Gold – a hedge, safe haven or a diversifier
A comparison between the Swedish and the American financial market

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Keywords

Acknowledgement

Definitions

"A hedge is defined as an asset that is uncorrelated or negatively correlated with another asset or portfolio on average." (Dirk G. Baur & Brian M. Lucey (2010))

This means that the asset that is investigated, in our case gold, would have a negative coefficient with stocks and bonds on average but not necessarily in times when the market is performing poorly.

"A diversifier is defined as an asset that is positively (but not perfectly correlated) with another asset or an asset portfolio on average." (Dirk G. Baur & Brian M. Lucey (2010))

This means that the asset investigated has a positive correlation that's less than 1 with the compared asset.

"A safe haven is defined as an asset that is uncorrelated or negatively correlated with another asset or portfolio in times of market stress or turmoil." (Dirk G. Baur & Brian M. Lucey (2010))

This means that when a market is performing poorly the correlation with the asset might change. This means that you analyse how gold performs when the market gives a return in the q-th percentile. This paper will analyse the 10th and 5th percentile to see if gold has a different correlation in those scenarios.

A forward hedge is defined as the effect of the previous period's return of an asset, in our case stocks or bonds, on the price of gold in the following period.

A lagged effect is the effect of the previous periods return and is the effect that is needed to make gold a forward hedge.

Sharpe Ratio is defined as reward-to-volatility ratio as a measure for risk adjusted return.

Bull market when a market, asset or a sector, is increasing significantly over a period of time.

Bear market when a market, asset or a sector, declines significantly over a period of time.

Short-selling is the procedure of selling a borrowed asset to profit from a decline in a market.

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Introduction

Throughout history the humankind has been obsessed with gold. It has been regarded as money throughout history. In the past 20 years, gold have gotten more and more attention from private and professional investors. But the view on gold doesn't always go hand in hand. Two of the world's greatest names in finance Warren Buffet and Ray Dalio have a completely opposing view on gold.

"Gold gets dug out of the ground in Africa, or someplace. Then we melt it down, dig another hole, bury it again, and pay people to stand around guarding it. It has no utility." – Warren Buffet (Forbes, 2017).

"If you're going to own a currency, it's not sensible not to own gold. Now it depends on the amount of gold. But if you don't own, I don't know 10%, if you don't have that and that depends on the world, then there's no sensible reason other than you don't know history and you don't know the economics of it." – Ray Dalio (businessinsider, 2012).

How does it come that two of the world's greatest investors have such an opposing view on gold. In this thesis we are going to find out if gold is a valuable investment asset.

1.1 Background

There are some studies that have investigated if gold could work as a hedge against inflation both in "undeveloped" countries such as Ghana (A. Mussah & M. Ibrahim, 2015) and in developed countries such as the USA and Japan (Wang, Lee & Nguyen Thi, 2011) with different results. While this certainly is something that is interesting for investors, inflation might not be as volatile in the future because of the central banks new policies. Therefore, the focus of this thesis will not be on inflation, but it will investigate if gold works as a hedge, safe haven or diversifier against Swedish and American stocks and bonds and the difference between these two markets.

All investing includes a risk to lose some or all of the invested capital and therefore the need to find assets that have negative correlation is of highest priority for investors. The term "flight to quality" refers to "The tendency of investors to move toward safer investments (often government bonds) during periods of high economic uncertainty" (Nasdaq Glossary, 2019). Safer investments are, as the quote says, often regarded as government bonds but could there be other assets that could be regarded as a "flight to quality", as well?

If the quotation above from John Updike's fictional hero Harry "Rabbit" Angstrom is correct then gold would work as a great asset in times of turmoil. It would, therefore, also work as a "flight to quality"-asset and be regarded as a safe haven i.e. an asset that has a negative correlation to other assets in times of market turmoil.

Several studies have been made on the American, the Eurozone's, Japans, Chinas and India's stock markets but there hasn't been any study made on the Swedish market. So, this thesis will examine if gold can work as a hedge, safe haven or a diversifier for the Swedish stock

and bond market and it will also compare it to the American stock and bond market. It will also investigate what the optimal mix of Swedish and American stocks and bonds, oil and gold has been the last twenty years, divided into four different periods. The periods that are investigated are the last 20 years divided into 4 different periods.

1.2 Research questions

This study's research questions are:

1. Has gold been a hedge, a safe haven or a diversifier for Swedish and American stocks and bonds the last 20 years?
2a. What has been the optimal mix of Swedish stocks, American stocks, oil, Swedish and American 10-year bonds and gold the last 20 years?
2b. What has been the optimal mix of Swedish stocks, American stocks, oil, Swedish and American 10-year bonds and gold the last 20 years if short selling is prohibited?

1.3 Layout

This study's layout is as follows:

In section 2 a literature review is presented for previous studies on the subject.

Section 3 consists of theory where we are presenting the theory behind the calculations and regressions.

In section 4 we are presenting the methodology we have been using to examine our research questions.

In section 5 we present where we got our data and the sample period.

In section 6 we present our empirical results consisting of one descriptive and correlation part, one econometric part where we have been examining if gold is a hedge, safe haven or a diversifier, the other part in this section is where we present the efficient portfolio frontier for gold, stocks, bonds and oil, for 4 different time periods.

In section 7 we discuss our econometric results and efficient portfolio frontier.

Finally, in section 8 we present our conclusions.

1.4 Ethical considerations

The ethics surrounding gold is a complex matter. The gold mining business is dirty with poor protection of workers' rights and it also has a huge environmental impact.

Among the 10 biggest producers of gold in the world there are countries such as China, Russia, Mexico, Indonesia and Ghana. These countries are ranked low according to the International Trade Union Confederations (ITUC) global rights index, which measures workers' rights in the world. ITUC's measurement considers such things as if the country has violated the right to organize unions, violated the right to strike and if workers are detained or arrested.

Among the 10 biggest producers of gold in the world, just one of the countries have a better rating than 3, which means that the countries regularly violate the workers right. China and Indonesia have a rating of 5+ which means that there is no guarantee of rights, due to the breakdown of law. The ITUC's report of 2019 also had one special case of workers violation in Ghana in Tarkwa Mine of Goldfields. The only country in the top 10 that has a better ranking than 3 is South Africa, which has a ranking of 2 which means that there is just repeated violation of workers' rights (Ituc-csi, 2019).

Data from Barrick's Gold show that it took between 2 to 91 tons of ore to produce one ounce of gold (Businessinsider, 2013). This is just one example of the huge environmental impact gold mining has.

When extracting gold from the sole, cyanide and mercury is used and this results in erosion which clogs water streams and rivers. When exposing the deep earth to air, chemical reactions take place that produce sulphuric acid which can leak down to the drainage systems. The Environmental Protection Agency reported in 2014 that 40% of the watersheds in the western United States have been contaminated by mining operations. The clean-up costs for this contamination are estimated to be up to 35 billion dollars (Smithsonian, 2014).

In 2004 the non-profit organization Earthworks started an initiative to promote "clean" gold mining. Earthworks initiative was presented such as the retailers only bought gold from mining companies that did not participate in environmentally and socially destructive mining practices. Earthwork set up 11 "golden rules" for companies to follow. In 2014, 8 of the 10 largest jewelry companies in the United States only bought gold from the companies that were following this 11 "golden rules" (Earthworks, 2019).

