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Dirk Baur
IIIS, Trinity College Dublin

Brian Lucey
School of Business Studies & IIIS, Trinity College Dublin

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Dirk G. Baur*

Institute for International Integration Studies, Trinity College Dublin

Brian M. Lucey

School of Business Studies, Trinity College Dublin

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Abstract

This paper addresses two questions. First, we investigate whether gold is a hedge against stocks and/or bonds and second, we investigate whether gold is a safe haven for investors if either stocks or bonds fall. A safe haven is defined as a security that loses none of its value in case of a market crash. This is counterpoised against a hedge, defined as a security that does not co-move with stocks or bonds on average. We study constant and time-varying relationships between stocks, bonds and gold in order to investigate the existence of a hedge and a safe haven. The empirical analysis examines US, UK and German stock and bond prices and returns and their relationship with the Gold price. We find that (i) Gold is a hedge against stocks, (ii) Gold is a safe haven in extreme stock market conditions and (iii) Gold is a safe haven for stocks only for 15 trading days after an extreme shock occurred.

JEL: G10, G11, G14, G15

Keywords: Safe haven, gold, stock-bond correlation, flight-to-quality

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* Corresponding author. Address: IIIS, The Sutherland Centre, College Green, Dublin 2, Ireland. Email: baurd@tcd.ie.

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Introduction

Financial markets have been growing steadily in terms of volume and value in recent decades. The same is true for the variety of financial instruments and its complexity. Moreover, increased interdependence among markets and assets create the potential need for an asset that is relatively simplistic and safe: a haven. This paper analyzes the existence of a safe haven by investigating the role of Gold and its relation to stocks and bonds.

The paper is motivated by three questions. First, what is a safe haven? Second, is gold a safe haven and are their differences in the short and in the long-run? And third, does the existence of a safe haven contribute to the resiliency and stability of the financial system? Moreover, we will examine the relationship of a hedge and a safe haven.

Webster's dictionary offers three definitions for the word 'haven', a harbour or a port, a place of safety or, a destination offering favourable opportunities or conditions. We follow the second and the third definition and define a safe haven as a place of safety that offers favourable opportunities and conditions.[1] The first definition is important since it describes a haven as a harbour or port, that is, it is a place where you only go to in times of unfavourable conditions. A port is not made for ships that never leave it. We analyze the role of gold with respect to investors that hold gold in normal market conditions and investors that buy gold only in extreme market events. Kaul and Sapp (2007) define a safe haven as an "*ideal venue to park money during periods of uncertainty […]*" The authors add that a safe haven is an asset that investors purchase when uncertainty increases.

More technically, an asset that functions as a haven for one asset or a portfolio of assets is an asset that does not co-move with the other asset *in times of stress*. In other words, it is uncorrelated or negatively correlated with another asset if this second asset exhibits severe losses. This definition also serves to distinguish a safe haven from a hedge in that an asset that acts as a hedge is one that is uncorrelated or negatively correlated with another asset *on average*.[2] An asset that functions as a safe haven is uncorrelated or negatively correlated with another asset in times of stress only and not necessarily on average. If the haven (asset) is (strictly) negatively correlated with the other asset it is compensating for losses since the price

[1] The word (prefix)„safe" in „safe haven" does not necessarily add information to the definition but puts an emphasis on the fact that a haven is safe.

[2] Capie et al. (2005) analyze the role of gold as a hedge for exchange rate risk and estimate the average (mean) association of gold and exchange rate risk. They do not distinguish between average shocks and extreme shocks.

of the haven asset rises when the price of the other asset falls. The existence of such an asset is likely to enhance the stability and resiliency of the financial system because it dampens negative shocks to an asset class through the gains obtained by the asset that functions as a safe haven. It is therefore likely that the existence of an asset that is strictly negatively correlated in extreme market conditions compensates for losses of stock or bond portfolios and helps to positively influence market sentiment and reduce the severity of crisis periods.

Studies relevant to this paper are scarce. One strand examines Gold (see as recent examples Lucey and Tully (2007), Lucey, Tully and Poti (2006) Faugere and Van Erlach (2006), Capie, Mills and Wood (2005) and another examines safe havens (see Kaul and Sapp (2007), Upper (2000),). There appears to be only one paper that explicitly analyzes the role of Gold as a hedge against the dollar (Capie, Mills and Wood (2005)) and one that analyzes the relationship of Gold and other asset classes in general (Baryshevsky (2004)). We are not aware of any paper that analyzes the role of Gold as a safe haven for both stocks and bonds. This present paper is also related to the *flight-to-quality* literature, that is, studies analyzing the question whether investors flee from stocks into bonds if stock markets exhibit severe losses (see Gulko (2002), Gonzalo and Olmo (2005) and Hartmann, Straetmans and de Vries (2004)). This paper is related to the flight literature since for gold to act as a haven it has to be the case that en route to haven status there is a flight to quality from stocks(bonds) to gold. The key difference is that the present paper investigates the role of gold as both a hedge and a safe haven in financial markets while the flight-to-quality literature only analyzes stocks and bonds and typically focuses on the factors that trigger a flight from stocks to bonds.

