA is similar, but here, it is evident that gold had considerably higher expected return per risk, hence the placement of OP. The MVP yields lower expected return to a higher risk, than the risk free rate that has by definition 0% risk and a stable (and higher in this case) return. In this recession, if the investor was risk averse and was only interested in lowering the risk, s/he should invested in the risk free rate instead of MVP.

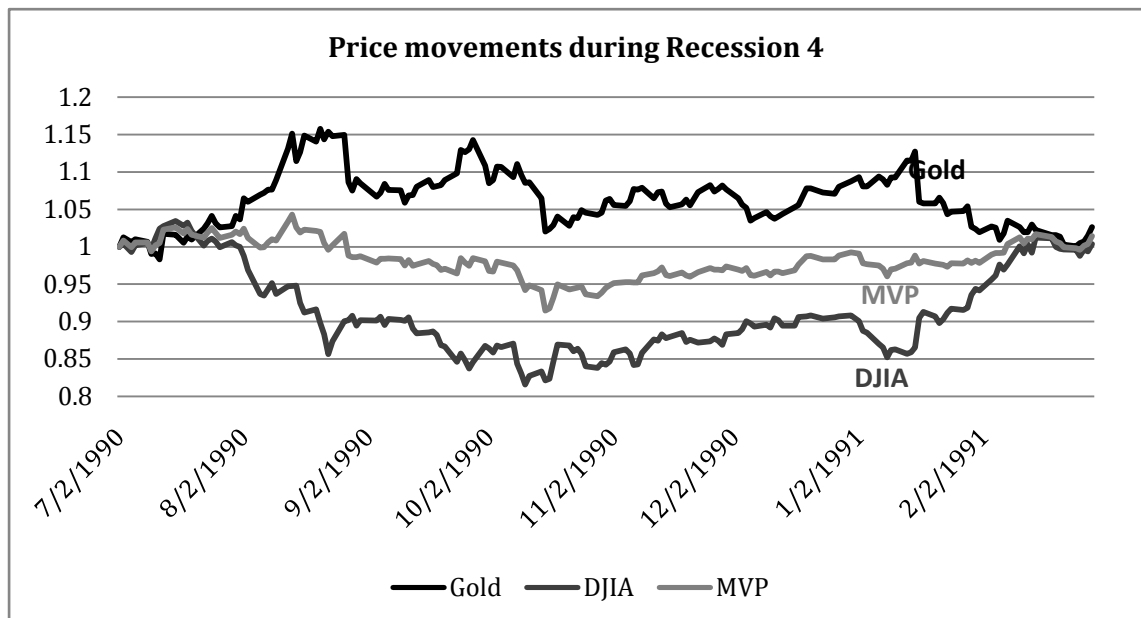


Figure 39 Movements of Gold, MVP and DJIA, 1990 - 1991

The correlation between gold and DJIA for this time period was -0.2259, and a first glance at Figure 39 can be interpreted as if gold and DJIA were moving mainly in negative correlation. However, a closer look at the figure will reveal that only few periods during the recession were negatively correlated with each other; July 1990 – August 1990, October 1990 and January 1991 and onwards. In between, the movements were positively correlated, thus the small total negative correlation of -0.2259.

The MVP was following almost the same pattern as the OP long-term 50/50 portfolio, since the allocation for MVP during this period was 46.88% in gold and 53.12% in DJIA (compared to 53% in gold and 47 in DJIA).

We want to point out once again that if the start and end dates for the recession were changed, the total return for both gold and DJIA could have been changed essentially noticeably, but because the gold increased and DJIA decreased at the same time in the end, the total return for both ended on a relatively low value.

6.2.5 Results and Analysis Recession 5 (2001 – 2001)

After the longest expansion in the economic history, the economy finally went into a recession again. If only the data was to be interpreted, it was a relatively smooth recession without any significant movements. However, event wise, the attacks on World Trade Center and the collapse of the dot.com bubble caused uncertainty on the market.