There are two other certificates that stand out: "fairmined" a gold-label certificate made by the Colombian non-government organization "fairmined". The second, more commonly known, organization is Fairtrade. Both labels support "clean" mines that seek to protect the environment in terms of mining methods, working conditions and wages for the workers. But still just a few hundred kilos are extracted in the ethical mines, compared to the global extraction of around 3300 tons of gold. (Japantimes, 2019).

2. Literature review

To be able to properly analyze the questions above, this paper has adopted the same definitions that Dirk G. Baur & Brian M. Lucey (2010) used in their paper "Is gold a Hedge or a Safe Haven? An analysis of Stocks, Bonds and Gold". In this paper, along with answering the question in the title, they define a hedge, safe haven and a diversifier as explained in the definitions. They also show that gold is a safe haven for American, UK and German stocks but only for a period of 15 trading days, and this is for the period November 30, 1995 to November 30, 2005. They could also conclude that during this period gold is not a safe haven for bonds.

When looking at a market as one unit, it is sometimes easy to forget that a stock market is a collection of many companies that themselves have different fundamentals driving their prices. Ke Chen & Meng Wang (2018) makes this clear by providing a "higher resolution picture" over the American market over the period 1980 - 2017. What they do is that they divide the American market into different sectors and evaluate if gold would work as a hedge or safe haven for the different sectors. Their conclusion is that gold was a safe haven for all market sectors except technology. They also find that gold does not serve as a hedge against the same sectors as it served as a safe haven against. Gold does not serve as a hedge against oil & gas, utilities and basic materials.

A paper that looks at 18 different countries and 5 different regional indexes from January 1970 to March 2012 (J. Beckmann, T. Berger, & R. Czudaj, 2014) found that gold works as "At least a weak form of both (hedge and safe haven) properties has been observed in the overwhelming number of all cases"(J. Beckmann et. Al. 2014 p.10). However, gold does not behave in the same way in all markets. For example, the difference between Russia, UK and USA is that in the US gold is a weak hedge but also a weak safe haven. In the UK gold is not a hedge at all but, quite surprisingly, it is a strong safe haven. In Russia gold is a strong hedge but not a safe haven at all. This shows us that gold is not an asset that is valued in the same way in all countries. It is also not clear what makes the difference. When the authors examined Australia and Canada, they thought that since this is two countries with a lot of natural resources firms in their indexes then these countries should have shown a significantly different relationship between gold and stocks compared to other countries with less exposure to natural resource companies. Surprisingly to the authors the results did not show anything special with these countries. The authors stress that the result is not clear but "worth mentioning" (J. Beckmann, T. Berger, and R. Czudaj, 2014 p.11).

Another study that looks at 13 countries and 6 regional indexes during March 1979 - March 2009 (Dirk G. Baur & Thomas K. McDermott, 2010) find that gold is a strong safe haven for most developed countries. They also look specifically at two different crises and find that during the stock market crash of 1987 gold worked as a safe haven for American and Canadian markets while during the financial crisis of 2008 gold worked as a safe haven for all developed countries.

3. Theory

3.1 Modern Portfolio Theory

Harry Markowitz (1927-) is known as the father of the Modern Portfolio Theory and he is also the one who came up with the idea to use variance as a measure of risk. Since the square root of the variance is the standard deviation, standard deviation is also a measure of risk (Nobelprize, 2019). In his paper from 1952 called "Portfolio Selection" Markowitz developed a mathematical way to optimize the share of different assets in a portfolio in order to receive an optimal risk-to-reward ratio. These kind of portfolios are called mean variance portfolios and follow the mean variance criterion (M-V) which means that an asset A is superior to B if the measures $E(Ra) \geq E(Rb)$ and $StdA \leq StdB$ holds and one measure is bigger, otherwise they might be equal (Bodie, Kane & Marcus , 2014. p.173). The ratio between risk and return is, therefore, the proper way to evaluate portfolios. The risk and return give a two-dimensional plane with returns in the Y-axis and risk (standard deviation) on the X-axis. In the graph one can evaluate all possible portfolios and plot out all the different portfolio ratios. When this is done, all available portfolios will be in the graph and it will be possible to draw a line where all the different portfolios are included. The most "western" point on this line will therefore be the portfolio with the lowest possible risk while the most "northern" point will be the one with the highest return. Between those two points there will be another point on the line which will be the optimal portfolio. The portfolio with the lowest risk is known as the "Minimum Variance Portfolio" and is the start of the "Efficient Frontier". The "Efficient Frontier" is the "north-western" part of the area where the different portfolios exist, this means that for a portfolio with a certain risk, the one on the efficient frontier will have the highest return, given that level of risk. (Bodie et al. 2014 p. 220)

When the efficient frontier is established one can look at the optimal allocation of risk-free and risky assets by drawing a "Capital Allocation Line" (CAL). The capital allocation line is a line that starts from the risk-free rate and has a positive slope. If you want to have the highest possible Sharpe Ratio then the capital allocation line will be a slope that starts at the risk-free rate and then is tangent to the maximized Sharpe Ratio portfolio. (Bodie et al. 2014 p. 248)

Markowitz wasn't the first person who knew that diversification was crucial in finance. The idea of spreading your risk is old and can be found in "The Merchant of Venice" where the character Antonio says "I thank my fortune - my ventures are not in one bottom trusted, nor to one place, nor is my whole estate upon the fortune of this present year"(CNBC, 2017). However, Markowitz was the first one to give diversification a proper formal model in the paper "Portfolio Selection" from 1952 mentioned above.

3.2 Arbitrage Pricing

The arbitrage pricing theory was developed by Stephen Ross in 1976. APT is a multi-factor asset pricing model that is based on the idea that the assets return can be predicted by using a linear relationship between the expected return from the asset and a number of other macroeconomic variables that captures systematic risk. APT, just like CAPM, provides investors with an estimated required rate of return on risky securities. The difference between APT and CAPM is the way that systematic risk is defined. CAPM have only one single market risk meanwhile APT has several factor risks. Factor risks could be variables such as inflation, unemployment rate and other macroeconomic factors. Other differences between APT and CAPM are that the factor is known in CAPM but not in APT and in CAPM the sign of the risk premium is known compared to the risk premium in APT. (Kumar, 2016. p 60-64)

The major assumptions of APT are that capital markets are always perfectly competitive, that investors always prefers more to less wealth, price-generating process is a K factor model, it assumes that markets are frictionless and that no arbitrage occurs and if it occurs traders will engage, which will bring market back to equilibrium. (Kumar, 2016. p 60-64)

The APT derived rate of return can be used to price assets correctly. If the price diverges, arbitrage should bring it back into line. APT advocates that the return of the asset is following a linear pattern. Investors can take advantage of deviations from the return from the linear pattern by using arbitrage strategy.
The arbitrage in APT differs a bit from the normal meaning of the term; in APT arbitrage is not a risk free operation but offers a high chance of success. APT offers investors a model to evaluate the theoretical fair market value of an asset. When the trader has determined a fair value of the asset, the trader starts looking for slight deviations from the fair value and trades accordingly (Corporatefinanceinstitute, 2019).