Therefore, the contribution of this paper is twofold. We are the first to analyze the role of Gold as both a hedge and safe haven for stocks and bonds. In addition, we define an empirically usable definition of what exactly constitutes a safe haven and we distinguish between short-run (contemporaneous) and long-run effects. The empirical analysis shows that gold is a safe haven for investments in stocks in the US, in the UK and in Germany. Gold is also a hedge for stocks in these markets. However, gold is neither a hedge nor a safe haven for bonds. Furthermore, gold is not a stock safe haven at all times but only after extreme negative stock market shocks and then only for about 15 trading days.

The paper is structured as follows. The first section outlines the hypotheses and the econometric framework. The second section comprises the empirical analysis including a description of the data and the econometric results of a dynamic regression model. The

section also features estimates of dynamic conditional correlations of stock, bond and gold returns. Section 3 summarizes the results and concludes.

1. Testing Framework

This section first outlines the hypotheses that we aim to analyze followed by a description of the econometric approach to test these hypotheses. The hypotheses aim to test whether gold functions as a hedge or a safe haven for investments in stocks or bonds.

Based on the research above, limited as it is, there appear to be two main hypotheses that can be tested. Hypothesis 1 relates to gold's hedging abilities, while hypothesis 2 relates to its being a safe haven. We can state these as below.

Hypothesis 1:

Gold is a hedge for stocks: The gold price and the stock price do not co-move on average.

Hypothesis 1*:

Gold is a hedge for bonds: The gold price and the bond price do not co-move on average.

Hypothesis 2:

Gold is a safe haven for stocks: The gold price and the stock price do not co-move in extreme (falling) stock market conditions.

Hypothesis 2*:

Gold is a safe haven for bonds: The gold price and the bond price do not co-move in extreme (falling) bond market conditions.

Note that if gold is a hedge for an asset this does not imply that it is also a safe haven for the same asset. Furthermore, if gold is a safe haven for an asset this does not imply that it is also a hedge for the same asset. The reason is that a hedge must be uncorrelated or negatively correlated with another asset *on average* while a safe haven must be uncorrelated or negatively correlated in extreme market conditions only. Thus the two concepts may be empirically distinguished.

We test these hypotheses using a dynamic regression model for the entire sample period and over two sub-samples. The model can allow us to distinguish between short-run (contemporaneous) and long-run (contemporaneous and lagged effects) of stock and bond

returns on the price of gold. Moreover, we extend the analysis by (i) examining the conditional correlations of the relationships between gold, stocks and bonds in order to obtain information about the potential time-variation of these relationships and by (ii) a simple portfolio study.

Regression model

We are particularly interested in the response of the gold price to changes in the stock and bond prices in order to investigate whether gold is a hedge or a safe haven for stocks or bonds. Therefore, our principal regression model is of the form

$$\begin{aligned} rGold(t) = a + b1\ rstock(t) + b2\ rstock(t,q) + c1\ rbond(t) + c2\ rbond(t,q) \ + \\ + e(t) \end{aligned} \quad (1)$$

where rGold, rstock and rbond are the return of gold, stock and bond prices. The parameters to estimate are a, b1, b2, c1, c2 and e is the error term. The terms rstock(t,q) and rbond(t,q) account for asymmetries of positive and negative shocks and are included in order to focus on falling stock and bond markets. In order to analyze the role of gold in times of stress or extreme stock or bond market situations the regressors contain the return that is in the q'th lower quantile such as the 5%, 2.5% and 1% quantile. If the return is larger than the q% quantile, the value of rstock(t,q) or rbond(t,q) is zero.

The structure of the model assumes that stock or bond prices can affect the price of gold. This is consistent with the safe haven hypothesis. If stocks or bonds exhibit extreme negative returns, investors may buy gold and thus influence the price of gold. We further assume that the price of gold does not influence stock or bond prices which rules out any feedback effect in the above model. The evidence is very limited for a relationship from gold to stock markets, with only weak effects and those concentrated in markets with significant numbers of gold mining stocks (See Davidson, Faff and Hillier (2003)). We are aware of no research that has examined a relationship between gold returns and bond yields.