Table 12 Data for Recession 5

	R5
Total Return Gold	6.1524%
Total Return DJIA	-13.2918%
Daily Expected Return Gold	0.0364%
Daily Expected Return DJIA	-0.0611%
Daily Standard Deviation Gold	1.0038%
Daily Standard Deviation DJIA	1.4829%
Correlation Gold vs DJIA	-0.2385
Risk free rate (13 week T-bill)	0.0092%

The daily expected return for gold in Recession 5 was 0.0364% compared to -0.0611% for DJIA, and the standard deviations were 1.0038% and 1.4829% respectively (Table 12). The return to risk ratio for gold was 0.0363 and for DJIA the ratio was -0.0412. As the ratio was negative for DJIA and positive for gold it is very likely that the portfolio combination with the highest return to risk ratio was more allocated towards gold than DJIA.

In this recession, it was more relevant to look at the total return of DJIA. The significantly large drop of -13.2918% for DJIA was mainly explained by the 9/11 attack. Remarkably, the DJIA did not display any other downturns during the recession.

Gold followed similar pattern up until 9/11, but experienced a price increase instead. This supports the theory about uncertainty and increased gold demand. The 9/11 attack shocked not only the financial market with all time high drops, but also a whole nation, causing a nationwide uncertainty which in turn shook the whole world. People were eager to secure their wealth by investing in 'secure' commodities, such as gold. This could be the reason why the gold price went up radically.

Other noticeable conclusions of Table 12 are that the standard deviation for gold was less than half of DJIA's, even though in Figure 43 they move in rather coherence with one another. The correlation was -0.2385, mainly due to the large fluctuations at the end of the recession. Thus one has to be very cautious when interpreting the correlation value. Since the correlation represents an average value of the movements, the assets could have been very volatile during a short amount of time and smooth the rest of the time, and is thus only a value of the total movement.

Table 13 MVP and OP for Recession 5

Gold	DJIA	Expected Return	Std Dev	
0.00%	100.00%	-0.0611%	1.4829%	
10.00%	90.00%	-0.0513%	1.3143%	
20.00%	80.00%	-0.0416%	1.1550%	
30.00%	70.00%	-0.0318%	1.0095%	
40.00%	60.00%	-0.0221%	0.8846%	
50.00%	50.00%	-0.0123%	0.7901%	
60.00%	40.00%	-0.0026%	0.7377%	
65.21%	34.79%	0.0025%	0.7305%	MVP
70.00%	30.00%	0.0072%	0.7366%	
80.00%	20.00%	0.0169%	0.7869%	
90.00%	10.00%	0.0267%	0.8799%	
100.00%	0.00%	0.0364%	1.0038%	OP

When looking at Table 13, here again one had to invest a large portion in gold in order to receive a positive return in the portfolio. The decision to only to invest in DJIA would be an unwise investment strategy in this recession. The standard deviation was high and the expected return was negative, a tendency that is worth noticing, as higher risk should yield higher returns.

The combined portfolio yielded a negative expected return for DJIA when the portfolio had more than 35% allocation to DJIA. The MVP is illustrated in Figure 40, where minimum amount of risk was taken. DJIA can be used in MVP since the correlation was negative; they offset each other. In OP (Figure 41) 100% was allocated in gold due to the high expected return to low risk.