The weakness of APT is that there are no particular suggested factors for a particular stock or asset. The investor has to estimate the risk sources and the factor sensitivities. In theory an oil company stock would be more sensitive to factors like oil price than what, for example, Walmart would be. Hence the real challenge in APT for the investors is not the calculation but to identify factors which affect the particular stock (Kumar, 2016. p 60-64).

To estimate the factors in APT, the investors first have to do a principal component analysis meaning simultaneously estimating the β and γ in the APT formula. After the estimation of β and γ the investor needs to specify the attributes of β, for example firm characteristic (Guevara, Porras. 2014. p 203-207).

At last the investor needs to do two-pass estimation either by using the Chen, Roll and Ross estimation by using macro variables or using a set of portfolios, the Fama French way (Shanken, Zhou, 2007. p 41-42).

4. Methodology

The first research question is:

Has gold been a hedge, safe haven or a diversifier for Swedish- and American stocks and for Swedish and American 10-year bonds?

The hypothesis that will be used for the first research question is:

Gold has not been a hedge or a safe haven for Swedish and American stocks or Swedish and American 10-year bonds.

The reason that diversifier is not in the hypothesis is because when gold is not a hedge or a safe haven it is automatically a diversifier.

To test this hypothesis, we will make a multivariate variable model in STATA based on the Arbitrage Pricing Theory, with gold as the dependent variable and American stocks American bonds, Swedish stocks and Swedish bonds as independent variables. The variables for this are OMXS30 for Swedish stocks, SNP500 for American stocks, BondS for Swedish bonds and BondA for American bonds.

There will also be a lagged effect on both bonds and stocks which will show if gold might be a forward hedge for bonds and stocks, the variables for this is L1OMXS30, L1SNP500, L1BondS and L1BondA. BondS stands for Swedish 10-year bonds and BondA stands for American 10-year bonds.

In order to see if gold is a safe haven we will include the variables OMXS30 (5% or 10%), SNP500 (5% or 10%), BondA (5% or 10%) and BondS (5% or 10%). These variables are dummies and are only activated in the lowest 5 or 10 percentiles of return. Since the amount of observations are too few in 3 out 4 periods, we will only analyze the lowest 5 percentiles in the time period 2007 – 2009. All the other periods will have a safe haven analysis of the lowest 10 percentiles of return.

The regression models:

$$Gold = \beta_0 + \beta_1 OMXS30 + \beta_2 OMXS30(5\% \ or \ 10\%) + \beta_3 L1OMXS30 + \beta_4 BondS + \beta_5 BondS(5\% \ or \ 10\%) + \beta_6 L1BondS + \varepsilon$$

$$Gold = \beta_0 + \beta_1 SNP500 + \beta_2 SNP500(5\% \ or \ 10\%) + \beta_3 L1SNP500 + \beta_4 BondA + \beta_5 BondA(5\% \ or \ 10\%) + \beta_6 L1BondA + \varepsilon$$

Where:
- $Gold$ = return on gold.
- ε = error term/unobserved component.
- β = coeffecient of variables.
- *(5% or10%)* = Lowest 5% or 10% percentiles of return.
- *L1* = A lagged effect of unit of time (Month or Day)

- *BondS* = Swedish 10-year bonds.
- *BondA* = US 10-year treasury bill.

We will use these regressions on 4 different time periods, these are: 1999 - 2009, 2009 - 2019, 1999 - 2019 and 2007 – 2009 respectively.

The second research question is:

What has been the optimal mix of Swedish stocks, Swedish bonds, American stocks, American bonds, oil and gold the last 20 years?

The second hypothesis that will be used is:

Gold is not useful in a modern portfolio consisting of American and Swedish stocks, American and Swedish bonds and oil.

To test these hypotheses this paper will create an efficient portfolio in Microsoft excel by first finding the minimum variance portfolio by changing the weights of the different assets that are being evaluated. Secondly, it will optimize the weights with regards to the Sharpe Ratio to get the best possible portfolio. It will then make two portfolios for every period, one without short sales and one with short sales.

4.1 Calculations

Rate of return refers to the gains from an investment over a holding period. After downloading closing prices, the rate of return, excess return and expected return are calculated as followed.

$$Rate\ of\ Return = r = LN[P_1/P_0]$$

$$Excess\ return = Er = r - r_f$$

$$Arithmetic\ average\ (expected\ return) = \bar{r} = \frac{\sum r}{n}$$

$$Sharpe\ Ratio = \frac{R_p - r_f}{\sigma_p}$$

Where:
- P_1 = ending price
- P_0 = beginning price
- r_f = risk-free rate (Stibor 3-month)
- n = number of observations
- R_p = return of portfolio

- σ_p = standard deviation of portfolio

The risk and return relationship is calculated assuming investors are risk-averse, meaning that they do not like risk. The reward-to-volatility more known as the Sharpe Ratio is used to compare the different portfolios, and therefore the investors do not take on additional risk if they are not rewarded for the amount of risk they take. If the investors know the risk of an asset the expected return reflects the risk of the same asset. The trade-off between reward and risk suggest that we measure the attraction of the portfolio by the ratio of risk premium to standard deviation of excess returns (Bodie et al., 2014, p.134-135).

Risk premium is the excess return that the asset provides over the 3-month Stibor rate (risk-free rate) (Bodie et al., 2014, p.129). The risk-return trade-off suggests that if investors seek higher expected returns, they are forced to pay a "penalty" by having higher variance in the expected return. The variability in returns is measured by variance and is denoted by. Variance is the mean or the average of squared differences from the expected return. The standard deviation is the square root of the variance and measures the dispersion around the average return (Bodie et al., 2014, p.131-133). Formulas for variance and standard deviation are shown below.

$$Variance = \sigma^2 = \frac{\Sigma(r - \bar{r})^2}{n - 1}$$

$$Standard\ deviation = SD = \sqrt{\frac{\Sigma(r - \bar{r})^2}{n - 1}}$$

Where:
- n = number of observations
- r = rate of returns
- $\bar{r}$ = mean return

5. Data

The importance of collecting correct and sufficient data cannot be over emphasized. In order to get accurate results, the data is collected from several sources and cross checked through the Bloomberg terminal. This paper was based on average monthly and daily quantitative time series data.

The data on exchange rates, the three-month Stibor and the Swedish 10-year bonds were collected at the official website of the Swedish central bank, Riksbanken.se. When downloading the data for OMXS30 and the Swedish 10-year bond we had to convert the numbers into dollars. We did this by dividing all monthly and daily returns by the average exchange rate for that same month. Yahoo finance provided us with the data on S&P500 and OMXS30. For gold and oil price we were looking at Yahoo finance, NASDAQ and Avanza, but those sources did not have adequate data. Therefore, we took data from Indexmundi and cross-checked it with the Bloomberg terminal. In table 1 we present a summary of where we found our data.

The optimal weights in the portfolio were calculated under the optimization framework of maximizing the Sharpe ratio. We only used the Swedish risk-free rate since this paper primarily turns to Swedish investors. Returns were calculated from the collected data from Riksbanken, Yahoo finance and Indexmundi. The results were analyzed in Excel to find the optimum allocation of assets by applying the Microsoft Excel solver function to maximize the Sharpe ratio of the portfolio. The constraints were that the weights should sum up to be equal to one and that no short selling is allowed.

