Gold – A 'safe haven'

A Quantitative Research of Gold and its Role as a 'safe haven' in Sweden

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Abstract

During stormy weathers ships searched for safe havens to stay until the storm had subsided. In much similarity to these ships, investors on the financial markets search for safe assets when the markets start to shake. What could be considered a safe asset seems to be a never-ending discussion but many points out gold as one. However, no further observations of gold as a safe haven on the Swedish financial market has been made. The purpose of this research is to examine if gold could act as a safe haven in Sweden. The data used in this research is daily returns from OMXS30 and the 10-year Swedish government bond, where all returns also has been denominated in U.S. dollar. Further, statistical model has been used.

The result show that gold potentially could act as a 'safe haven' for denominated stock returns but not for bond returns. Further, the result show that gold could act as a hedge for stock and bond return (non-denominated). The study concludes that gold does not act as a safe haven for stocks or bonds in Sweden. However, gold show weak safe haven attributes for denominated stock return.

Keywords; safe haven, gold, stocks, bonds, ARCH, GARCH, GARCH (1,1)

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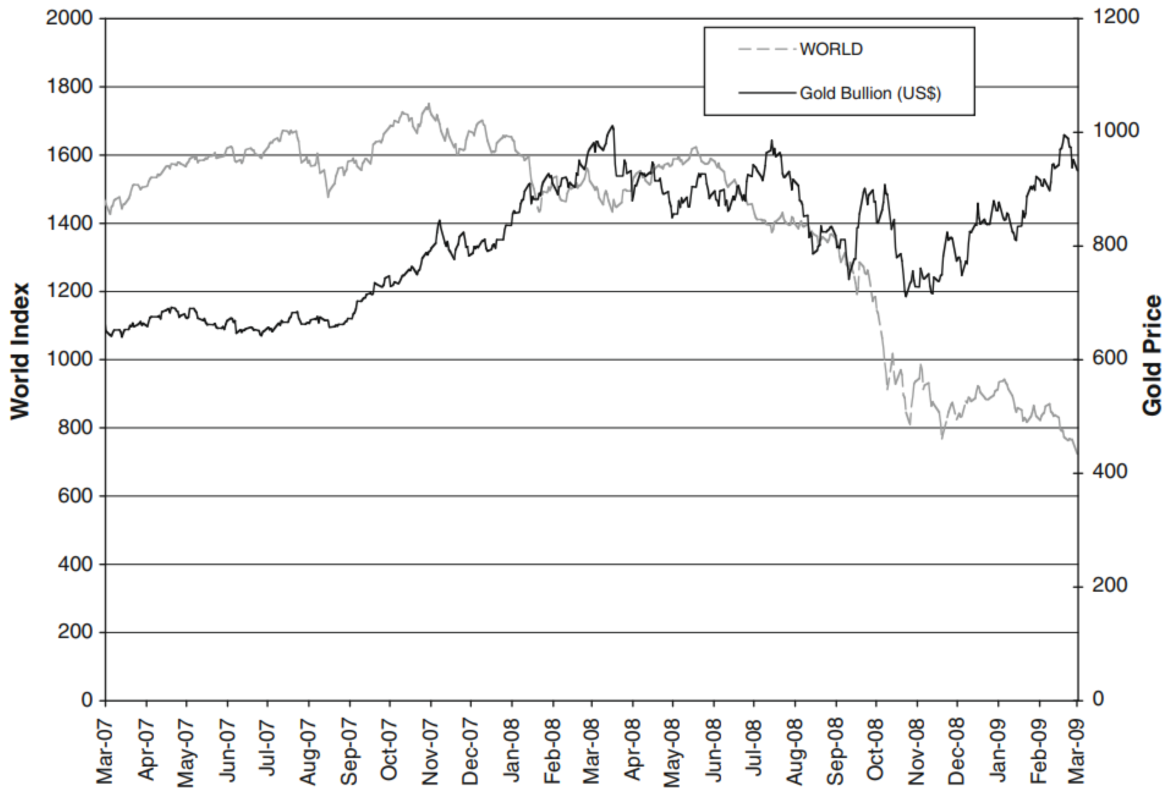
1. Introduction

In financial distortions and crises, such as the financial crisis in 2008 which erupted when the investment bank Lehman Brothers was filed for bankruptcy, stock markets tend to decrease over a longer period. In Sweden the stock market dropped almost 60 per cent over a one-year period, marking one of the biggest crises since the great depression in the 1930's (Ohlin, 2018).

When these financial crises occur, investors tend to look for safe investments in assets that have a negative correlation to the stock market, meaning that when stock market drops, the asset tend to surge. In general terms and in financial contexts this kind of asset is called a safe haven. Several studies (Bauer and Lucey 2010; Ranaldo and Söderlind 2013) have tested assets that could be considered safe havens, where gold has been the dominant asset.

Graph 1: Gold and stock return



Source: Baur and McDermott (2010)

Safe haven is a place to seek safety and originates from the ships who searched for havens during stormy weather (Baur and McDermott 2010). This is the metaphor used to describe the behavior when investors, during extreme market shocks, seeks for safer investments. One of the most recognized assets that investors consider to be safe is gold as it tends to correlate negative to the stock and bond market. As graph 1 shows, gold tend to be more stable and surge when stock markets has dropped during market turmoil's. Baur and Lucey (2010) provide the historical background as an explanation for the perception that gold is indeed safe. Although, gold is not the only asset that has been studied as a safe haven. Ranaldo and Söderlind (2007) examine currencies as a safe asset when there are market turmoil's. Among the currencies they test they found that the Swiss franc carries a strong safe haven attribute, especially during extreme changes on the monetary market. What Ranaldo and Söderlind found is that currencies are affected by macro factors, such as income growth, money supply and inflation. This could be a 'perception' that gold holds a stronger attribute for being safe.

Erb and Harvey (2013) study how to treat gold in asset allocation and tries to justify how gold can act as inflation hedging, currency hedging and disaster protection but they found little evidence that gold act as a hedge for unexpected inflation. What they found remarkable is that the supply of gold has not increased but the nominal gold price has fivefold. This diverging attribute could be, as Warren Buffet mentioned (Erb and Harvey 2013, p.2), a bubble or that gold is underowned as the opposite side claims. However, gold has been more and more used in allocation strategy among investors and the most widely belief is still that gold is an inflation hedge, according to Erb and Harvey. Jastram (1978) also examined how gold could act as a hedge for inflation and found that the golds long run average real return was around zero, which was also confirmed by Harmstons (1998) study, based on Jastrams result. What Harmston also found was that inflation itself is one of the major drivers of the gold price, as inflation raises the gold price raises.

Qadan and Yagil (2012) study the gold price and its association to a volatility index (VIX) which is an index that tries to measure the predicted volatility 30 days forward (CBOE n.d.). Often this implied volatility index is referred to as the 'fear index' (Cheng 2016). Qadan and Yangs found that VIX was a causality driver of changes in the gold price. This is important contribution of claiming gold to be a safe haven. The findings from Qadan and Yang showed very similar to the findings in Chan *et al.* (2011) who examined three markets; financial, commodity and real estate during two types of periods. A period of economic expansion exhibits positive stock returns, and for periods of crisis, exhibiting negative stock returns. Chan *et al.* found that during economic expansion, characterized by lower volatility and positive stock returns, there was a flight from gold to stocks. During periods of crisis, they found mostly a flight from stocks to treasury bonds even though gold return was positive. These findings contribute to the benefit of calling gold a safe haven in 'stormy weather'.

1.1 Research Questions

Could gold act as a safe haven in Sweden for the stock and bond market?

1.2 Contributions and Delimitations

The earlier studies and researches discuss the characteristics of the gold and its ability to act as a hedge or safe haven to the stock and bond market during high volatility. However, no further observations have been made on the Swedish stock or bond market and how gold particularly could act as a hedge or safe haven in Sweden. The study will only examine the Swedish stock and bond market as well as gold during a period between 2000 and 2018. It will also examine three specific crises; Dotcom bubble (2000), global financial crisis (2008) and European sovereign debt crisis (2011).

1.3 Disposition

The rest of this study is organized as followed. Part two gives a historical background of gold and why gold is considered to be a safe asset. Part three summarizes the literature on field and studies that have contributed to this research. Part four reviews the methodology used in this research and define the models. This part also includes the data gathering process. This is followed by part five that displays the results and the last part for discussion and conclusion.

2. Historical Background

This part will provide a historical background of gold and its meaning to the modern monetary system.