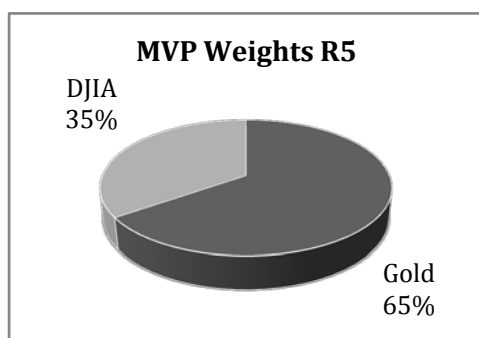


Figure 40 MVP in Recession 5

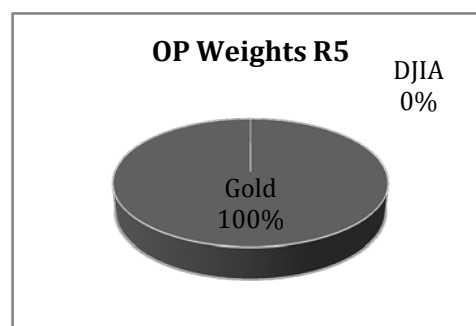


Figure 41 OP in Recession 5

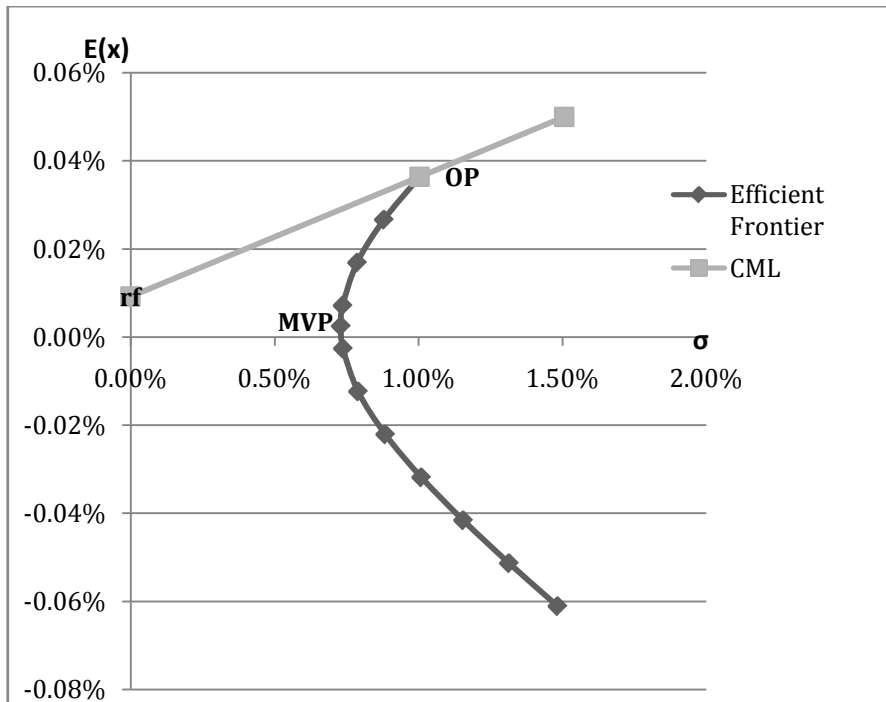


Figure 42 OP and MVP for Gold and DJIA on the Efficient Frontier R4, 2001 – 2001

In Figure 42, the majority of the combinations are under the X-axis. The negative expected values of DJIA have a great impact on the combined portfolios. Since MVP lies below the risk free rate, a rational investor would first invest in the risk free rate, and then in MVP. Since the investor would get a higher return to no risk, instead of a lower return to a low risk. Likewise MVP in Recession 4, the MVP in this Recession 5 is yielding lower expected return to higher risk. Therefore, the risk free rate should be invested in. As can be seen, the OP is made up of only gold, since it has higher return to lower risk than DJIA.