Another set of portfolios were added where short selling was not prohibited. The rules surrounding short selling differs a lot from fund to fund, therefore the constraint added was that no asset could be shorted more than 30%, more commonly known as the 130/30 rule . To run these portfolios, the constraints in excel solver was that none of the asset could go below -30% and none could exceed 100% in asset allocation (Aktiespararna, 2009).

Table 1. List of Sources.

Data	Source
OMXS30	Yahoo Finance
S&P500	Yahoo Finance
Gold price	Indexmundi, Bloomberg
Oil price	Indexmundi, Bloomberg
Swedish 10-year bond	Riksbanken
US treasury 10-year bond	Yahoo Finance
US-swe exchange rate	Riksbanken
Stibor (risk-free rate)	Riksbanken

5.1 Sample period

Choosing different time periods can vary the outcome of the study. Using data from 20 years showed that including gold as a portfolio component was beneficial throughout the entire period. But if the study period was changed to 1995-2001 or before 1973 the results would have been different (Macrotrends, 2019).

This study examines the investment properties of gold over a time span of 20 years with four different holding periods, as listed below. With this approach it was possible to examine the optimal allocation of gold during these different time periods. The data ranges from January 1999 until January 2019. Two portfolios were examined for each sub period, one portfolio when short-selling was allowed and one portfolio when short-selling was prohibited. The portfolios for which short-selling was allowed are portfolios 2, A2, B2 and C2. First the whole period from 1999-2019 was examined to find the optimal allocation of gold in a long holding period of 20 years (240 observations). Second step was to divide the entire time period into to sub periods of 120 months to examine if the optimal allocation of gold was valid for the sub periods as well, and whether to see if the allocation was the same for the sub period A and sub period B.

Third step was to look at a special sub period, this study wanted to examine what was the optimal allocation during a period of economic turmoil and chose the financial crisis during the years 2007-2009(501 observations).

Table 2. List of Sample periods.

Sample Period	Start	End	Observations
Full period 1	1999 Jan	2019 Jan	240 months
Full period 2	1999 Jan	2019 Jan	240 months
Sub period A1	1999 Jan	2009 Jan	120 months
Sub period A2	1999 Jan	2009 Jan	120 months
Sub period B1	2009 Jan	2009 Jan	120 months
Sub period B2	2009 Jan	2019 Jan	120 months
Sub period C1	2007 Jan	2009 Jan	501 days
Sub period C2	2007 Jan	2009 Jan	501 days

6. Empirical findings

6.1 Descriptive statistics and correlation for the sample periods

To determine the degree of correlation we use Pearson's correlation coefficient. We use 5 different metrics:
-Perfect: if the value is close to ± 1
-High degree: If the coefficient value lies between ±0.5 - ±1
-Moderate degree: If the value lies between ±0.30 - ±0.50
-Low degree: When the value lies below ±0.29
-No correlation: When the value is 0.
(Statisticssolutions, 2019)

Table 3 and 4 presents descriptive statistics and a correlation matrix for monthly returns on gold, OMXS30, S&P500, Swedish 10-year bond, US 10-year treasury bonds, oil and the risk-free rate, for the entire period 1999-2019.

Mean monthly return for gold was 0.0062 and that is a lot higher than both OMXS30 and S&P500. Oil had a slightly better return than gold but with a variability of 0.0872. The variability for gold (0.0383) was lower than both S&P500 (0.0423) and OMXS30 (0.0632).

The only assets that had negative returns were US and Swedish bonds both with a negative return of -0.002. The Swedish bonds had by far the highest variability of 0.1514. The risk-free rate (Stibor) for the period had a negative return (-0.030).

Table 4 shows a correlation matrix for all assets. Gold show a low degree of correlation with all assets. US bonds shows a moderate degree of correlation with S&P500 (0.300) and Swedish bonds (0.334). Oil shows a low degree of correlation with all assets. The only assets that show a high degree of correlation are the S&P500 and OMXS30 (0.767).

Table 3. Descriptive statistics with monthly frequency for all assets. (1999-2019).

Assets	OBS	Mean	STD.DEV	Min	Max
Gold	240	0.0062	0.0383	-0.125	0.160
OMXS30	240	0.0025	0.0632	-0.292	0.194
S&P500	240	0.0031	0.0423	-0.186	0.102
Swe Bonds	240	-0.002	0.1514	-1.140	0.810
Oil	240	0.007	0.0872	-0.316	0.203
Us Bonds	240	-0.002	0.0819	-0.265	0.310
Stibor	240	-0.030			

Table 4. Correlation matrix. (1999-2019).

	OMXS30	S&P500	Gold	Oil	Swe Bonds	Us Bonds
OMXS30	1					
S&P500	0.767	1				
Gold	0.022	-0.129	1			
Oil	0.167	0.182	0.140	1		
Swe Bonds	0.106	0.075	-0.130	0.174	1	
US Bonds	0.283	0.300	-0.176	0.254	0.334	1

6.2 Testing Safe haven, Hedge and diversifier by the econometric models

In this following section we will analyze the Swedish and American financial markets. In table 5 and 6 the regression analysis for S&P500 and OMXS30 are presented. Table 5 contain the S&P500, the lagged effect of S&P500, S&P500 worst returns. It also contains American bonds, the lagged effect of American bonds and American bonds worst returns. In column 1,2 and 3 the data set is rather small and therefore we only analyze the lowest 10 percentiles. In column 4 and 5 the data set is bigger and therefore we will analyze the lowest 10 and 5 percentiles.

Table 5. S&P500 regression analysis.

	Gold	Gold	Gold	Gold	Gold
	(1)	(2)	(3)	(4)	(5)
SNP500	-0.003	-0.168	0.159	-0.025	-0.018
	(-0.02)	(-1.45)	(0.74)	(-0.40)	(-0.31)
SNP500 (t-1)	-0.076	0.43	-0.217	-0.107**	-0.104**
	(-0.66)	(0.52)	(-0.89)	(-2.05)	(-2.00)
SNP500 (0.10)	0.008	-0.032**	0.022	0.008**	
	(0.64)	(-2.07)	(1.36)	(2.27)	
SNP500 (0.05)					0.013**
					(2.44)
Bonds	-0.080*	-0.192	-0.009	0.033	0.031
	(-1.82)	(-1.20)	(-0.64)	(0.65)	(0.63)
Bonds (t-1)	-0.011	0.133	-0.094**	0.056	0.059
	(-0.56)	(1.22)	(-2.36)	(1.50)	(1.56)
Bonds (0.10)	0.014	-0.097	-0.010	0.005**	
	(-1.16)	(0.38)	(-0.76)	(2.14)	
Bonds (0.05)					0.006**
					(1.89)
Intercept	0.008**	0.014***	0.004	-0.002	-0.001
	(2.53)	(3.64)	(0.82)	(-2.20)	(-1.87)
Observations	239	119	119	500	500
Adjusted R-squared	0.0289	0.0683	0.1023	0.0513	0.0566
Period	1999-2019	1999-2009	2009-2019	2007-2009	2007-2009
Data frequency	Monthly	Monthly	Monthly	Daily	Daily

1. *t*-values are in parentheses.
2. * = 0.10, ** = 0.05, *** = 0.01 significance level.

Table 5 shows the coefficients and the t-values of different regressions over the American financial market. The first period is a regression over the period 1999 – 2019 where the data that is being used is monthly return, the second is over the period 1999 – 2009 where the data is monthly, the third is over the period 2009 – 2019 and the data is monthly and the fourth, and last, is over the period 2007 - 2009 with daily data. All regressions are made with gold as the dependent variable.