The above regression is static and does not account for any dynamics such as the lagged impact of stock or bond returns on the price of gold. A dynamic regression model is thus also estimated of the form

$$rGold(t) = a + \sum b0(i)\, rGold(t-i) + \sum b1(i)\, rstock(t-i) + \sum b2(i)\, rstock(t-i,q) + \\ + \sum c1(i)\, rbond(t-i) + \sum c2(i)\, rbond(t-i,q) + e(t) \qquad (2)$$

The difference of this specification compared with equation 1 is the inclusion of lagged returns and regressors that account for extreme negative stock or bond returns denoted as rstock(t-1,q) or rbond(t-1,q), respectively. The q stands for returns that are in the q% quantile. This model includes the lags of the gold, stock and bond returns of order i. The structure of the model is likely to account better for the time-series structure of the data especially lagged stock and bond return shocks on the price change of gold. The model also shows how stock or bond returns influence the price of gold today (t), tomorrow (t+1) and the following days (t+2,…T). It is important to analyze this effect since negative stock returns are often followed by positive stock returns potentially changing the initial effect on gold. In other words, it is possible that negative stock returns at t increase the price of gold at t but decrease the price of gold at t+1. This would have strong implications for investors and the existence of a safe haven. It would imply that gold is only a contemporaneous safe haven but not a safe haven in the long run, i.e. it is not a safe haven for investors that purchase gold after the extreme negative return shock occurred. Capie, Mills and Wood (2005) also estimate a dynamic regression model but additionally include a GARCH specification in order to account for the heteroscedasticity of the residuals. We control for error distribution issues using Newey-West heteroscedastic and autocorrelation consistent standard errors.

We now focus on equation (1) to explain the relationship of the model and the hypotheses. We commence with hypothesis 1 and 1*. The parameter estimate of stock returns (b1) or bond returns (c1) must be smaller than zero. In order to test the validity of hypothesis 2 the sum of the parameter estimates for stock returns b1 and negative (extreme negative) stock returns b2 must be smaller than zero or equal to zero. For hypothesis 2* the sum of the parameter estimates c1 and c2 must be smaller than zero or equal to zero.

Table 1 summarizes the content of the three hypotheses and the corresponding parameters to be tested.

Hypothesis	Wording	Parameter Implication (Equation 1)
Hypothesis 1	Gold is a hedge for stocks. The gold price and the stock price do not co-move on average.	$b1 < 0$
Hypothesis 1*	Gold is a hedge for bonds. The gold price and the bond price do not co-move on average.	$c1 < 0$
Hypothesis 2	Gold is a safe haven for stocks. The gold price and the stock price do not co-move in extreme (falling) stock market conditions.	$b1+b2 <= 0$
Hypothesis 2*	Gold is a safe haven for bonds. The gold price and the bond price do not co-move in extreme (falling) bond market conditions.	$c1+c2 <= 0$

Table 1: Hypotheses

Dynamic Conditional Correlations

The above regression model estimates the constant impact of stock and bond returns on the return of gold. In order to examine whether the hedge ratio is potentially constant we estimate the dynamic conditional correlations model (DCC) of Engle (2002) and compute time-varying betas. We do not analyze the question whether gold is a safe haven for stocks or bonds since the covariance or correlation is estimated in a GARCH-type specification, that is, the conditional covariance is regressed on a constant, the lagged cross-product of shocks and the lagged covariance. Thus, the specification cannot explicitly account for extreme returns as the regression model above. Consequently, the estimates are more apt to analyze whether gold is a hedge rather than examining its potential as a safe haven.

The DCC model is estimated pragmatically, using a DCC(1,1) specification based on demeaned returns and univariate GARCH(1,1) estimates in a first stage. The conditional correlation estimates are denoted R(i,j,t) where i and j are the asset classes or markets (e.g. i=US stocks, j=Gold) and t denotes the time.

2. Empirical Analysis

The data consist of daily prices of MSCI price return stock and bond indices and US closing spot gold. The MSCI bond indices are sovereign total return indices with maturities longer than 10 years (10year+). All stock and bond prices are in local currency, i.e. US Dollar, British Pound and EURO. The gold price is converted from US dollar into British Pound (GBP) or EURO when necessary. The data cover a time-period of 10 years from November, 30 1995 until November 30, 2005.

The fact that we analyze the data in local currencies implies that the study focuses on the characteristics of gold for US investors, UK investors and German investors. If all prices were computed in US Dollar for example, the study would examine the question whether gold is a hedge or a safe haven from a US investor's perspective only. We leave aside the issue of the adequacy of hedging, assuming that the investors are fully hedged.