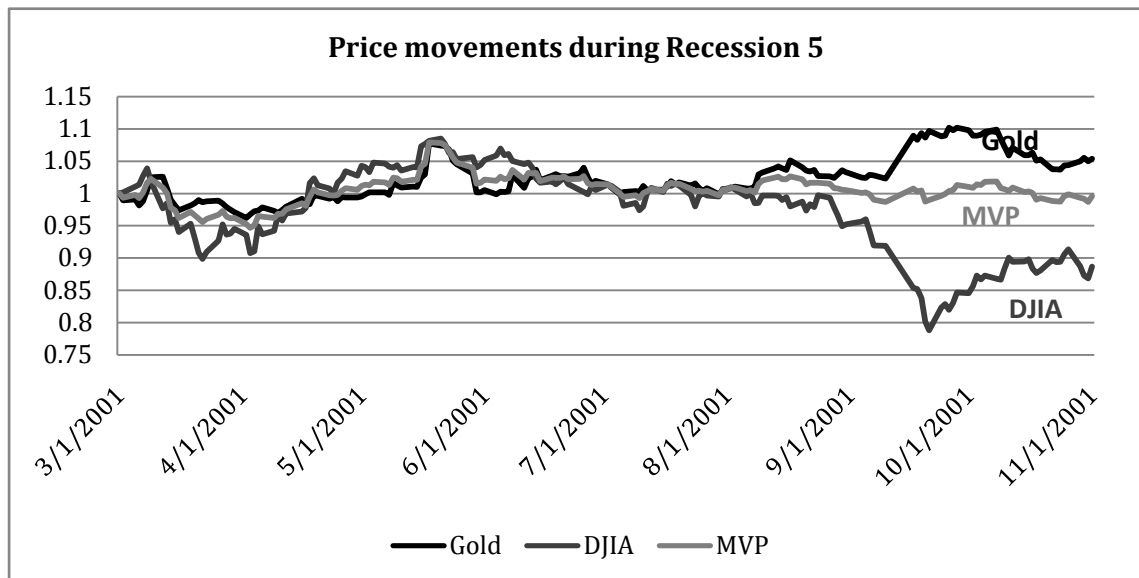


Figure 43 Movements of Gold, OP, MVP and DJIA 2001 – 2001

In Figure 43 only three lines, gold, MVP and DJIA are seen, because OP is the same as gold in the figure (OP was 100% gold). All movements follow each other rather well under almost two thirds of the time, until the 9/11 attack occurred that triggered a large fluctuation in the economy and made the recovery from the recession delayed. The recession had not had a large impact on DJIA during the recession up until the attack, due to its nature with a compilation of industrial companies. However, after the attack, DJIA experienced all time price drops (2001) and many industrial firms faced tough recovery. The gold prices shifted upwards, which again supports the theory about how uncertain times makes investors to believe gold is a safer investment. The demand increased and so did the price.

6.3 Comparison of gold with other assets

Table 14 illustrates how silver, oil and the commodity index CCI would have performed against DJIA instead of gold during the five recessions.

Table 14 Comparison of gold with other assets

	<i>R1</i>	<i>R2</i>	<i>R3</i>	<i>R4</i>	<i>R5</i>
DJIA - Total Return	-20.6254%	5.7848%	3.9311%	0.3670%	-11.3514%
DJIA - Daily Expected Return	-0.0594%	0.0502%	0.0168%	0.0094%	-0.0611%
DJIA - Daily Standard Deviation	1.4861%	0.9859%	1.0134%	1.2011%	1.4829%
	<i>R1</i>	<i>R2</i>	<i>R3</i>	<i>R4</i>	<i>R5</i>
Gold - Total Return	87.4742%	17.9625%	1.2441%	2.6573%	6.1524%
Gold - Daily Expected Return	0.2138%	0.2207%	0.0270%	0.0244%	0.0364%
Gold - Daily Standard Deviation	2.1075%	4.1979%	2.1778%	1.2967%	1.0038%
Gold VS DJIA - Correlation	0.0492	-0.0045	0.2085	-0.2259	-0.2385
Gold VS DJIA - Sharpe Ratio	0.0918	0.0499	N/A	0.0044	0.0271
	<i>R1</i>	<i>R2</i>	<i>R3</i>	<i>R4</i>	<i>R5</i>
Silver - Total Return	53.3101%	-55.7616%	18.7283%	-23.4706%	-3.8202%
Silver - Daily Expected Return	0.1836%	-0.3510%	0.0963%	-0.1514%	-0.0201%
Silver - Daily Standard Deviation	3.3387%	7.4202%	3.0352%	1.4470%	0.8517%
Silver VS DJIA - Correlation	0.0087	0.1866	0.2560	-0.0678	-0.3428
Silver VS DJIA - Sharpe Ratio	0.0489	N/A	0.0214	N/A	N/A
	<i>R1</i>	<i>R2</i>	<i>R3</i>	<i>R4</i>	<i>R5</i>
Oil - Total Return				14.6989%	-26.3139%
Oil - Daily Expected Return				0.2506%	-0.1457%
Oil - Daily Standard Deviation		NO DATA		5.6255%	2.6988%
Oil VS DJIA - Correlation				-0.4942	-0.0417
Oil VS DJIA - Sharpe Ratio				0.0437	N/A
	<i>R1</i>	<i>R2</i>	<i>R3</i>	<i>R4</i>	<i>R5</i>
CCI - Total Return	-5.5046%	2.0085%	-13.2783%	-9.1121%	-16.1116%
CCI - Daily Expected Return	-0.0098%	0.0184%	-0.0403%	-0.0548%	-0.1034%
CCI - Daily Standard Deviation	1.1969%	0.7272%	0.6038%	0.6337%	0.5967%
CCI VS DJIA - Correlation	0.0304	0.2459	0.3905	-0.2861	-0.0350
CCI VS DJIA - Sharpe Ratio	N/A	N/A	N/A	N/A	N/A