Gold has been linked to, and a part of, our financial system over a long time. Some researches even go back hundreds of years before Christ where gold could be interpreted as a viable currency. In order to understand its association to the modern monetary system one has to go back to the second half of the 1800 century. The money usually consisted of coins made of precious metals or issue notes from the banks, where the issue notes was pegged to a specified value of gold. The issue notes were also referred to as fiat money, which was a currency with no intrinsic value, meaning there was no fundamental value which there were in coins made by precious metals. This system was called the golden standard and United Kingdom was the pioneer in applying it. Sweden applied the golden standard, along with Denmark and Norway, in 1873 (Jonung 1984, s.362). Up to the first World War, the majority of all countries used the golden standard where currencies were strictly linked to gold. The monetary system was later on replaced by the Bretton-Wood system, changing the floating exchange rate that the golden standard meant. Countries' currencies were instead pegged to U.S. dollar and the U.S. dollar was backed by gold. This was due to the United States already holding two thirds of the world's gold supply. In 1971 U.S. government suspended the backing of gold to the U.S. dollar and it was no longer convertible to gold. (IMF n.d.)

During the time of the suspension to convert U.S. dollar to gold, investors considered and experienced that gold could act as a hedge for inflation due to its intrinsic value and its scarcity. During the unusually high inflation rates of double digits in the early 1980's, the value of gold was increasing. This was, however, later criticized during the high inflation later that decade leading to a drop in the gold price. (Harvey, 2018)

Today gold has a more comprehensive purpose including technology and healthcare. Due to its characteristics as a conductor, gold is also used in most of the electronics and in medical treatment (World Gold Council n.d.). Along with the arguments above, there are more interpretations why gold could be considered 'safe'. One of these arguments is handled in the Basel III regulation, which regulates how banks are operating and the capital requirements, that states that gold are considered less risky than holding cash items. This means that in the banks point of view they can hold gold rather than liquidity, money, and still comply with the Basel III rules. (BIS 2019)

3. Literature Review

This part of the thesis covers the literature within the field of safe havens. It discusses the earlier findings, theories and scientific contributions.

3.1 Risk and Volatility

In order to understand why investors make decisions in investments and explicitly in relation to risk one has to go back to the 1950's. Markowitz (1952) describes the rationale of investors trying to gain highest possible return to the lowest risk. A procedure to reduce the overall risk in a portfolio of assets is diversification, which can reduce the overall variance. Therefore, the diversified portfolio would be preferred to the non-diversified portfolios given they generate the same return. The discussions that has been presented can be applied to the theory that was presented by Markowitz. Gold, a possible hedge or even safe haven, could be an asset that reduce the risk in any portfolio and therefore would be desirable to add in any investor's portfolio. Findings in Shakil *et al.* (2017) showed that gold tended to be useful as a portfolio hedge, and even an inflation hedge.

Volatility is a common measure in financial contexts and exhibit an asset's standard deviated, or squared variance in, return. In extensive financial research it has been a measure of risk based on the asset's changes in price and return. Markowitz (1952), in the presentation of modern portfolio theory, made an important assumption that investors are risk-averse. This assumes that investors avoid risks in a large as possible extent. Similar volatility models have been used in earlier financial research (Black and Scholes 1973).

What also has been discovered is how volatility behave during longer time periods and Mandelbrot (1963) found evidence that volatility tend to cluster. When high volatility appears, as larger variance in an asset, the volatility tends to stay high, creating clusters. The same attributes apply for lower volatility. He found that the changes in an assets price are changing more extreme in certain periods, creating these volatility clusters.

3.2 Gold as Safe Haven, Hedge or Diversifier

Since there is no formal definition what a safe haven asset classifies as there are studies trying to explain such assets. As mentioned, Baur and McDermott (2010) describes a haven as a place of safety and resemble it with a ship looking for safety during stormy weathers. What then could describe a safe haven is that this safety place is kept safety during uncertain conditions. Baur and Lucey (2010) use the same definition as a safe haven but also add two types of assets, which are hedge and diversifier.

The definition of what characterize a safe haven asset are described in previous study (Baur and McDermott 2010; Baur and Lucey 2010). They describe the asset being uncorrelated or negatively correlated with another asset or portfolio in times of market stress or turmoil. However, a safe haven is also positively correlated to the asset or portfolio on average. Baur and McDermott argue that there are two types of safe haven; weak and strong. Nevertheless, studies (Ranaldo and Söderlind 2010; Baur and Lucey 2010) only examine safe haven as assets that are negatively correlated to a market portfolio in times of distress and positively correlated on average.

Baur and Lucey (2010) also identify two other attributes of an asset which are hedge and diversifier. A hedge is being described as an asset that is uncorrelated or negatively correlated with another asset or portfolio on average. a hedge does not strictly reduce losses during market turmoil since it can have a positive correlation in such periods and negative correlation in times of hiking stock and bond markets. A diversifier is defined as an asset that is positively correlated with another asset or portfolio on average. This means, similar to a hedge, that the diversifier does not have the ability to reduce losses during market turmoils since there could be positive correlation during these times. The asset is only used to decrease the variance in a portfolio.

The asset categories, definitions and properties has been summarized in table 1. It presents a definition of the name, defined by Baur and McDermott (2010). The second column presents the correlation to the benchmark, which in their study was a stock index. The third column presents the properties and attributes that the asset class hold.

Table 1: Definitions of assets

Name	Corr.	Properties
Safe Haven	- / +	The asset is negatively correlated to the financial market during financial distress and positively correlated on average.
Hedge	0 / -	The asset is negatively or uncorrelated to the financial market on average.
Diversifier	+	The asset is positively correlated to the financial market on average.

Source: Definitions used by Baur and McDermott (2010); Baur and Lucey (2010)

3.3 Summary of The Main Findings

Extensive literature has shown that gold hold some attributes that characterize a safe asset and is the dominating asset to use. Bauer and Lucey (2010) claim that there is not a specific theory explaining why gold usually is referred to as a safe haven. One fundamental underlying explanation could be the history of gold and its use as money. As there are no theories for assets that act as safe havens, this study will review the previous study within the area. Most of the earlier studies have found gold negatively correlated during extreme market turmoil's and the summaries of the studies used for this thesis has been summarized in table 2. Baur and Lucey found that gold act as a safe haven for stocks but not for bonds, using a GARCH model. Baur and McDermott (2010) found that gold acted as a safe haven for stocks, using same model. They also found that this was exhibited more when using daily data. Shakil *et al.* (2017) found that gold acted as a portfolio and inflation hedge and Anand and Madhogaria (2012) found that golds correlation between stocks and gold changes on a daily basis.

Among recent studies (Baur and McDermott 2010; Bialkowski *et al* 2010; Baur and Lucey 2010; Qadan and Yagil 2012) gold has been the most exoteric asset to test during ‘stormy weathers’. Bauer and Lucey (2010) examine how gold act as a safe haven for stock and bond markets in U.S., U.K. and Germany. Their findings contribute to the evidence that gold carries attributes for being a safe haven, where U.S. and U.K. showed negative correlation to the stock market. However, Bauer and Lucey only find this being true when the stock market exhibits extreme negative returns.

Table 2: Previous findings

Study	Asset	Model	Findings
Baur and Lucey (2010)	Gold	GARCH (1,1)	Gold acted as safe haven for stocks but not for bonds
Baur and McDermott (2010)	Gold	GARCH (1,1)	Gold acted as a safe haven for stocks, especially when using daily data.
Shakil et al. (2017)	Gold	ARDL	Gold acted as a portfolio and inflation hedge
Anand and Madhogaria (2012)	Gold	Granger Causality TEST	Correlation between stocks and gold change on a day to day basis

Source: Baur and Lucey (2010), Baur and McDermott (2010), Shakil *et al.* (2017) and Anand and Madhogaria (2012).

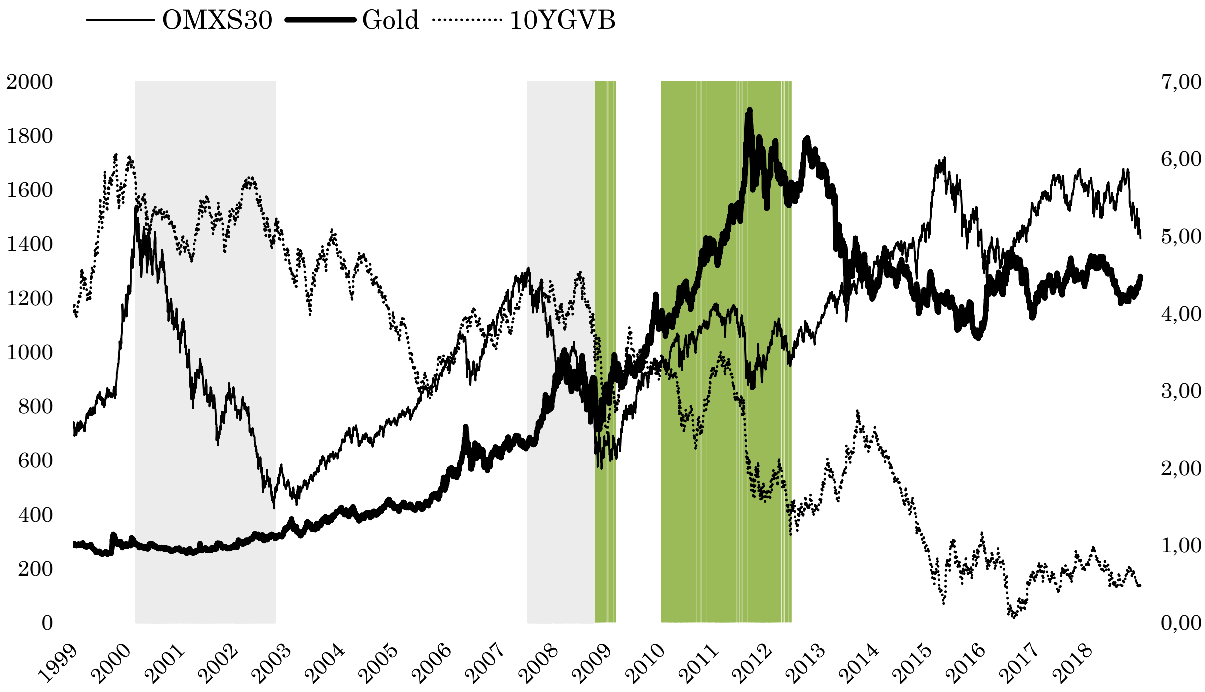
4. Methodology

This section describes the periods that has been examined for this thesis. It also presents data and statistical models that has been used. The last part of this section presents the regression model and its variables.