2.1. Descriptive Statistics

Figure 1 presents the prices for the entire sample period for stocks (upper graph), bonds (centre) and gold (bottom graph). Stock prices peaked around the year 2000 (late 1999) followed by a bear market that ended around mid-2003. Bond price fluctuations exist but are less pronounced. In general prices have been rising for the entire sample period with relatively short periods of falling markets compared to stock prices. The bond prices of all three markets are clearly higher at the end of the sample than in the beginning of the sample period. Gold prices are also higher at the end of the sample compared to the beginning but there was no obvious upward trend of the price for Gold. The evolution of the Gold price can be divided into two periods. In the first one spanning from 1995 until 2000 prices were falling and in the second half spanning from 2000 until 2005 prices were rising.

returns	Mean	Std. Dev.	Min.	Max.	Skewness	Kurtosis
US stocks	0.0003	0.0114	-0.0697	0.0561	-0.1033	6.1231
US bonds	0.0003	0.0056	-0.0312	0.0203	-0.4245	4.4749
Gold in USD	0.0001	0.0080	-0.0582	0.0738	0.5452	11.5999
UK stocks	0.0002	0.0109	-0.0601	0.0559	-0.2087	5.9710
UK bonds	0.0003	0.0047	-0.0351	0.0323	-0.1431	5.5684
Gold in GBP	0.0001	0.0104	-0.0449	0.0768	0.3396	6.5998
GER stocks	0.0002	0.0164	-0.0771	0.0778	-0.0944	4.7394
GER bonds	0.0003	0.0134	-0.0523	0.0694	0.1029	4.1683
Gold in EURO	0.0001	0.0082	-0.0665	0.0685	0.2123	10.9541

Table 2 : Descriptive Statistics: Stock, Bond returns and gold return.

Table 2 presents the descriptive statistics of the continuously compounded returns of stocks, bonds and gold and Table 3 illustrates the unconditional correlations of US, UK and German stock, bond and gold returns.

Table 2 shows that gold has a lower mean return than stocks and bonds, and that the standard deviation is higher for stocks than for bonds. The standard deviation of the gold return is lower than stocks but higher than bonds in the US and in the UK and lower than both stocks and bonds in Germany. Germany has the highest stock and bond market volatility relative to the US and the UK. The last columns in the table contain the skewness and the kurtosis and show that the returns are qualitatively similar among the three markets with one exception. While bond returns are negatively skewed in the US and in the UK, this number is positive in Germany.

Table 3 contains the correlation matrix of all returns and illustrates that stock and bonds are negatively correlated in the US and in the UK and positively correlated in Germany. Stocks and gold are positively correlated in the US and negatively correlated in the UK and in Germany. Moreover, there is a positive correlation of bond and gold returns in the US and in the UK and a negative correlation in Germany.

	US STOCKS	US BONDS	GOLD IN USD	UK STOCKS	UK BONDS	GOLD IN GBP	GER STOCKS	GER BONDS	GOLD IN EURO
US stocks	1.0000	**-0.0748**	**0.0706**	-0.4126	-0.0469	0.1013	-0.3540	0.1362	0.0357
US bonds		**1.0000**	**0.0241**	-0.1221	0.4790	0.0616	-0.1038	0.2752	-0.0496
Gold in USD			1.0000	-0.1301	0.0711	0.8930	0.0874	0.3129	0.7492
UK stocks				1.0000	**-0.1331**	**-0.2125**	0.4994	-0.2611	0.0533
UK bonds					**1.0000**	**0.1053**	-0.0409	0.4213	-0.0450
Gold in GBP						1.0000	0.1844	0.5217	0.4850
GER stocks							1.0000	**0.3846**	**-0.2197**
GER bonds								**1.0000**	**-0.3453**
Gold in EURO									1.0000

Table 3 : Correlation Matrix US, UK and German stock, bond and Gold returns

Finally, the correlation coefficients also indicate that there is an average negative relationship between stock market returns in the US and the UK (-0.4126), the US and Germany (-0.3540) and a positive linkage between the UK and Germany (0.4994). The correlations of bond returns are positive for all pairs of markets.