The periods 1999 – 2019, 1999 – 2009 and 2009 – 2019 all use monthly returns.

During the period 1999 – 2019 the S&P500 regression shows significance at the 0.1 level for bonds with a negative coefficient of -0.080. This indicates that gold works as a hedge against American bonds for this period. The adjusted R^2 has a rather small value on 0.0289.

During the period of 1999 – 2009 the coefficient for the lowest 10 percentiles of return for S&P500 has a significant result on a 0.05 confidence level. The coefficient is negative which indicates that gold was a safe haven for SNP500 during this period. The adjusted R^2 is 0.0683.

During the period 2009 – 2019 the S&P500 regression shows a significant result on a 0.05 level for the lagged effect of bonds with a negative coefficient. This means that the return of gold is affected by the last periods return on bonds and is gold is therefore a forward hedge. The adjusted R^2 is 0.1023.

For the period 2007 - 2009 we are using daily returns in order to have a sufficient number of observations.

During the period 2007 – 2009 the coefficient of the lagged effect of S&P500 has a significant result on a 0.05 level with negative coefficients in column 4 and column 5. This makes gold a forward hedge against the S&P500. There is a significant result on a 0.05 significance level for when the S&P500 performs in its worst 10 and 5 percentiles of return. However, the coefficients are positive which means that gold is not a safe haven, but a diversifier for stocks, i.e. when the S&P500 performs in its worst 10 and 5 percentiles then gold gives negative returns. There's also a similar result for bonds when they perform badly, i.e. a positive coefficient with a significance level of 0.05 which makes gold a diversifier. This means that gold is not a safe haven during this period, but it seems as gold is a forward hedge for S&P500. The adjusted R^2 are 0.0513 in column 4 and 0.0566 in column 5.

Table 6. OMXS30 regression analysis.

	Gold	Gold	Gold	Gold	Gold
	(1)	(2)	(3)	(4)	(5)
OMXS30	0.130	0.027	0.258	0.025	0.037
	(1.62)	(0.36)	(1.41)	(0.48)	(0.78)
OMXS30 (t-1)	0.001	0.037	-0.001	0.060	0.065
	(0.03)	(0.87)	(-0.06)	(1.45)	(1.60)
OMXS30 (0.10)	0.025**	0.009	0.037**	0.003	
	(2.05)	(0.56)	(2.20)	(0.96)	
OMXS30 (0.05)					0.006**
					(1.73)
Bonds	-0.053***	-0.212*	-0.033	-0.031	-0.001
	(-3.14)	(-1.95)	(-1.65)	(-0.70)	(-0.03)
Bonds (t-1)	-0.009	0.142	-0.048***	0.047	0.052
	(-0.43)	(1.27)	(-3.63)	(1.20)	(1.37)
Bonds (0.10)	0.025**	-0.040**	-0.020*	-	
	(2.05)	(-2.29)	(-1.71)	-	
Bonds (0.05)					0.005
					(1.29)
Intercept	0.006*	0.012***	0.010	-0.001	-0.001
	(1.76)	(2.90)	(1.10)	(-1.20)	(-1.49)
Observations	239	119	119	500	500
Adjusted R-squared	0.0394	0.0888	0.0979	0.0106	0.0157
Period	1999-2019	1999-2009	2009-2019	2007-2009	2007-2009
Data frequency	Monthly	Monthly	Monthly	Daily	Daily

1. *t*-values are in parentheses.
2. * = 0.10, ** = 0.05, *** = 0.01 significance level.

Table 6 shows the coefficients and the t-values of different regressions over OMXS30, OMXS30 with a lagged effect, OMXS30 when it performs in its worst 10 and 5 percentiles, Swedish 10 year bonds, Swedish 10 year bonds with a lagged effect and Swedish 10 year bond when it performs in its worst 10 and 5 percentiles. The data that is being used is monthly return on all periods except on the period 2007 – 2009 where the data is on a daily basis.

The periods 1999 – 2019, 1999 – 2009 and 2009 – 2019 all use monthly returns.

During the period of 1999 – 2019 OMXS30 is significant on a 5% level when it performs in its worst 10 percentiles. However, the coefficient is positive, which means that when OMXS30 performs in its worst 10 percentiles, gold gives negative returns and therefore gold is not a safe haven, rather it's a diversifier for the lowest 10 percentiles. Bonds have a 1% significance level and a negative coefficient which makes gold a hedge for Swedish bonds during these 20 years. The lowest 10 percentiles of return have a positive significant coefficient on a 5% making gold a diversifier in times of turmoil. The adjusted R^2 are 0.0394.

During the period of 1999 - 2009 there is a 0.10 significance level for bonds with a negative coefficient. This suggests that when bonds have a negative return gold will have positive a return. This means that gold is a hedge against Swedish bonds. There's also a 0.05 significance level for bonds when it performs in its worst 10 percentiles. The coefficient is negative which means that gold would be a safe haven for Swedish bonds. The adjusted R^2 are 0.0888.

During the period of 2009 – 2019 there is a significant result on a 0.05 significance level for OMXS30s worst 10 percentiles. The coefficient is positive which means that gold is a diversifier during this period. There's 0.01 significance for bonds with a lagged effect. The coefficient is negative and makes gold a forward hedge. The coefficient for bonds when it performs in its 10 worst percentiles is significant on a 0.05% level and negative. This suggests that gold would be a safe haven for Swedish bonds. The adjusted R^2 are 0.0979.

For the period 2007 - 2009 we are using daily returns in order to have a sufficient number of observations.

During the period of 2007 – 2009 the only significant result is when OMXS30 performs in its worst 5 percentiles and then the coefficient is positive and significant on a 0.05 significance level. This would suggest that during this period gold worked as a diversifier in regard to OMXS30 lowest 5 percentiles of return. The adjusted R^2 is 0.0106 in column 4 and 0.0157 in column 5.

6.3.1 Efficient portfolio frontier with Gold, stocks, bonds & oil for 1999-2019

Table 7 present the results for the portfolio analysis for gold, 10-year Swedish bonds, 10-year US treasury bonds, oil, S&P500 and OMXS30 for the entire period 1999-2019. Without the ability to short a maximum Sharpe Ratio of 1.314 was achieved. The optimal asset allocation was obtained by constructing a portfolio with 0% in OMXS30, 41.10% in S&P500, 1.67% in

oil, 2.51% in Swedish bonds and 54.72% in gold. This generated a portfolio return of 0.46% and by a portfolio risk of 2.60%.

With the ability to short the portfolio achieved a Sharpe Ratio slightly higher of 1.382. The optimal asset allocation was obtained by allocating -17.12% in OMXS30, 54,30% in S&P500, 0.41% in Oil, 1.87% in Swedish bonds, 5.87% in US bonds and 54.64% in gold. This generated a return of 0.44% and a portfolio risk of 2.40%.

Table 7. Optimal asset allocation. 1999-2019 monthly frequency.