4.1 Financial Crises

The word 'financial crisis' imply a disruption in the financial system. However, there are no mutual definition of what a financial crisis is. Mishkin (1991) attempt to explain it as a disruption on financial markets where problems such as *moral hazard* and *adverse selection* inflates. This will create misallocations and result in lower efficiency. Both moral hazard and adverse selection are coined expressions based on asymmetric information, meaning that one party has the information advantage over another party. As these problems enhances, Mishkin argue that financial markets are entering periods with financial distress. One of the factors in a financial crisis is declines in stock or bond markets and the need for alternatives are significant. The financial crises that this study attempts to examine are shaded in graph 2. It also exhibits the closing price of the stock, bond and gold spot price.

Graph 2: Return during specified crisis periods and whole period (1999-2018)*



Source: Daily closing prices of OMXS30 and Gold spot price from Infront

* OMXS30 and Gold spot price (left axis) and 10-year Swedish government bond (right axis). Periods (shaded area) in order from left to right; Dotcom bubble, global financial crisis and European sovereign debt crisis.

Ofek and Richardson (2003) explains how the Dotcom bubble came to be one of the major periods of negative stock return. From the beginning of 1998 to early 2000 global stock markets gained hundreds of percent returns mostly driven by public companies in the internet sector and represented 5 percent of the U.S. market capitalization for public companies. In their research Ofek and Richardson study the pre-period of the Dotcom bubble between 1st of January 1998 to 29th of February 2000. One could therefore interpret, as they do not explicitly state, that the bubble burst at the end of February 2000. When the bubble burst companies started to lose a lot of their market value. What also support this date as the burst of the bubble is that this date was also the peak of the NASDAQ index in the U.S., a heavily weighted index by information technology companies (Geier 2015). There is no specific date where the period ended due to a bubble characteristic where the burst happens quickly. The stock market experienced a following market with negative return over a longer period and reached its bottom at October 2002 (Panko 2008).

As the Dotcom bubble was a result of internet stocks surging some periods of negative returns are occurred due to fundamental issues in the financial system. The global crisis during 2008 was one of the most impactful financial crisis in modern financial history since the 'Great Depression'. It started with a dubious interlinked derivative system that would collapse. The losses compounded and there was unknown in what degree individual banks was exposed to (Alessandrini 2011). A commonly used date for the eruption of the global crisis is 9th of August 2007 when BNP Paribas froze $2.2 billion due to the suspiciousness of subprime mortgage sector (Kar-Gupta and Le Guernigou 2008). This was followed by the shocking decision in 15th of September 2008 when the U.S. government decided not to bail out one of the, of that time, largest investment bank. 6th of March 2009 the major indices in U.S. had hit bottom low and therefore the 6th of March 2009 is a natural date to end the period of financial distress (Elliot 2011). However, the crisis left a lot of trails, among them a new rising crisis.

At the end of April 2010, all focus was shifted from the problem of the private sector to the public sector. During this time the International Monetary Funds (IMF) and the European Central Banks (ECB) objective was to handle the insolvency for the European governments and not the banks. Roman and Bilan (2012) explain the crisis as national authorities trying to save financial institutions at the same time as the global economy experienced a downturn. This directly led to significant accumulating budget deficits. At this point Greece requested a bailout from the EU and IMF. The 2nd of May 2010 the EU members and IMF approved a bailout to rescue Greece (Papadimas and Strupczewski 2010). As the crisis was very protracted this study will only consider the crisis to October 2012 when the European Union launched the crisis fund with a lending capacity of €500 billion (European Safety Mechanism 2015).

The whole dataset consists of 5019 daily closing prices and this study will distinguish between the three periods discussed above, where the financial market has exhibit turmoil or extreme negative return. The periods where gold will be tested as a safe haven for stocks and bonds are the Dotcom bubble, the global financial crisis and the sovereign debt crisis in Europe, as summarized in table 3. Gold will also be tested on the whole period including all observations.

Table 3: Periods used in the research

Name	Start	End	N
The Dotcom Bubble	1st of March 2000	9th of October 2002	656
The Global Financial Crisis	9th of August 2007	6th of March 2009	395
The European Sovereign Debt Crisis	23rd of April 2010	8th of October 2012	624
The Whole Period	4th of January 1999	20th of December 2018	5019

N = number of observations in each period

4.2 Data

The data for this study consists of closing prices for the Swedish stock market index (OMXS30), a value weighted index that represents the 30 most traded stocks, the spot price for gold, measured in USD per ounce and the 10-year Swedish government bond. The data has been gathered from a professional trading terminal, provided by Infront[1], that is widely used on the financial market in Sweden. The dataset consists of the daily log return between 1999-01-05 and 2018-12-20, a composition of 5018 observations. The daily log-return has been calculated according to equation 1.

$$r_{i,t} = ln(\frac{P_{i,t}}{P_{i,t-1}}) \cdot 100 \qquad \text{Equation (1)}$$

In equation 1 r is the return of asset i at time t. $P$is the price of asset i at time t. To calculate the log-return, I have taken the natural log of the price for each asset at time t over the price of same asset at time $t-1$. The stock market index used for this research has been chosen as it is the most representative index for the Swedish stock market, as it represents the Swedish stock market on average (Nasdaq n.d.). The bond return has been used from the 10-year government bond

[1] Infront is a leading market data and trading solution provider in the Nordics (https://www.infrontfinance.com/company)

in Sweden as it is one of the instruments used on the Swedish fixed income market (Nasdaq n.d.). The gold return is the spot gold price. All observations are daily data and has been calculated as equation 1.

The summarized statistics has been summarized in table 4, for gold, stocks (OMXS30) and bonds (10YGVB). During the whole period, gold has been strong and generated a return of over 200 percent. At the same time stocks has generated modest return while bonds have generated extremely negative return. When looking at the period of crisis, the Dotcom bubble generated an extreme negative return of -74.57 percent for stocks and -18.27 percent for bonds. At the same time as gold generated positive return of 6,38 percent. The global financial crisis generated extreme negative return for both stocks and bonds while gold generated positive return. The stock index dropped approximately 56 percent and the 10-year government bond dropped more than 38 percent. What is interesting during this crisis is that gold generated a positive return of 30 percent.

Table 4: Summarized statistics

	Gold				
Period	Return*	Mean	Max	Min	St.dev.
Dotcom Bubble	0.0638	0.0001	0.0647	-0.0282	0.0082
Global Financial Crisis	0.3006	0.0008	0.0601	-0.0797	0.0179
European Sovereign Debt Crisis	0.4984	0.0007	0.0456	-0.0581	0.0117
The Whole period	2.2907	0.0002	0.0700	-0.0959	0.0109
	OMXS30				
Period	Return*	Mean	Max	Min	St.dev.
Dotcom Bubble	-0.7457	-0.0018	0.0884	-0.0852	0.0209
Global Financial Crisis	-0.5623	-0.0018	0.0986	-0.0751	0.0230
European Sovereign Debt Crisis	-0.0361	0.0000	0.0623	-0.0696	0.0151
The Whole period	0.1317	0.0001	0.0986	-0.0880	0.0147
	10YGVB				
Period	Return*	Mean	Max	Min	St.dev.
Dotcom Bubble	-0.1827	-0.0002	0.0393	-0.0366	0.0087
Global Financial Crisis	-0.3844	-0.0010	0.0711	-0.0942	0.0164
European Sovereign Debt Crisis	-0.6358	-0.0012	0.2640	-0.1338	0.0276
The Whole period	-0.998	-0.0004	0.7480	-0.5555	0.0412

* Cumulative return

To decrease any affect exchange rates can have on the gold spot price, the daily closing price of stock market and bond market has been denominated into U.S. dollar. This has also been made for earlier studies (Baur and Lucey 2010; Baur and McDermott 2010). For denomination the spot price of SEK/USD has been used on the closing price and transformed all closing prices into U.S. dollars.