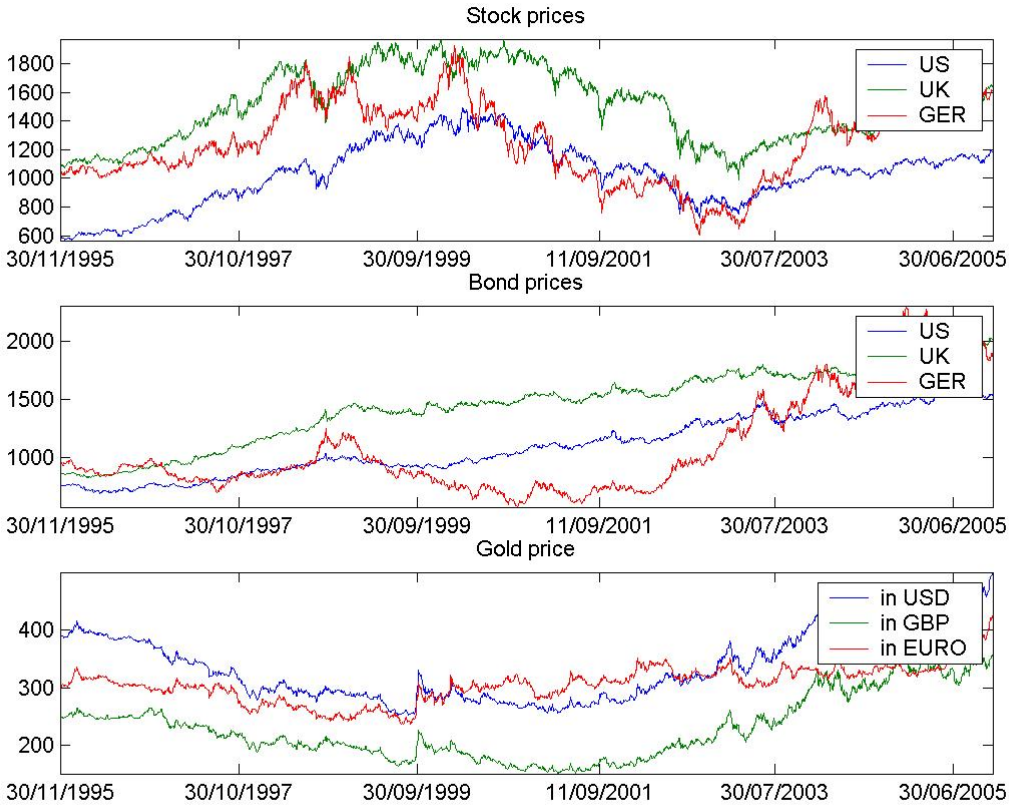

Figure 1: Stock, Bond and Gold prices

Time-varying volatilities

As a precursor to the structured econometric analysis, we estimate simple GARCH(1,1) models of demeaned stock, bond and gold returns. The conditional volatilities of stock, bond and gold returns are illustrated in Figures 2, 3 and 4, respectively. The estimates show that there is the typical time-variation of volatility and clusters of higher and lower volatility. More interesting perhaps is the fact that the gold returns also exhibit this time-variation and clusters. However, the volatility of the gold return often decreases in the periods in which the volatility of stocks increases. Events in which the volatility of gold decreases while stock volatility increases are at the end of 1997 (Asian crisis), around September 11 (2001) and in 2003. Figure 3 (in the Appendix) shows the conditional volatilities of the bond returns and illustrates that the variation is less pronounced for bonds than for stocks. The volatility of gold is often higher than bond volatility and exhibits various extremes that are unmatched by bond volatility. Finally, the volatility of UK bond returns is clearly the lowest of all returns in our sample (see also table 2a).