99-19 No short-selling		99-19 Short-sell allowed	
OMXS30	0	OMXS30	-17.12%
S&P500	41.10%	S&P500	54.30%
Oil	1.67%	Oil	0.41%
Gold	54.72%	Gold	54.64%
Swe Bonds	2.51%	Swe Bonds	1.87%
US Bonds	0	US Bonds	5.89%
	=100%		=100%
Portfolio Return	0.46%	Portfolio Return	0.44%
Portfolio Risk	2.60%	Portfolio Risk	2.40%
Sharpe Ratio	1.314	Sharpe Ratio	1.382

6.3.2 Efficient portfolio frontier with Gold, stocks, bonds & oil for Sub period A 1999-2009

Table 8 present the results for the portfolio analysis for gold, 10-year Swedish bonds, 10-year US treasury bonds, oil, S&P500 and OMXS30 for the sub period 1999-2009. The optimal asset allocation was obtained by constructing a portfolio with 4.82% in OMXS30, 32.75% in oil and 62.43% in gold. This generated a portfolio return of 0.49% with a portfolio risk by 4.4%. By using this portfolio composition a Sharpe Ratio of 0.194 was achieved.

With the ability to short the portfolio achieved a slightly higher Sharpe ratio of 0.197. The optimal asset allocation was obtained by allocating 22.88% in OMXS30, -28.69% in S&P500, 47.99% in oil, 77.69% in gold, and by short-selling both Swedish and US bonds by -13.76% and -6.11% respectively. This generated a better return than the no short-selling portfolio with a return of 0.84% and with a portfolio risk of 6.10%.

Table 8. Optimal asset allocation 1999-2009 monthly frequency.

99-09 No short-selling		99-09 Short-sell allowed	
OMXS30	4.82%	OMXS30	22.88%
S&P500	0	S&P500	-28.69%
Oil	32.75%	Oil	47.99%
Gold	62.43%	Gold	77.69%
Swe Bonds	0	Swe Bonds	-13.76%
US Bonds	0	US Bonds	-6.11%
	=100%		=100%
Portfolio Return	0.49%	Portfolio Return	0.84%
Portfolio Risk	4.40%	Portfolio Risk	6.10%
Sharpe Ratio	0.194	Sharpe Ratio	0.197

6.3.3 Efficient portfolio frontier with Gold, stocks, bonds & oil for Sub period B 2009-2019

Table 9 present the results for the portfolio analysis for gold, 10-year Swedish and American bonds, oil, S&P500 and OMXS30 for the sub period 2009-2019.

To obtain the best Sharpe Ratio a portfolio was constructed by allocating 43.81% in S&P500, 52.83% in gold and 3.36% in US treasury bonds. This gave us the return of 0.61% with a low portfolio risk of 2.30%. The Sharpe Ratio that was obtained was the second best among all the periods with a value of 2.658.

With the ability to short-sell the portfolio achieved a Sharpe Ratio of 2.702. The optimal asset allocation was obtain by allocating -11.24% in OMXS30, 54.25% in S&P500, -2.29% in Oil, 54.87% in gold, 0.024% in Swedish bonds and 4.17% in US treasury bonds. This generated a portfolio return of 0.64% with a portfolio risk slightly lower than the no short-selling portfolio of 0.22.

Table 9. Optimal asset allocation. 2009-2019 monthly frequency.

09-19 No short-selling		09-19 Short-sell allowed	
OMXS30	0	OMXS30	-11.24%
S&P500	43.81%	S&P500	54.25%
Oil	0	Oil	-2.29%
Gold	52.83%	Gold	54.87%
Swe Bonds	0	Swe Bonds	0.24%
US Bonds	3.36%	US Bonds	4.17%
	=100%		=100%
Portfolio Return	0.61%	Portfolio Return	0.64%
Portfolio Risk	2.30%	Portfolio Risk	2.20%
Sharpe Ratio	2.658	Sharpe Ratio	2.702

6.3.4 Efficient portfolio frontier with Gold, stocks, bonds & oil for Sub Period C 2007-2009

Table 10 present the results for the portfolio analysis for gold, 10-year Swedish bonds, 10-year US treasury bonds, oil, S&P500 and OMXS30 for the sub period 2007-2009. Without the ability to short-sell a maximum Sharpe ratio of 0.571 was achieved. The optimal asset allocation was obtained by allocating 86.21% in gold and the rest in Swedish bonds (13.79%). This generated the greatest portfolio return by 0.92% with a portfolio risk of 4.20%.

With the ability to short-sell we obtained a slightly higher Sharpe Ratio of 0.783. This was obtained by allocating 37.65% in Swedish bonds, 71.78% in gold, 42.49% in S&P500 and by short-selling OMXS30 by -30%, US treasury bonds by -3.28% and oil by -18.63%.

Table 10. Optimal asset allocation. 2007-2009 monthly frequency.

07-09 No short-selling			
OMXS30	0	OMXS30	-30%
S&P500	0	S&P500	42.49%
Oil	0	Oil	-18.63%
Gold	86.21%	Gold	71.78%
Swe Bonds	13.79%	Swe Bonds	37.65%
US Bonds	0	US Bonds	-3.28%
	=100%		=100%
Portfolio Return	0.92%	Portfolio Return	0.83%
Portfolio Risk	4.20%	Portfolio Risk	3.00%
Sharpe Ratio	0.571	Sharpe Ratio	0.783

6.3.5 Summary of Efficient portfolio frontier

Figure 1 presents the efficient portfolio composition for all of the periods. Portfolio 2, A2, B2 and C2 represent the short-selling portfolios. OMXS30 is the most short-sold asset in 3 out of 4 portfolios. Gold have the highest asset allocation in all portfolios, with the highest allocation in sub period C1 by 86.21%. S&P500 has a greater allocation than OMXS30 in every portfolio except for 1999-2009 where it has 0% in asset allocation. Highest allocation of equity was in sub period B2 when S&P500 had an asset allocation of 54.25%, compared to 54.87% in gold.

Comparing the portfolios one can see a clear pattern that gold and S&P500 is dominating the asset allocation, except for the period 1999-2009, when oil had a big allocation with 32.75% in sub period A1 and 47.99% in sub period A2.

The maximum return was in sub period C1 (2007 – 2009 Short prohibited) with 0.92% monthly returns and with a portfolio risk of 4.20%. The highest portfolio risk was between 1999-2009 in portfolio A2 with a portfolio risk of 6.10% and with a return of 0.84%.