4.3 Ordinary Least Squares

The regression model for ordinary least squares (OLS) are the most common and used model in economic and financial research. The model is linear and aims to explain relationships between two given variables, for example to estimate the gold return given the return on the stock market. The use of the model has been popular due to its simplicity and comprehensive property. The general equation in its most primitive form is:

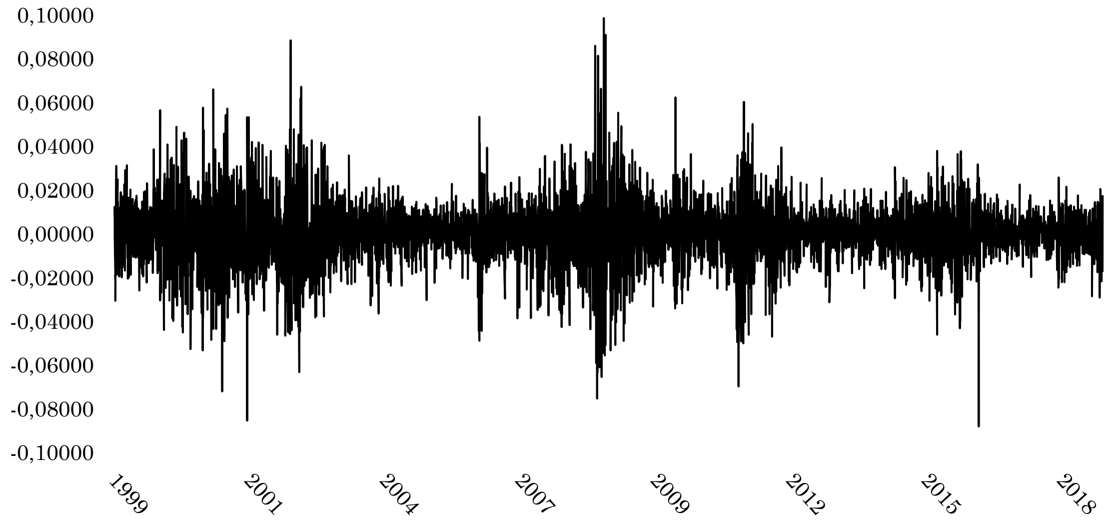
$$y_i = \alpha + \beta x_i + \varepsilon_i \qquad \text{Equation (2)}$$

In equation 2 y is the independent variable, α is the intercept in the model, $\beta$is the coefficient of the linear line, x is the dependent variable and ε is the error term. Assumptions for this model is that the error term is normally distributed and the variance during the whole period is constant. However, there are shortcomings in a linear model to generate accurate estimations when time series exhibit the volatility clustering's, presented by Mandelbrot (1963). One of the assumptions that are made in OLS is that the model assumes that the error terms exhibits homoskedasticity, meaning that the error terms are normally distributed around the estimation line. Usually this is not true and when working with financial time series the data is subject to the volatility clustering's effect. Therefore, a model that capture this effect is appropriate. (Brooks 2008)

4.4 ARCH

The autoregressive conditional heteroskedasticity (ARCH) model is commonly used when working with time series and specially in financial time series where volatility is varying, introduced by Robert F. Engle (1982). The model, unlike a simple regression, is non-linear and assumes that the variance of the error term is related to the size of previous periods error terms. One of the assumptions for linear regression models is that the variance of errors is constant, also known as homoscedasticity. Usually when working with time series, especially involving volatility, the data exhibits heteroskedasticity and this is from the fact that the error terms variance is not constant. The ARCH model describes the variance as the error term is likely affected by the size of previous periods error term. This ARCH effect is usually referred to as 'volatility clustering' and it means that if there are high volatility, the volatility in the next period tend to be affected by the volatility in previous period, and therefore experience higher volatility (Brooks 2008). This effect is exhibited in 3 for the return of Swedish stock market over the whole period.

Graph 3: Log return of OMXS30



Source: OMXS30 log return over the whole period from Infront

The pattern in graph 3 shows that the volatility appears in clusters. We also see that the volatility comes in spikes or bursts, both for positive and negative return. One could therefore consider that volatility is autocorrelated, answering how strong correlated today's return is with the return in the previous period. The ARCH model is defined below.

$$\sigma_t^2 = \alpha_0 + \alpha_1 u_{t-1}^2 + \alpha_2 u_{t-2}^2 + \ldots + \alpha_q u_{t-p}^2 \quad \text{Equation (3)}$$

$$Var(u_t | u_{t-1}, u_{t-2}, \ldots, u_{t-p}) = \sigma_t^2 \quad \text{Equation (4)}$$

In equation 3, σ_t^2 is the conditional variance of the error term, α is the coefficients and u_{t-1}^2 is the previous periods error variance. Depending on the p lags the model use, equation 3 is the general equation. As the variance of the error term is conditional it means that it is depending on previous variance of the error terms in previous periods. This is shown in equation 4. The model used in this study includes an ARCH (1) model since the variance depends on one lagged error term. This model is also used in previous study (Baur and McDermott 2010; Baur and Lucey 2010) examining gold and volatility.

Both equation 3 and equation 4 are only a part of the model and represent the conditional variance equation (Brooks 2008). This is also how we can test for the ARCH effect where we assume α_1> 0. An assumption that is made in the ARCH model is that the coefficients in the conditional variance term will have a value larger than 0. If the coefficients are 0 it means that the data exhibit homoskedasticity and the OLS is a more proper model to use. The second part of the model is the conditional mean equation and can be written as:

$$y_t = \alpha_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots \beta_t x_t + u_t \qquad \text{Equation (5)}$$

The mean equation is similar to the regular OLS as can be seen in equation 2. In equation 5, y represents the dependent variable, α is the intercept, β is the coefficient of the linear line, x is the dependent variable and ε is the error term. This study will only consider an ARCH (1) with following mean model.

$$y_t = \alpha_0 + \beta_1 x_1 + u_t \qquad \text{Equation (6)}$$

$$\sigma_t^2 = \alpha_0 + \alpha_1 u_{t-1}^2 \qquad \text{Equation (7)}$$

Equation 6 represents the simple conditional mean equation, given x as the independent variable. Equation 6 and 7 represents the complete ARCH (1) model. However, the ARCH model could get excessive when using many lags and therefore a more general model should be considered (Brooks 2008). Baur and McDermott (2010) use the GARCH model in order to consider the ARCH effect.

4.5 GARCH and GARCH (1,1)

The generalized autoregressive conditional heteroskedasticity (GARCH) model was developed by Bollerslev (1986) who introduced a model where the conditional variance could be dependent upon previous own lags. Engel (2001) argue that the model also implies that the most accurate predictions of the variance in future periods is a weighted average of the long-run average variance. The conditional variance equation is:

$$\sigma_t^2 = \alpha_0 + \alpha_1 u_{t-1}^2 + \beta_0 \sigma_{t-1}^2 \qquad \text{Equation (8)}$$

Equation 8 now implies we have a lag of one previous period. σ_t^2 is known as the conditional variance in the error term and is one period ahead. α_0 is the intercept, α_1 and β_0 is the coefficients, u_{t-1}^2 is the previous periods variance in the error term and σ_{t-1}^2 is the previous conditional variance in the error term. These terms are called the ARCH term (u_{t-1}^2) and the GARCH term (σ_{t-1}^2). This is the most common model used in similar studies (Baur and Lucey 2010; Baur and McDermott 2010) and is referred to the GARCH (1,1) model. It is also a model that will capture sufficient volatility clustering and widely used within finance. (Brooks 2008)

4.6 Regression Model

The regression model that will be used in this study takes the similar form that Baur and McDermott (2010) used. It will include the daily return of the dependent variable, which in this study will be return in gold, and the independent variables, which are the stock market return and 10-year government bond return. To deal with the ARCH effect, the GARCH (1,1) model will be used according to equation 9 and 10.

$$r_{gold} = \alpha_0 + \beta_1 r_{stocks} + \beta_1 r_{bonds} + u_t \qquad \text{Equation (9)}$$

$$\sigma_t^2 = \alpha_0 + \alpha_1 u_{t-1}^2 + \beta_0 \sigma_{t-1}^2 \qquad \text{Equation (10)}$$

In equation 9 the dependent variable is the daily return of gold, α_0 is the intercept, β_1 and β_2 are the coefficients, r_{stocks} is the daily return of the stock market and r_{bonds} is the daily return of the 10 year Swedish government bond. Equation 10 is the GARCH (1,1) model which has been explained earlier.

5. Result

This part begins by presenting the test for ARCH effect in every period, followed by the result from the regressions models. It also displays graphically the return of gold, stocks and bonds.