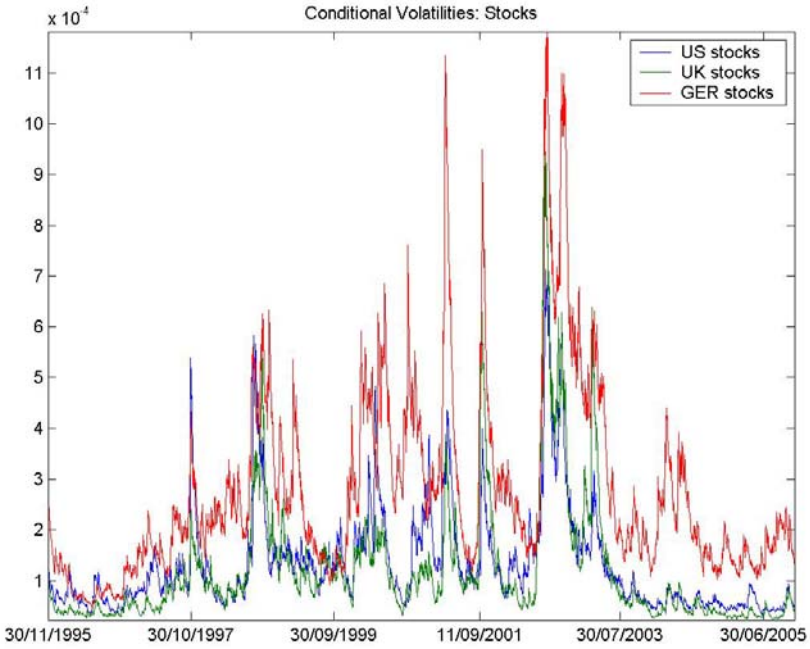

Figure 2: Conditional Volatilities (GARCH(1,1)) of stocks

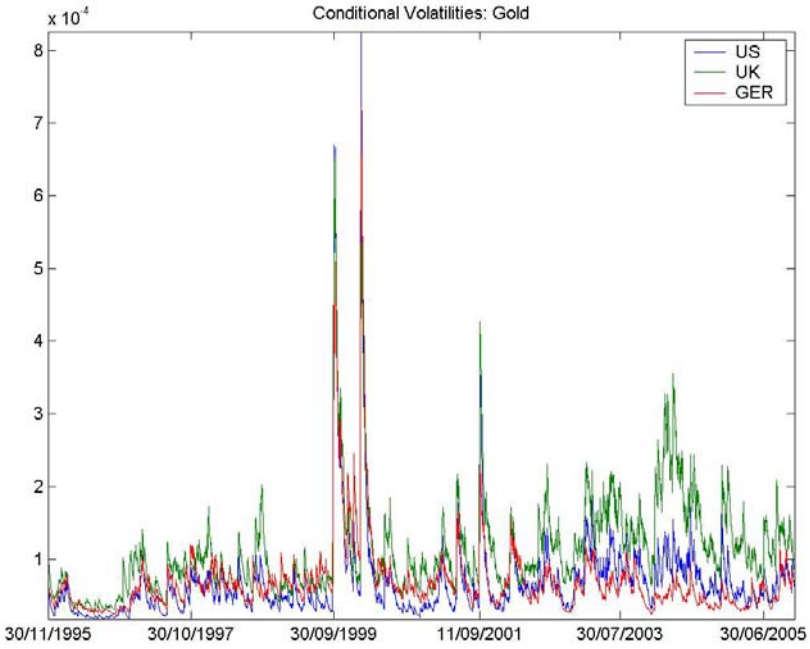

Figure 3: Conditional Volatilities (GARCH(1,1)) of gold (in USD, GBP and EURO)

2.2. Econometric Results

2.2.1. Regression Model

This section presents the estimation results of the dynamic regression model. Table 4 presents the results of a dynamic regression model with two lags for the dependent variable y (gold return) and the independent variables (positive and extreme negative stock and bond returns). The lag length is chosen with a general-to-specific strategy. We started with 5 lags and decreased the number of lags if the maximum lag length was not significant for any of the independent variables. The second lag is significant for some of the independent variables but not for all. For consistency we chose two lags for all variables and all markets. Table 4 presents the results for all three markets for the 5% quantile, table 4 for the 2.5% quantile and table 5 for the 1% quantile.

The upper parts of the tables show the coefficient estimates and their corresponding t-statistics for the US, the UK and Germany. The lower parts of the tables illustrate the short-run effects of stocks and bonds on the price of gold. The t-statistics are based on Newey-West standard errors with 5 lags.

Results show that gold is a hedge against stocks as indicated by the negative parameter estimates: -0.0568 for the US, -0.1988 for the UK and -0.0497 for Germany. All estimates are highly significant. The table also shows that based on the estimated parameters gold is not a hedge against bonds for the US (0.0140), for the UK (0.1278) but is for Germany (-0.2096). In order to examine whether gold is also a safe haven for stocks or bonds, the parameter estimates of the hedge and the safe haven at t (for the contemporaneous effect) must be added. The sum for each market and asset is shown in the last two rows of the table and indicates that gold is a safe haven against stocks for all markets but not for bonds.

	q5	US		UK		GER	
		Coeff.	**t-stat.**	**Coeff.**	**t-stat.**	**Coeff.**	**t-stat.**
	const.	0.0001	0.6032	0.0003	1.1316	0.0004	2.1854
	y(t-1)	0.0128	0.3113	0.0564	1.9155	0.0054	0.1285
	y(t-2)	0.0203	0.9249	0.0013	0.0578	0.0008	0.0409
Hedge	**s(t)**	-0.0568	-3.2068	-0.1988	-8.2923	-0.0497	-3.4986
	s(t-1)	0.0200	1.1573	0.0441	1.8221	0.0270	1.7567
	s(t-2)	0.0246	1.4653	-0.0020	-0.0925	-0.0108	-0.8437
Hedge	**b(t)**	0.0140	0.2873	0.1278	2.2652	-0.2096	-12.1366
	b(t-1)	0.0737	1.9964	-0.0254	-0.5050	0.0115	0.7113
	b(t-2)	0.0799	2.2037	0.1053	1.9705	0.0353	2.1452
Safe haven	**s(t,q)**	0.0251	0.6959	0.0074	0.1194	-0.0005	-0.0122
	s(t-1,q)	-0.0385	-1.2666	0.0085	0.1622	0.0115	0.3666
	s(t-2,q)	0.0281	0.7124	0.0199	0.3742	0.0672	2.4786
Safe haven	**b(t,q)**	0.0546	0.7435	0.1857	1.6174	0.1045	3.0911
	b(t-1,q)	0.0800	1.1191	-0.0274	-0.2444	-0.0168	-0.5102
	b(t-2,q)	-0.0537	-0.7906	0.0791	0.7338	0.0013	0.0431
Contemporaneous							
Hedge	**stocks**	-0.0568	-3.2068	-0.1988	-8.2923	-0.0497	-3.4986
	bonds	0.0140	0.2873	0.1278	2.2652	-0.2096	-12.1366
safe haven	**stocks**	-0.0317		-0.1914		-0.0502	
	bonds	0.0686		0.3135		-0.1051	