Figure 1. Summary of efficient portfolio frontiers. Portfolios 1,A1,B1 and C1 represent the portfolios where short-selling is prohibited. Portfolios 2, A2, B2 and C2 represent when short-selling are allowed.
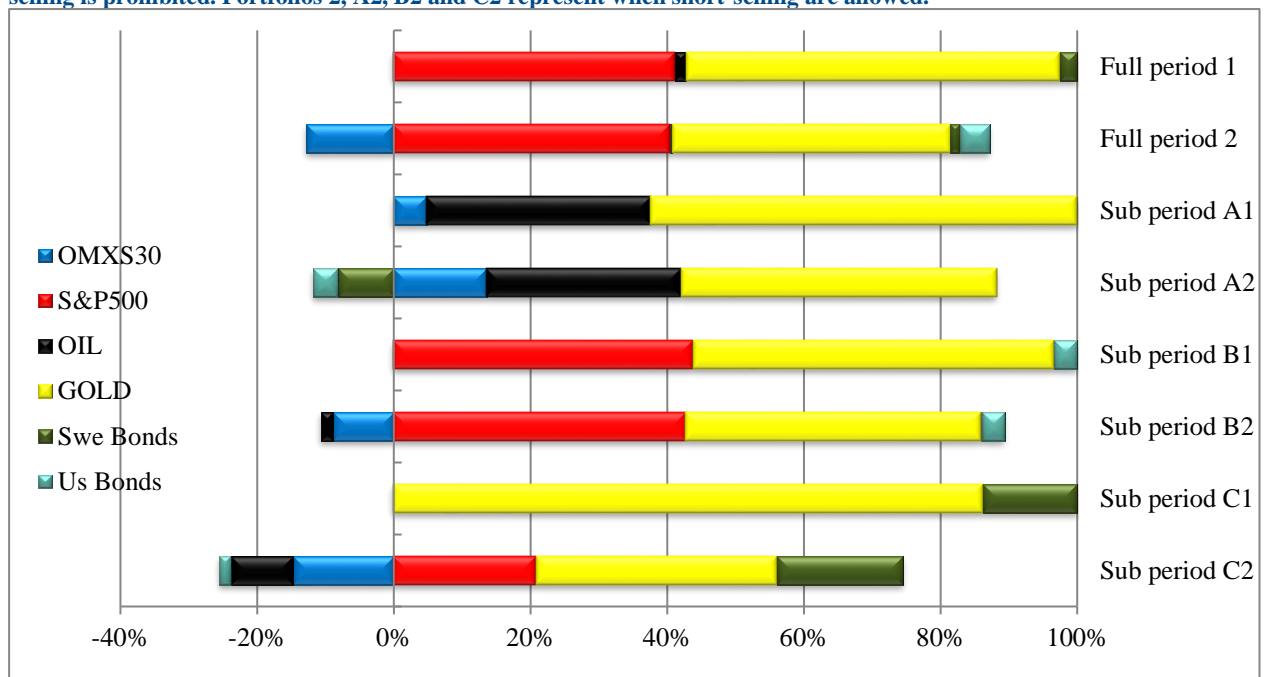

Table 8 presents the Sharpe Ratio for the different portfolios. Portfolio B1 and B2 (2009-2019) perform really well and have a Sharpe Ratio of 2.658 and 2.702 respectively. The full period portfolios perform fairly well with a Sharpe Ratio of 1.314 and 1.382. The other portfolios perform fairly poorly with Sharpe Ratio as a measurement; Sub period C's portfolios had a Sharpe Ratio of 0.571 and 0.783 respectively.

Sub period A had the worst Sharpe Ratio of 0.194 and 0.197. Overall the short-selling portfolios have a better Sharpe Ratio than the no short-selling portfolio, the biggest difference

is seen in sub period C where C1 has Sharpe Ratio of 0.571 compared to C2 with a Sharpe Ratio of 0.783. The portfolio's when short-selling is allowed has overall a higher Sharpe Ratio than the portfolios without short-selling.

Table 11. Comparison of Sharpe Ratio's for the different portfolios.

Portfolio	Sharpe Ratio	Rank
Full Period 1	1.314	4
Full Period 2	1.382	3
Sub Period A1	0.194	8
Sub Period A2	0.197	7
Sub Period B1	2.658	2
Sub Period B2	2.702	1
Sub Period C1	0.571	6
Sub Period C2	0.783	5

7. Discussion

The purpose of this paper was to:

1. See if gold has been a hedge, safe haven or a diversifier to Swedish and American stocks and bonds.
2. Find the optimal mix of Swedish and American stocks and bonds, gold and oil.

The study involves 4 different periods stretching from 1999 – 2019. The 4 different periods are 1999 – 2019, 1999 – 2009, 2009 – 2019 and 2007 – 2009.

Earlier studies from Dirk G. Baur & Brian M. Lucey (2010) find that gold works as a safe haven for the German, the American and the UKs stock market. According to this thesis, gold only worked as a safe haven for the American stock market in the period 1999 - 2009 and in no period for the Swedish stock market. However, this could perhaps be explained by the fact that while Dirk G. Baur & Brian M. Lucey (2010) used daily returns, our thesis mainly used monthly returns. Also, the periods investigated are not the same.

We found that gold was a forward hedge for the American stock market during the period 2007 – 2009. This means that after a day with negative return gold has a positive return. 2007 – 2009 is the only period in this thesis with daily return and this might be of importance. Dirk G. Baur & M. Lucey (2010) found that gold was a hedge for 15 trading days for American stocks and this effect might disappear when one uses monthly returns. However, D. Baur & T. McDermott (2010) found gold is a hedge against American stock market both on a daily and a monthly basis. However, it's important to remember that the time periods in the different papers differ. For the Swedish stock market, we found no significant results on gold being a hedge.

In our results gold has a different function for Swedish and American bonds. While gold never is a safe haven for American bonds, just as D. Baur & B. Lucey (2010) show in their paper, gold is a safe haven for Swedish bonds during 1999 – 2009 and 2009 – 2019 separately. For the whole period of 1999 – 2019 gold is not a safe haven but a diversifier. This is an important result since we can clearly see that there is a difference between gold's function against Swedish and American bonds.

According to D. Baur & B. Lucey (2010) gold is not a hedge against German, UK and American bonds. What we find in our thesis is that gold is a hedge against American and Swedish bonds. In the period of 1999 – 2019 gold is a hedge against both American and Swedish bonds while in the period of 1999 – 2009 gold is only a hedge against the Swedish market.

When the effect of bond returns is lagged we have significant results for American and Swedish bonds during the same period, 2009 – 2019. The coefficients are negative, and this means that during 2009 – 2019 gold has been a forward hedge against the bond market, both in the Swedish bond market and the American bond market.

All the regressions in this paper has a rather low R^2, ranging from 0.0106 to 0.1023. Since the other papers have used GARCH (1,1) it is not possible to compare the different studies, but we can acknowledge that the low R^2 suggest that only a small part of the variability can be explained by the variables that we have chosen.

When comparing the different efficient portfolios the results are surprising given the results from the econometric analysis. The empirical findings showed that gold is a major part in every portfolio in all the periods. The sample period is quite small for this kind of a study and the results might be inaccurate or skewed.

Comparing the historical prices of gold one can conclude that the returns have been extraordinary. If this paper would have included 30 years, the results would have been different. In January 1999 gold was at 287$ per ounce and in January 2019 at 1291.75$. During this period the price of gold has gone more than 400%. By adding 10 more years we would have included the years which were not beneficial for gold. In January of 1989 the price of gold was at 411.60$, and in January 1999 it was at 287$, a decline by -36%. (Indexmundi, 2019).

The problem with collecting historical data is choosing a time-span. The result depends a lot on when it starts and when it ends. Different cut-off points create entirely different conclusions, choosing other cut-off points would have changed the asset allocation in the portfolios. If we would have ended sub period A in 2007 before the financial crash, stocks would have a much higher asset allocation.

Sub period A (1999-2009) start on a high price level for stocks, i.e. 1999 when the dotcom bubble pushed the prices upwards. Sub period B (2009-2019) started at a low price level on stocks because of the financial crisis that hit its bottom in March 2009 (Yahoo Finance, 2020). So, if anything we should've seen different allocations for the different periods when taking the starting points into consideration. With this in mind, we think that starting an analysis in 1999 and 2009 is not a problem since we can see that gold is important in both periods. Especially as we can see that the last 10 years have been great for stocks and that gold still finds a part in our portfolios. This gives us a hint that gold has been a great asset in bad times and in good times. If gold will be a great asset in the future remains to be seen since the premises change all the time.