5.1 Test for ARCH effects

One condition in order to use the GARCH model is that the data set exhibit ARCH effects, meaning that there is volatility clustering. In order to test for these effects an Autoregressive conditional heteroskedasticity Lagrange multiplier (ARCH-LM) test using 1 lag has been made with the null hypothesis that there is no ARCH effect and the alternative that there is ARCH effect. The result for every period observed has been concluded in the table 5 below. Three of the four periods are subject to ARCH effect, where the global financial crisis was not significant. This means that a GARCH model is appropriate for every period except the global financial crisis, where an OLS model will be used. The ARCH-LM test has also been made on stocks and bonds separately and can be found in table 12 and 13 in Appendix 1.

Table 5: ARCH-LM test for ARCH effect

H_0 No ARCH effects H_1 ARCH(p) distrurbance

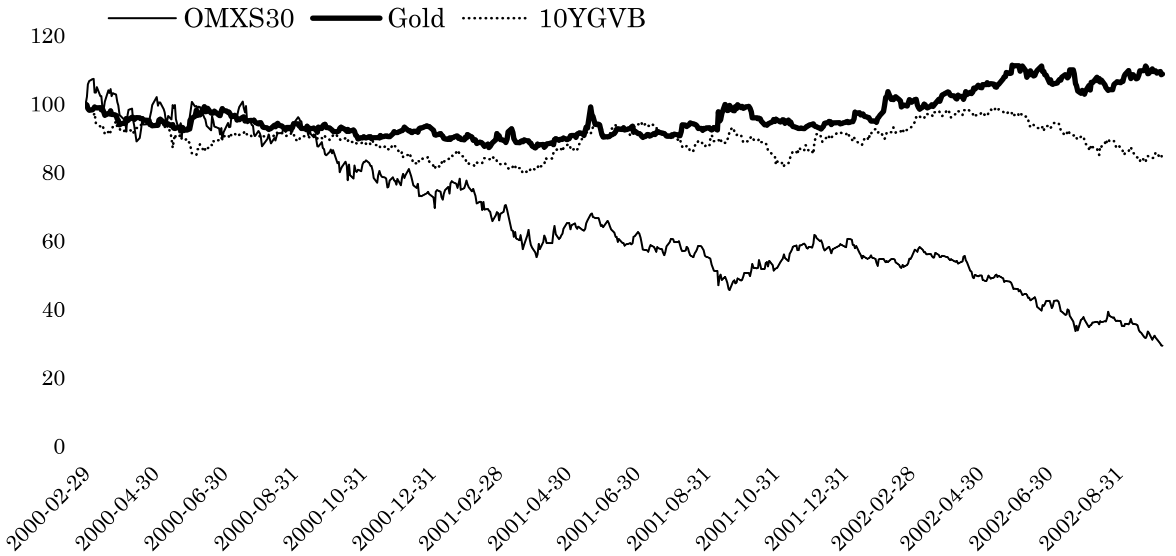
	Denominated in $U.S.		Non-denominated	
Period	lags(p)	Chi2	lags(p)	Chi2
The Whole Period	1	91.915***	1	86.851***
The Dotcom Bubble	1	11.816***	1	8.915***
The Global Financial Crisis	1	1.758	1	0.762
The European Sovereign Debt Crisis	1	12.009***	1	7.622***

***** Significant at a 10% level, ****** significant at a 5% level, ******* significant at a 1% level.

5.2 The Dotcom Bubble

The first period of financial turmoil that has been examined is the Dotcom bubble the includes 655 observations. As can be seen in graph 4 the gold and bond price move in a slightly surging manner while the stock index dropped over 70 percent during this period. We can see a negative correlation for this period between gold and stocks but not between gold and bonds. The 10-year Swedish government bond tend to move similar to gold.

Graph 4: Return during the dotcom bubble*



* Closing non-denominated prices of OMXS30, 10-year Swedish government bond and spot gold price indexed (starts at 100).

The output from the regression has been summarized in table 6. The independent variable is gold and the dependent variables are OMXS30 and 10-year Swedish government bond in this model. The mean equation of the non-denominated stock and bond log-returns shows that the coefficients are significant at the 1 percent level and negatively correlated to gold. The denominated stock and bond log-returns shows that OMXS30 is statistically significant the 1 percent level but bonds are not.

For the variance equation model both ARCH and GARCH coefficient is statistically significant at the 1 percent level as can be seen in the table below.

Table 6: Regression from the dotcom bubble

Mean Equation Model			Mean Equation Model		
Gold	Coef.	z-score	Gold	Coef.	z-score
omxs30	-0.059228	-4.68***	omxs30 (in $U.S.)	-0.044911	-4.07***
gvb	-0.095868	-3.49***	gvb (in $U.S.)	0.027265	0.95
constant	0.000017	0.05	constant	0.000037	0.12
Variance Equation Model			Variance Equation Model		
ARCH (1)	0.236258	4.69***	ARCH (1)	0.245775	4.70***
GARCH (1)	0.558029	7.31***	GARCH (1)	0.572121	8.29***
constant	0.0000	5.27***	constant	0.0000	5.40***

***** Significant at a 10% level, ****** significant at a 5% level, ******* significant at a 1% level.

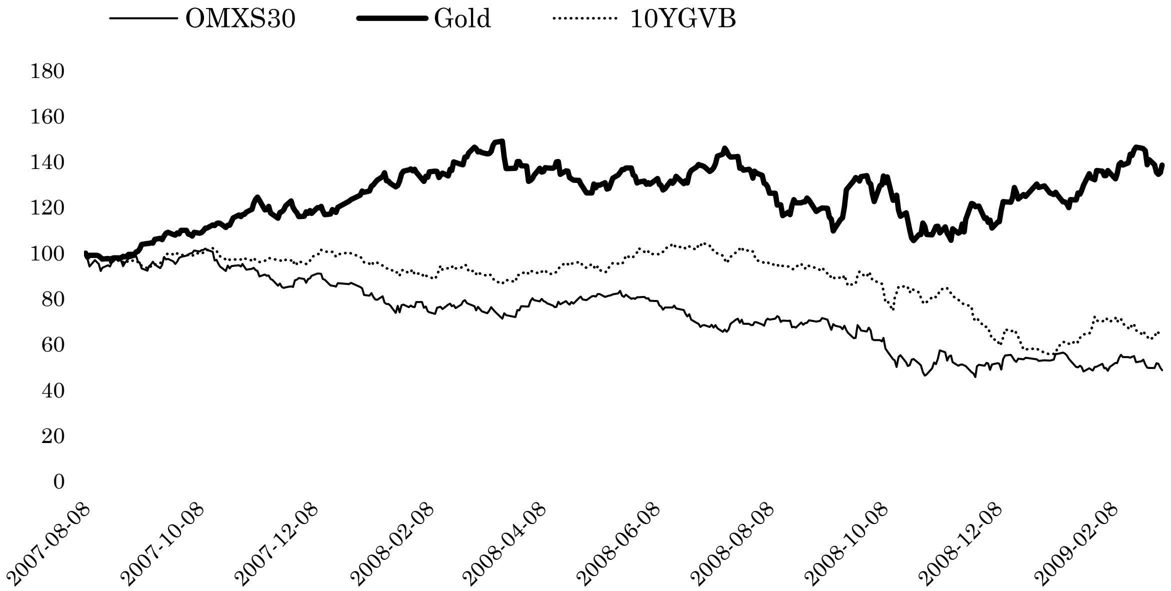
Model: $r_{gold} = \alpha_0 + \beta_1 r_{stocks} + \beta_2 r_{bonds} + u_t$ and $\sigma_t^2 = \alpha_0 + \alpha_1 u_{t-1}^2 + \beta_0 \sigma_{t-1}^2$

The regression output when running every dependent variable separately in the model has been summarized in table 14 and 15 which can be found in Appendix 2. The result shows that stocks correlated negatively, at a significant level, with gold when using both non-denominated returns and denominated returns. When looking at bond market the result is only significant when using non-denominated returns.

5.3 The Global Financial Crisis

The financial crisis includes 393 observations of log-return. As can be seen in the graph below gold had a positive return over the whole period but exhibit high volatility, as gold price tends to move extremely. Both the stock market and the 10-year government bond generated negative return during this period. The period has also been summarized in graph 5.

Graph 5: Return during the Global financial crisis*



* Closing non-denominated prices of OMXS30, 10-year Swedish government bond and spot gold price indexed (starts at 100).

The output from the regressions has been summarized in table 7. As this is an OLS model we only have a mean equation model and not a variance model. The non-denominated log-returns of both stock and bonds show no statistically significance. When looking at the denominated returns the 10-year government bond is statistically significant on a 5 percent level with a positive coefficient meaning that there is no negative correlation between bonds and gold. The denominated return for stocks is not statistically significant.