Silver was only in Recession 3 the better alternative than gold if only looking at the expected return, but in general, silver performed worst with low return to risk ratios. The price of silver plummeted in Recessions 2 and 4, rose sharply in Recession 1 and 3 and had a small decrease in the last recession. This led to negative Sharpe ratios when combining silver with DJIA in three out of five recessions, thus no optimal portfolios could be obtained by combining silver with DJIA in these recessions.

Regarding oil, it is hard to draw any conclusions as only two recessions could be analyzed. The data availability was limited, but by looking at these two periods presented, oil seemed to be very unpredictable with the highest standard deviations compared to the other assets in Recession 4 and 5. Despite this, oil performed relatively well in most categories in Recession 4 but relatively poorly in Recession 5.

The commodity index CCI had the lowest standard deviation in all recessions, making it the best asset to invest in to minimize risk. However as it had a low or negative return and a high correlation to DJIA in most recessions, investors aiming at maximizing return to risk should not consider it as an investment alternative. This is in line with Dempster's theory of commodity prices described in section 4.1.2.2.

Overall, gold can clearly be recognized as a good investment. Gold beat the other assets in many areas but stand out in Return and Sharpe ratio where gold was superior in Recession 1, 2 and 5. Overall, all assets had negative correlation to DJIA in Recession 4, including gold. The missing data for oil in the first three recessions can have an impact on these results, but apart from that, gold is undeniably a good investment during recessions.

6.4 Conclusive analysis

In general, one could have expected DJIA to perform poorly during recessions, but in this study, the opposite was proven; DJIA actually had positive returns in three out of five recessions. Gold had positive returns during all recessions, and could thus be concluded to be a good performer during recessions. Gold performed best in recessions caused by uncertainty and inflation, however, it could not be concluded that gold outperformed the market just because it was in a recession. Since we have not investigated gold and its performance outside the recessions, we can only conclude that it is performing well in recessions driven by uncertainty and inflation and not in general market conditions.

Further, it was found that gold could be used to maximize return to risk and minimize risk in most recessions. Even though gold had higher standard deviation (higher risk) compared to DJIA, it was compensated with higher return, which in turn led to the conclusion that gold had a larger share in Optimal Portfolios than Minimum Variance Portfolios. However the optimal amount of gold to invest in varied for the different recessions. For the OP, the weights varied heavily; in Recession 3 an investor should not have had gold at all (everything in T-bills) while in Recession 1, 2 and 5 the allocation should have been 100% in gold. The weights for the MVP varied too, though not as much as gold, from 5% in Recession 2 to 65% in Recession 5.

When comparing gold to other assets, gold performed better on average. However gold had neither the highest return nor the lowest risk in most recessions, but it was the asset that had the best combination of return and risk. The correlation between gold and DJIA was relatively stable around zero in the long run but varied more in the short run with fluctuations between -0.24 and 0.21.