Table 4: OLS Regression: Gold on stocks and bonds including extreme negative shocks (5% quantile). T-statistic is based on Newey-West standard errors with 5 lags.

The fact that gold is a safe haven for stocks at t implies that investors that hold gold in normal times and in times of stress are compensated for losses caused by negative stock returns through positive gold returns. This is the contemporaneous effect. However, what happens if investors purchase gold after an extreme stock market shock has occurred? The estimates of lagged stock returns (s(t-1)) and extreme lagged stock returns (s(t-1,q)) are all positive with only one exception indicating that negative stock returns at t lead to negative gold returns at t+1. The exception is the US where the coefficient estimate of s(t-1,q) is -0.0385 and the sum of s(t-1) and s(t-1,q) is also negative implying that negative stock returns at t increase the gold price at t. Therefore, purchasing gold after an extreme stock market shock is consistent with the safe haven hypothesis for the US market but not for the UK and for Germany. Recall that the point of a safe haven is that the asset is one to which one moves in times of turbulence.

The goodness of fit of the regressions (R squared) is rather low, between 1% and 15%. However, the aim of this study is not to explain the gold price or its return but only how gold is influenced by stock and bond returns. Therefore, the significance of the parameter estimates is the crucial number.

Note that the existence of a hedge does not imply a safe haven. The fact that gold is both a hedge and a safe haven for stocks (and for bonds in Germany) but neither a hedge nor a safe haven for bonds in the US and in the UK is an empirical result but neither of the findings is implied by the other one. Theoretically, it is possible that gold is negatively correlated with stocks on average (gold is a hedge) but positively correlated with stocks in extreme market conditions. Such a finding could be linked to cross-asset contagion, that is, either gold or stocks infect the price of the other asset. Moreover, it is also possible that gold does not lose any value in extreme stock market conditions (gold is a safe haven) but co-moves with stocks on average (gold is not a hedge).

The long-run effects are different from the short-run effects due to the lagged returns of stocks and bonds in the model. The persistence of the gold return is too low in order to influence the estimates significantly. The difference in the short-run and long-run is illustrated by the lags of the stock returns of the US market as an example. The contemporaneous effect is -0.0568. The first lag is given by 0.0200 and the second lag is estimated as 0.0246. The sum yields a number significantly smaller than the contemporaneous effect which indicates that the long-run effect is less pronounced.

The estimation results for the 2.5% quantile and the 1% quantile are shown in tables 5 and 6.

	q2.5	US		UK		GER	
		Coeff.	**t-stat.**	**Coeff.**	**t-stat.**	**Coeff.**	**t-stat.**
	const.	0.0000	0.2335	0.0002	0.8032	0.0002	1.5378
	y(t-1)	0.0127	0.3116	0.0563	1.9211	0.0056	0.1320
	y(t-2)	0.0206	0.9386	0.0031	0.1365	0.0026	0.1237
hedge	**s(t)**	-0.0567	-3.3439	-0.1832	-7.7847	-0.0434	-3.2416
	s(t-1)	0.0144	0.9081	0.0478	2.1434	0.0268	1.9262
	s(t-2)	0.0285	1.7431	-0.0033	-0.1578	-0.0045	-0.3719
hedge	**b(t)**	0.0107	0.2404	0.1406	2.4898	-0.2017	-12.0075
	b(t-1)	0.0937	2.6461	-0.0448	-0.9450	0.0135	0.8753
	b(t-2)	0.0880	2.5362	0.1031	2.0213	0.0305	1.9740
safe haven	**s(t,q)**	0.0339	0.8052	-0.0526	-0.7062	-0.0350	-0.8508
	s(t-1,q)	-0.0387	-1.1335	0.0028	0.0440	0.0359	0.9700
	s(t-2,q)	0.0164	0.3484	0.0311	0.5245	0.0555	2.0055
safe haven	**b(t,q)**	0.0999	1.2816	0.1930	1.5905	0.0712	1.7660
	b(t-1,q)	-0.0114	-0.1637	0.0504	0.4896	-0.0298	-0.7476
	b(t-2,q)	-0.1093	-1.6327	0.1008	0.8187	0.0141	0.4292
contemporaneous							
hedge	**stocks**	-0.0567	-3.3439	-0.1832	-7.7847	-0.0434	-3.2416
	bonds	0.0107	0.2404	0.1406	2.4898	-0.2017	-12.0075
safe haven	**stocks**	-0.0228		-0.2358		-0.0784	
	bonds	0.1106		0.3336		-0.1305	