Table 7: Regressions from the global financial crisis

Mean Equation Model			Mean Equation Model		
Gold	Coef.	z-score	Gold	Coef.	z-score
omxs30	-0.064523	-1.49	omxs30 (in $U.S.)	-0.025083	-0.59
gvb	0.0567631	0.94	gvb (in $U.S.)	0.161724	3.01***
constant	0.000774	0.85	constant	0.001075	1.19

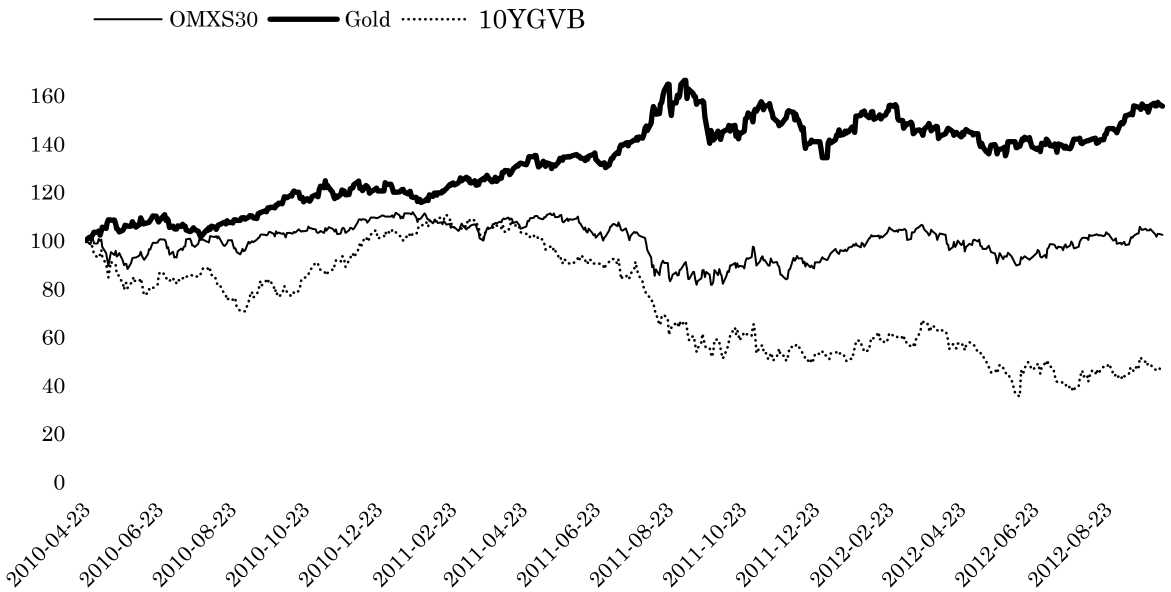
***** Significant at a 10% level, ****** significant at a 5% level, ******* significant at a 1% level.

Model:: $r_{gold} = \alpha_0 + \beta_1 r_{stocks} + \beta_2 r_{bonds} + u_t$

5.4 The European Sovereign Debt Crisis

The last period that is examined is the European sovereign debt crisis which consists of 624 observations. The return for the independent variable and the dependent variables has been displayed in graph 6. The graph shows that gold move similar to stocks and bond at the beginning of the period but later start to show divergence. Right after that period they keep moving similar to each other.

Graph 6: Return during the European debt crisis*



* Closing price of OMXS30, 10-year Swedish government bond and spot gold price indexed (starts at 100).

The regression output has been summarized in table 8. The model shows that there is no statistically significance between the correlation of gold and stocks or bonds. However, when looking at the denominated prices gold has a positive correlation to stocks on a significant level.

Table 8: Regression from the European sovereign debt crisis

Mean Equation Model			Mean Equation Model (Denominated)		
Gold	Coef.	z-score	Gold	Coef.	z-score
omxs30	0.0319	0.94	omxs30 (in $U.S.)	0.0965	3.24***
gvb	-0.0020	-0.09	gvb (in $U.S.)	-0.0029	-0.13
constant	0.0009	2.09	constant	0.0008	2.01
Variance Equation Model			Variance Equation Model (Denominated)		
ARCH (1)	0.0456	4.45***	ARCH (1)	0.0461	4.40***
GARCH (1)	0.9404	67.43***	GARCH (1)	0.9409	68.06***
constant	0.0000	1.88*	constant	0.0000	1.82*

* Significant at a 10% level, ** significant at a 5% level, *** significant at a 1% level.

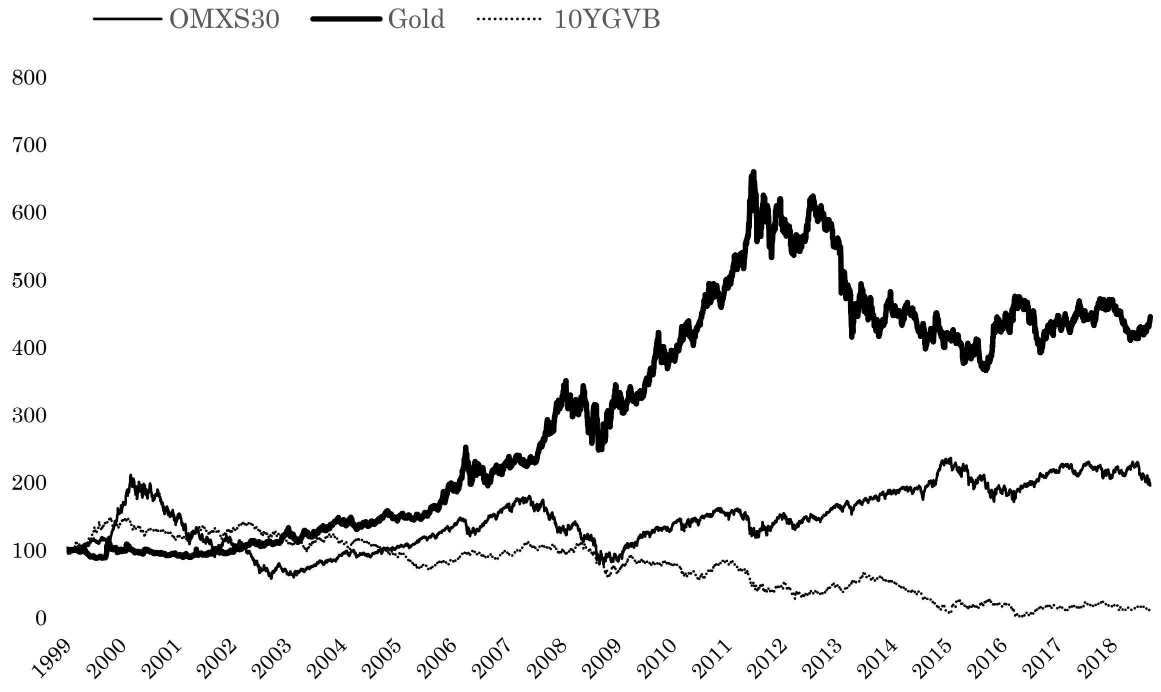
Model: $r_{gold} = \alpha_0 + \beta_1 r_{stocks} + \beta_2 r_{bonds} + u_t$ and $\sigma_t^2 = \alpha_0 + \alpha_1 u_{t-1}^2 + \beta_0 \sigma_{t-1}^2$

The regression output for stocks and bonds separately has been summarized in table 17 and 18, which can be found in Appendix 4. The result shows that gold has a negative correlation, on a significant level, to bonds when using denominated return. However, it is not significant to stock market.

5.5 The Whole Period

Graph 7 below displays the whole period that also has been summarized in table 4. The graph shows that gold has been surging over the whole period, as well as stocks. The 10-year Swedish government bond has dropped during the whole period. The most significant difference between gold and stocks and bonds was during the financial crises and the period afterwards, as gold reached its peak. The first regression model will consider the whole period.

Graph 7: Whole Period*



* Closing price of OMXS30, 10-year Swedish government bond and spot gold price indexed (starts at 100).

The output from running the regressions for the whole period has been summarized in table 9. The mean equation model shows that gold has a negative correlation to stocks at a statistically significant level. However, it is not significant to bonds. When looking at the denominated stock and bond prices it shows no significance. When looking at the variance equation when using 1 lag, meaning GARCH (1,1) model we found that both coefficients in the variance equation are significant in both denominated and non-denominated indices. In this particular case the constants, or intercept, are not the interest as the coefficient which exhibit the correlations are more of interest. The R-squared value for the model is generally low. However, the purpose is only to examine the assets relationship and not to explain it, as the R-squared value has been excluded.

Table 9: Regression from the whole period

Mean Equation Model			Mean Equation Model (Denominated)		
Gold	Coef.	z-score	Gold	Coef.	z-score
omxs30	-0.0409	-5.07***	omxs30 (in $U.S.)	0.0067	0.96
gvb	-0.0046	-1.62	gvb (in $U.S.)	-0.0019	-0.66
constant	0.0002	1-.71	constant	0.0002	1.64
Variance Equation Model			Variance Equation Model (Denominated)		
ARCH (1)	0.0694	23.63***	ARCH (1)	0.0677	24.21***
GARCH (1)	0.9163	264.98***	GARCH (1)	0.9177	271.94***
constant	0.0000	10.93***	constant	0.0000	11.28***

* Significant at a 10% level, ** significant at a 5% level, *** significant at a 1% level.