7 Conclusion

In this conclusive section, the findings from the study will be summarized together with the research questions. Further recommendations for future studies will be presented.

The purpose of this thesis was to look back at the historical price development of gold and DJIA during recessions in order to find out whether an inclusion of gold could improve a DJIA index portfolio held today. In addition, the allocation of gold and the differences in the weights to an index portfolio was part of the purpose.

From the results and analyses that have been conducted, it can be concluded that gold indeed have improved the performance of an index portfolio by either increasing the return given risk or by minimizing the risk. The combination of an index portfolio and gold has been shown to be profitable in the majority of the recessions. Due to the low correlation between DJIA and gold, it has been shown to improve stability to the portfolio. The performance of gold varied heavily for the different recessions, but always in a positive direction, making it a safe investment in economic downturns. In three out of five recessions, the best return to risk was obtained by allocating 100% to gold in a portfolio, thus making it a very attractive investment in recessions. As gold has both high return and relatively high fluctuations it has been proved to be more suitable to create optimal portfolios than minimum variance portfolios.

In our analysis we decided to compare gold to other commodities to see whether its performance in recessions was good in a relative sense. The results of this comparison showed gold to be a good investment, with an overall higher return to risk ratio than the other commodities during the recessions.

The fluctuations of the price of gold have made the allocation vary from recession to recession, which in turn has complicated a generalization of an optimal allocation in the short run. Gold has been fluctuating more than DJIA in the short run and this can be explained by the different influences in the macro economy that affect gold and DJIA differently. The price of gold is dependent on more global variables while DJIA is mostly determined by national influences. DJIA is an index composed of 30 multinational companies, thus it has a high market risk. Gold on the other hand is not an index, it is a valuable metal; it therefore has a high unique risk.

In the long run, if money was placed in gold and DJIA (1970 – 2008), it has evidently been shown that the allocation should be around 50% in gold and 50% in DJIA to obtain an Optimal Portfolio. Thus in the long run, gold has proven to be an efficient investment when combined with DJIA.

With gold's past performance in mind, we would recommend an investor today (2008-2009) to hold gold in his/her investment portfolio. This because the uncertain environment of today, and due to the high return to risk ratio for gold. The optimal amount to invest in gold could however be questioned. For an investor with a long time horizon, a high amount of gold could be more easily defended than for a short term investor. In the long run, spotted short term deviations have tended to smooth out, to an optimal allocation around 50% in gold. Of these reasons together with the fact that every investor has different risk aversion it is hard to predict an optimal amount of gold to possess in this recession. Even though it may be hard to predict we would still urge investors to own a portion of gold in his/her portfolio today (2008-2009), due to the high return to risk characteristics of gold.

7.1 Further studies

Since the financial market is highly driven by expectations and assumptions, further studies within the field of behavioral finance would be of interest and relevance to investigate. The phenomena of how investors can influence each other and how the decisions made by the Fed can create uncertainty would also definitely add some new perspectives and more credibility to the study. Further, it would be enlightening to look at other markets and how gold have developed relatively to the domestic indexes. In addition, it would be interesting to follow the price development of gold in all parts of a business cycle; from a trough to a peak. More studies could be conducted in expansion phases and in different parts of the recession phase to see if the development of gold prices performs as well there.

With earlier studies within these fields, together with the findings presented in this study, gold should still be considered a good investment, despite new inventions of financial instruments. Further studies can enhance the understanding of to what extent gold can act as a good investment.

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Figure 1 <http://www.advfn.com/nikkei/NIKKEICharts.asp?index=NI225>

Figure 2 <http://www.advfn.com/djia/DowJonesQuotes.asp?index=INDU>

Figure 3 <http://www.advfn.com/ftse/FTSEPrices.asp?index=MCX>

Figure 4 <http://www.advfn.com/hkex/HangSengPrices.asp?index=HSIX>

Figure 5 <http://www.research.gold.org/prices/annual/>