Comparing the variability of the assets one can conclude that gold has the lowest variability of all assets. We know that this is a property that is highly rewarded in modern portfolio theory and therefore an important property for sophisticated investors.
Comparing all the Sharpe ratios of the different portfolios you see a clear pattern that the short-selling portfolios outperform the portfolios where short-selling is prohibited. This is not surprising since if you had the ability to short-sell you would have gained big returns in the dotcom bubble and in the 2008 crash.

The best Sharpe Ratio was in sub period B (2009-2019), in B1 a Sharpe Ratio of 2.658 and portfolio B2 with a Sharpe Ratio of 2.702. It is not surprising that we obtain the best Sharpe Ratio under those years, the market has been relatively stable and we have experience a bull market for the past 10 years. The optimal asset allocation between 2007 and 2009 was

86.21% in gold and the rest in Swedish bonds. In this sub period gold had the best mean monthly average return by any of the asset classes for all time periods.

What can be seen by comparing all the different portfolios is that gold has a major part in a modern portfolio composition and in what degree depends on the time period.

8. Conclusions

From the monthly data, we can find that for the US market:
Gold is a safe haven for stocks in the period of 1999 – 2009.
Gold is a hedge for bonds in the period 1999 – 2009.
Gold is a forward hedge for bonds in the period of 2009 – 2019.

From the monthly data, we can that find for the Swedish market:
Gold is a diversifier for stocks in the periods 1999 - 2019 and 2009 – 2019.
Gold is a hedge for bonds in the period of 1999 – 2019 and 1999 – 2009.
Gold is a forward hedge in the period of 2009 – 2019.
Gold is a diversifier in times of turmoil in 1999 – 2019.
Gold is a safe haven for bonds in the periods of 1999 – 2009 and 2009 – 2019.

From the daily data, we can find that for the US market:
Gold is a forward hedge for stocks in the period of 2007 – 2009.
Gold is a diversifier for stocks in times of turmoil in the period of 2007 – 2009.
Gold is a diversifier for bond in the period of 2007 – 2009.

From the daily data, we can find that for the Swedish market:
Gold is a diversifier in the lowest 5 percentiles of return for the period of 2007 – 2009

For the whole period of 1999 – 2019 the results from our regression show that gold is a hedge for American bonds and Swedish bonds. This contradicts D. Baur & B. Lucey (2010) since they found that gold was not a hedge nor a safe haven for American bonds. During the same period gold is a diversifier in the lowest 10 percentiles of return for Swedish bonds. The American and the Swedish bond market seem to have a similar relation towards gold.

Gold works as a hedge and safe haven for the American stock market while it only serves as a diversifier for the Swedish stock market so there are differences. For example, S&P500 have a lagged effect on gold during 2007 – 2009 while there are no significant results for OMXS30 during that same period. During 1999 – 2009 gold was a safe haven for American stocks but gold was not a safe haven for Swedish stocks during any time period.

So, what we see is that there are some differences between the American and the Swedish markets but the differences are not consistent over time.

What we see is that there are some differences between the American and the Swedish markets but the difference are not consistent over time. What we see is that gold is a safe haven to American stocks for one period but not to Swedish stocks during any period. Gold is a forward hedge to American stocks but not for Swedish stocks. Gold works as a safe haven to Swedish bonds but not to American bonds.

On this thesis second question: could gold be useful in a modern investment portfolio the answer is yes.

The second research question and hypothesis are:

What has been the optimal mix of Swedish stocks, American stocks, oil, Swedish and American 10-year bonds and gold the last 20 years?

Gold is not useful in a modern portfolio consisting of American and Swedish stocks, American and Swedish bonds and oil.

We can reject our null hypothesis by the fact that the results show that gold has been allocated between 52.83-86-21% in the portfolios.

The optimal mix of assets shows different results depending on the time period. What we can say is that by comparing the portfolios: we should at least have 52.83% gold in asset allocation in order to maximize the Sharpe Ratio. The reason for this is the relatively low variability compared to the other assets and the stable return. We see this especially during a time of turmoil, the portfolios which had the biggest allocation of gold was during the dotcom bubble in 2000 and financial crisis in 2008. Especially during 2007-2009, when the other assets experienced a negative monthly return except for gold.

In the portfolios when short-selling is prohibited we see a consistent pattern that gold and S&P500 have the biggest asset allocations. Oil, OMXS30 and bonds do not have a high allocation except for oil in 1999-2009. The conclusions drawn from these results are that for the last 20 years, gold and S&P500 have been the most valuable assets to own in order to maximize Sharpe Ratio.

When we have the option to short-sell we have a more evenly distributed asset allocation, but we still see a consistent pattern that gold and S&P500 have the biggest asset allocations. OMXS30 is the most shorted asset in 3 out of 4 portfolios. Oil and bonds have a minor part in all portfolios. The conclusions drawn for these results are that for the last 20 years gold and S&P500, are the most valuable assets to hold and OMXS30 the most valuable asset to short-sell in order to maximize Sharpe Ratio.

When comparing the econometric and portfolio composition results, we can see that while the regressions do not give a consistent answer, the portfolio compositions shows that gold plays a major part in all times. During the financial crisis gold has the biggest allocation of the portfolios which indicates that gold is very attractive in bear markets. We suggest that even though the regression does not show that gold would be a hedge against stocks, our results show that gold is valuable both in bear and bull markets.

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Appendix

FULL PERIOD A

- ■ OMXS30
- ■ S&P500
- ■ OIL
- ■ GOLD
- ■ Swe Bonds
- ■ Us bonds

FULL PERIOD B
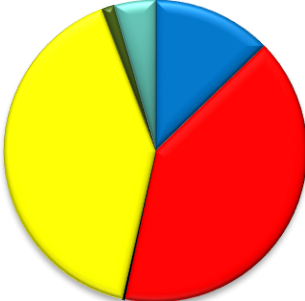
- ■ OMXS30
- ■ S&P500
- ■ OIL

SUBPERIOD A1

- ■ OMXS30
- ■ S&P500
- ■ OIL
- ■ GOLD
- ■ Swe Bonds
- ■ US bonds

SUB PERIOD A2
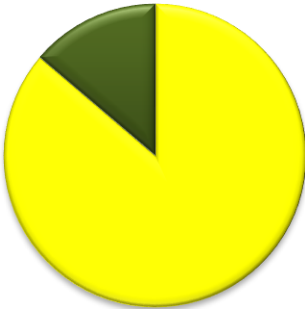

- OMXS30
- S&P500
- OIL
- GOLD
- Swe Bonds
- US bonds

SUB PERIOD B1

- OMXS30
- S&P500
- OIL
- GOLD
- Swe Bonds
- Us bonds

SUB PERIOD B2

- OMXS30
- S&P500
- OIL
- GOLD
- Swe bonds
- US bonds

SUB PERIOD C1

Legend: OMXS30, S&P500, OIL, GOLD, Swe Bonds, US bonds

SUB PERIOD C2

Legend: OMXS30, S&P500, OIL, GOLD, Swe bonds, US bonds