Model: $r_{gold} = \alpha_0 + \beta_1 r_{stocks} + \beta_2 r_{bonds} + u_t$ and $\sigma_t^2 = \alpha_0 + \alpha_1 u_{t-1}^2 + \beta_0 \sigma_{t-1}^2$

It is interesting to examine the output from the regression model when using only one dependent variable. It is not possible to examine how much the model consider each variable. The result of using the model for stocks and bonds separately has been conducted in table 17 and 18, which can be found in Appendix 5. It shows that gold correlates negative to stock market when not being denominated. The same holds for the non-denominated bond return. It is not statistically significant for the stock and bond return when denominated in U.S. dollar.

6. Discussion

As earlier studies (Baur and McDermott 2010; Baur and Lucey 2010) discussed, a safe haven asset is an asset that is negatively correlated to an asset or market portfolio during market distress or turmoil. At the same time, it should be positively correlated to the asset or market portfolio on average. If the asset is a hedge, it should be negatively correlated to an asset or market portfolio on average and if it is a diversifier the asset should be uncorrelated to an asset or market portfolio. If gold act as a safe haven for stocks or bonds there should be a positive correlation over the whole period, meaning that there is a positive correlation on average. The models should also show that there is a negative correlation during the three given periods of crisis that this study consider examining.

What is interesting is that one of the periods did not exhibit ARCH effect and therefore an OLS model has been used. The period was the global financial crisis. What could be speculated is that the whole period was suffering high volatility and therefore the ARCH-LM test cannot find any ARCH effect. The result was the same when testing for stocks and bonds separately, which can be found in Appendix 1.

6.1 The Dotcom Bubble

The first period of market distress or turmoil is the Dotcom bubble. When first looking at the graph of gold price, stocks and bonds, one can see that all assets are moving in a somewhat similar manner. As the time develops, stocks tend to generate more negative return as gold and bonds positive modest positive return. One could therefore expect that there should be a negative correlation against stocks but not for bonds. Table 4 shows the summary statistics, where one can see that gold generated a return of 6 percent return, stocks generated a negative return of 75 percent and bonds generated a negative return of 18 percent. When looking at the regression output, stocks show a negative coefficient at a statistically significant level. What is interesting is that bonds do as well. What should be considered is that the coefficient for bonds may pick up some effect from stocks and the regression has been run separately, which is concluded in table 14 and 15 (Appendix 2).

When looking at the regression output, when running bonds and stocks separately bonds show that it has a negative coefficient at a significant level. It has a negative correlation at a statistically significant level. When looking at the denominated bond return the test found that there is a modest negative correlation. However, it is not statistically significant. The denominated stock return has a negative correlation and it is statistically significant. Although, the non-denominated return exhibited a more negative correlation. It is most likely that the exchange rates had a positive impact on stock prices during this crisis and the denominated return move more like gold during this period. There could be other exogenous factors that has impact on the gold price.

6.2 The Global Financial Crisis

The financial crisis that occurred has, in extensive literature, been referred to the most impactful economic crisis in modern time since the Great depression. During the period examined in this study, gold generate a remarkable return of 30 percent. However, financial markets generated the opposite. Stock market in Sweden lost almost three quarters of its value and generated a negative return of nearly 75 percent. Bonds generated a negative return of 38 percent. There is clearly a wide spread when looking at graph 5, showing the return of gold, stocks and bonds. Therefore, one could assume that gold exhibit negative correlation to stocks and bonds.

The model used during this period is an OLS, since the ARCH-LM test did not show any ARCH effect. The regression output, that can be seen in table 7, showed a negative coefficient to stocks but a positive coefficient to bonds. This was the case for both non-denominated and denominated return. However, only the non-denominated bond return was statistically significant. When looking at the model when running stocks and bonds separately, it gives similar output. The denominated bond return had a positive correlation at a statistically significant level. What could be said about this test is that the period suffered extreme volatility and the ARCH-LM test came out not to be significant. Therefore, one could ask if the OLS model is sufficient to give reliable output.

6.3 The European Sovereign Debt Crisis

The last period of crisis that was examined was the European debt crisis. During this crisis gold generated a return of nearly 50 percent. Stocks generated a modest negative return of almost 4 percent while bonds generated a negative return of nearly 64 percent. The reason for the extreme negative return in bonds was that during this crisis several countries defaulted and could not pay their obligations. When looking at the graph gold move somewhat similar to each other during the beginning of the period. However, there seem to be some sort of infliction point where bonds and stocks turn down, as gold raise. During this period, one could assume that there is a negative correlation between gold and stocks and bonds, on average.

The regression output, that has been summarized in table 8, show that stock return had a positive coefficient while bonds had a negative coefficient. However, only the denominated stock return was statistically significant. In this particular case it is interesting to see how gold correlated to stocks and bonds separately. Table 18 and 19, in Appendix 4, show that both non-denominated stock return exhibits a modest positive correlation while bond return exhibit nearly no correlation at all. When looking at the denominated return it exhibits a positive correlation at a significant level for stocks and a modest positive correlation for bonds, but not at a statistically significant level.

6.4 The Whole Period

As Baur and McDermott (2010) as well as Baur and Lucey (2010) argued, a safe haven asset should be positively correlated to a market portfolio or an asset on average. In this study, it means that gold should be have a positive correlation to OMXS30 and the 10-year government bond during the whole period. When looking at graph 7, showing the whole period gold has generated extreme positive return, while stocks generated a positive return. Bonds generated an extreme negative return and one could therefore assume that gold has a negative return to bonds but not to stocks.

Table 9 has summarized the output from the regression and shows that non-denominated stock returns had a negative coefficient, as well as bond returns. However, the stock return was statistically significant which is interesting as it states that gold could not be considered an asset that correlates positive on average to stocks. Bond return was not significant. The non-denominated return for stocks showed that it was a very modest positive coefficient while bonds was slightly negative. However, none of the returns was significant.

6.5 Analysis

If one first looks to the non-denominated bond return it was only one period that showed a negative coefficient at a significant level, which was the Dotcom bubble. On average, the correlation was negative for non-denominated bond returns. The non-denominated stock return had a negative coefficient during the Dotcom bubble and global financial crisis, but positive coefficient during the debt crisis. However, only the Dotcom bubble was significant and there was a negative coefficient during the whole period. When looking at the denominated returns, it shows that bonds had a positive return during the Dotcom bubble, global financial crisis and the whole period. It had a negative coefficient for bonds. Only the whole period and the global financial crisis was significant. The only asset that showed any potential safe haven classification was denominated stocks as it was positively correlated on average. However, it was not significant. All coefficients have been summarized in table 10 below.

Table 10: Coefficients from every period

	Non-denominated Returns			
	The Whole Period	The Dotcom Bubble	The Global Financial Crisis	The European Debt Crisis
Stocks	-0.0410***	-0.0592***	-0.0645	0.0319
Bonds	-0.0047	-0.0959***	0.0568	-0.0020
	Denominated Returns			
	The Whole Period	The Dotcom Bubble	The Global Financial Crisis	The European Debt Crisis
Stocks	0.0068	-0.0450***	-0.0251	0.0965***
Bonds	-0.0056**	0.0273	0.1617***	-0.0029

***** Significant at a 10% level, ****** significant at a 5% level, ******* significant at a 1% level.

To answer if gold is a safe haven, one could go back to Baur and McDermotts (2010) definitions, that is summarized in table 1. What can be analyzed from the table above is that gold exhibits a more safe haven characteristics for stocks rather than bonds. What should be considered although, is that the 10-year government bond in Sweden tend to represent the interest rates in Sweden. Sweden, as the rest of the financial markets, has experienced low rates which is an important factor that one should considered. This model has not considered the interest rate levels in Sweden and therefore the bond returns could be improper. When looking at stock returns, the denominated stock return shows the most 'safe haven' characteristics, as it is positively correlated to gold on average and negative during the crisis, except for the debt crisis. When looking at the non-denominated stock returns it exhibited a negative correlation to gold on average. The differences between the two coefficients are explained by the exchange rates between the U.S. dollar and Swedish krona. During the period, the exchanged rate has had an impact on the stock return as the U.S. dollar has appreciated to the Swedish krona.

When comparing the results to the previous study from Baur and Lucey (2010), this result show different findings, as gold does not really act as a 'safe haven' for stocks. It was also the same for the findings in Baur and McDermott (2010) who found that gold acted as a 'safe haven' for stocks. It is more likely that these findings support the result in the study from Shakil *et al.* (2017). Gold exhibited more hedge attributes rather than being a 'safe haven'.

However, when using a statistical model to explain safe haven attributes one has to consider any omitted variables. Usually there are other assets affecting gold prices, stock returns and bond returns. This could generate a misleading output. What could also be considered are exogenous factors, such as economic indicators. Sweden has been subject to low interest rates which affect the bond return and one could therefore consider using another asset instead of the 10-year government bond.

7. Conclusions

As there are not significant negative correlation during all periods of crisis, on a statistically significant level, one could not assume that gold is a safe haven for neither stocks or bonds. Gold has shown weak 'safe haven' attributes to denominated stock returns and strong hedge attributes to non-denominated stock return. Further, gold showed weak hedge attributes to non-denominated bond return as it was negative correlated on average. For denominated bond return, this study can not classify how gold act as its attributes are undistinguishable. The classifications have been summarized in table 11.

Table 11: Classification*

	Non-denominated		Denominated	
	Stocks	Bonds	Stocks	Bonds
Classification	Strong hedge	Weak hedge	Weak safe haven	N/A

* Classifications used in Baur and Lucey (2010) and Baur and McDermott (2010)

This study shows that gold is not a safe haven for non-denominated stocks and bond in Sweden. It is more likely a hedge as it is negatively correlated on average. Gold show some safe haven attributes for denominated stocks, but it is not convincing. Gold show neither safe haven, hedge or diversifier attributes for denominated bonds. This concludes that gold can not act as a safe haven for the Swedish stock and bond market.

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Appendix

Appendix 1: ARCH-LM Test

Table 12: ARCH-LM test for ARCH effect using only stocks

H_0 No ARCH effects H_1 ARCH(p) disturbance

	Denominated in $U.S.		Non-denominated	
Period	lags(p)	Chi2	lags(p)	Chi2
The Whole Period	1	91.896***	1	89.259***
The Dotcom Bubble	1	12.031***	1	9.402***
The Global Financial Crisis	1	1.440	1	0.838
The European Sovereign Debt Crisis	1	12.075***	1	7.707***

* Significant at a 10% level, ** significant at a 5% level, *** significant at a 1% level.

Table 13: ARCH-LM test for ARCH effect using only bonds

H_0 No ARCH effects H_1 ARCH(p) disturbance

	Denominated in $U.S.		Non-denominated	
Period	lags(p)	Chi2	lags(p)	Chi2
The Whole Period	1	86.635***	1	89.312***
The Dotcom Bubble	1	14.175***	1	12.365***
The Global Financial Crisis	1	1.901	1	1.010
The European Sovereign Debt Crisis	1	7.827***	1	6.761***

* Significant at a 10% level, ** significant at a 5% level, *** significant at a 1% level.

Appendix 2: Results from the Dotcom Bubble

Table 14: Regression for stocks during the Dotcom bubble

Mean Equation Model			Mean Equation Model (Denominated)		
Gold	Coef.	z-score	Gold	Coef.	z-score
omxs30	-0.0691	-5.51***	omxs30 (in $U.S.)	-0.0392	-3.59***
constant	0.0000	0.02	constant	0.0000	0.13
Variance Equation Model			Variance Equation Model (Denominated)		
ARCH (1)	0.2489	4.91***	ARCH (1)	0.2456	4.82***
GARCH (1)	0.5723	8.41***	GARCH (1)	0.5650	8.61***
constant	0.0000	5.44***	constant	0.0000	5.86***

* Significant at a 10% level, ** significant at a 5% level, *** significant at a 1% level.

Model: $r_{gold} = \alpha_0 + \beta_1 r_{stocks} + u_t$ and $\sigma_t^2 = \alpha_0 + \alpha_1 u_{t-1}^2 + \beta_0 \sigma_{t-1}^2$

Table 15: Regression for bonds during the Dotcom bubble

Mean Equation Model			Mean Equation Model (Denominated)		
Gold	Coef.	z-score	Gold	Coef.	z-score
gvb	-0.1282	-4.73***	gvb (in $U.S.)	-0.0143	-0.50
constant	0.0001	0.37	constant	0.0001	0.35
Variance Equation Model			Variance Equation Model (Denominated)		
ARCH (1)	0.2267	4.47***	ARCH (1)	0.2390	5.06***
GARCH (1)	0.5348	7.40***	GARCH (1)	0.5520	9.23***
constant	0.0000	6.46***	constant	0.0000	6.61***

* Significant at a 10% level, ** significant at a 5% level, *** significant at a 1% level.

Model: $r_{gold} = \alpha_0 + \beta_2 r_{bonds} + u_t$ and $\sigma_t^2 = \alpha_0 + \alpha_1 u_{t-1}^2 + \beta_0 \sigma_{t-1}^2$

Appendix 3: Results from the Global Financial Crisis

Table 16: Regressions for stocks during the global financial crisis

Mean Equation Model			Mean Equation Model		
Gold	Coef.	t-stat	Gold	Coef.	t-stat
omxs30	-0.0475	-1.21	omxs30 (in $U.S.)	0.0411	1.11
constant	0.0007	0.82	constant	0.0009	1.03

***** Significant at a 10% level, ****** significant at a 5% level, ******* significant at a 1% level.

Model: $r_{gold} = \alpha_0 + \beta_1 r_{stocks} + u_t$

Table 17: Regressions for bonds during the global financial crisis

Mean Equation Model			Mean Equation Model		
Gold	Coef.	t-stat	Gold	Coef.	t-stat
gvb	0.0190	0.35	gvb (in $U.S.)	0.1455	3.16***
constant	0.0009	0.94	constant	0.0011	1.24

***** Significant at a 10% level, ****** significant at a 5% level, ******* significant at a 1% level.

Model: $r_{gold} = \alpha_0 + \beta_1 r_{stocks} + u_t$

Appendix 4: Results from the European Sovereign Debt Crisis

Table 18: Regression for stocks during the European debt crisis

Mean Equation Model			Mean Equation Model (Denominated)		
Gold	Coef.	z-score	Gold	Coef.	z-score
omxs30	0.0299	0.97	omxs30 (in $U.S.)	0.0936	3.67***
constant	0.0009	2.10	constant	0.0008	2.01
Variance Equation Model			Variance Equation Model (Denominated)		
ARCH (1)	0.0456	4.59***	ARCH (1)	0.0461	4.52***
GARCH (1)	0.9404	71.08***	GARCH (1)	0.9408	70.77***
constant	0.0000	1.97**	constant	0.0000	1.87*

* Significant at a 10% level, ** significant at a 5% level, *** significant at a 1% level.

Model: $r_{gold} = \alpha_0 + \beta_1 r_{stocks} + u_t$ and $\sigma_t^2 = \alpha_0 + \alpha_1 u_{t-1}^2 + \beta_0 \sigma_{t-1}^2$

Table 19: Regression for bonds over the European debt crisis

Mean Equation Model			Mean Equation Model (Denominated)		
Gold	Coef.	z-score	Gold	Coef.	z-score
gvb	0.0067	0.33	gvb (in $U.S.)	0.0300	1.53
constant	0.0009	2.12	constant	0.0009	2.13
Variance Equation Model			Variance Equation Model (Denominated)		
ARCH (1)	0.0460	4.61***	ARCH (1)	0.0461	4.59***
GARCH (1)	0.9395	67.56***	GARCH (1)	0.9396	67.52***
constant	0.0000	1.92*	constant	0.0000	1.89*

* Significant at a 10% level, ** significant at a 5% level, *** significant at a 1% level.

Model: $r_{gold} = \alpha_0 + \beta_2 r_{bonds} + u_t$ and $\sigma_t^2 = \alpha_0 + \alpha_1 u_{t-1}^2 + \beta_0 \sigma_{t-1}^2$

Appendix 5: Results from the Whole Period

Table 20: Regression for stocks during the whole period

Mean Equation Model			Mean Equation Model (Denominated)		
Gold	Coef.	z-score	Gold	Coef.	z-score
omxs30	-0.0423	-5.25***	omxs30 (in $U.S.)	0.0056	0.81
constant	0.0002	1.71	constant	0.0002	1.64
Variance Equation Model			Variance Equation Model (Denominated)		
ARCH (1)	0.0690	23.68***	ARCH (1)	0.0676	24.30***
GARCH (1)	0.9167	266.77***	GARCH (1)	0.9178	272.94***
constant	0.0000	10.91***	constant	0.0000	11.48***

* Significant at a 10% level, ** significant at a 5% level, *** significant at a 1% level.

Model: $r_{gold} = \alpha_0 + \beta_1 r_{stocks} + u_t$ and $\sigma_t^2 = \alpha_0 + \alpha_1 u_{t-1}^2 + \beta_0 \sigma_{t-1}^2$

Table 21: Regression for bonds during the whole period

Mean Equation Model			Mean Equation Model (Denominated)		
Gold	Coef.	z-score	Gold	Coef.	z-score
gvb	-0.0056	-1.96**	gvb (in $U.S.)	-0.0015	-0.52
constant	0.0002	1.65	constant	0.0002	1.65
Variance Equation Model			Variance Equation Model (Denominated)		
ARCH (1)	0.0680	24.45***	ARCH (1)	0.0678	24.45***
GARCH (1)	0.9173	270.60***	GARCH (1)	0.9176	271.47***
constant	0.0000	11.28***	constant	0.0000	11.46***

* Significant at a 10% level, ** significant at a 5% level, *** significant at a 1% level.

Model: $r_{gold} = \alpha_0 + \beta_2 r_{bonds} + u_t$ and $\sigma_t^2 = \alpha_0 + \alpha_1 u_{t-1}^2 + \beta_0 \sigma_{t-1}^2$