Table 5:: OLS Regression: Gold on stocks and bonds including extreme negative shocks (2.5% quantile). T-statistic is based on Newey-West standard errors with 5 lags.

Table 5 shows that the estimates for the hedge and safe haven for stocks are more pronounced for the UK and for Germany and only slightly different for the US. The results are qualitatively not different compared to the 5% quantile. The same is true for the results with the 1% quantile. The table is shown in the Appendix.

Table 7 contains the estimates of the contemporaneous effect for the full sample period and two sub-samples for comparison. The full sample is separated in two equal parts spanning a period of 5 years each and comprising around 1300 observations. The partitioning is arbitrary to some degree but coincides with two distinct regimes of the gold price. In the first half of the full sample, the price of gold was falling on average and in the second half, the price of

gold was rising on average (see figure 1). Thus, the analysis of the two sub-samples is likely to yield different answers to the question whether gold functions as a hedge or a safe haven for either stocks or bonds.

full sample		US	UK	GER		US	UK	GER		US	UK	GER
contemporaneous		q5	q5	q5		q2.5	q2.5	q2.5		q1	q1	q1
hedge	**stocks**	-0.0572	-0.1985	-0.0496		-0.0567	-0.1834	-0.0447		-0.0542	-0.1870	-0.0438
	bonds	0.0153	0.1283	-0.2098		0.0107	0.1416	-0.2009		0.0275	0.1715	-0.2017
safe haven	**stocks**	-0.0339	-0.1881	-0.0592		-0.0228	-0.2318	-0.0735		-0.0152	-0.2417	-0.0942
	bonds	0.0593	0.3282	-0.1164		0.1106	0.3417	-0.1235		0.0340	0.2286	-0.0620
Sub sample 1		US	UK	GER		US	UK	GER		US	UK	GER
contemporaneous		q5	q5	q5		q2.5	q2.5	Q2.5		q1	q1	q1
hedge	**stocks**	0.0087	-0.1390	-0.0254		0.0060	-0.1238	-0.0175		0.0001	-0.1347	-0.0202
	bonds	-0.1388	-0.1353	-0.3592		-0.1928	-0.1407	-0.3531		-0.1830	-0.1108	-0.3442
safe haven	**stocks**	0.0056	-0.1660	-0.0264		0.0010	-0.2260	-0.0734		0.0583	-0.2329	-0.0676
	bonds	-0.2315	0.1293	-0.2399		-0.0738	0.2461	-0.2063		-0.0324	0.1844	-0.1943
Sub sample 2		US	UK	GER		US	UK	GER		US	UK	GER
contemporaneous		q5	q5	q5		q2.5	q2.5	Q2.5		q1	q1	q1
hedge	**stocks**	-0.0820	-0.1908	-0.0499		-0.0659	-0.1730	-0.0442		-0.0629	-0.1681	-0.0428
	bonds	0.1542	0.4175	-0.1031		0.1656	0.4720	-0.1104		0.1840	0.5023	-0.1024
safe haven	**stocks**	-0.0370	-0.1704	-0.0629		-0.0863	-0.2125	-0.0807		-0.1347	-0.2643	-0.1120
	bonds	0.1966	0.6751	-0.0800		0.1733	0.5477	-0.0546		0.0333	0.2728	-0.0793

Table 7: Full sample and two sub-samples: Summary of contemporaneous effects of OLS Regression: Gold on stocks and bonds including extreme negative shocks (5% , 2.5% and 1% quantile). T-statistic is based on Newey-West standard errors with 5 lags.

Table 7 shows that the results for the two sub-samples are very different compared to the full sample period. This is not surprising bearing in mind that both periods are characterized by a very different evolution of the gold price. Since the gold price was falling in the first sub sample it is not surprising that the evidence for a hedge or a safe haven is less pronounced or not existent. In contrast, the evidence for a hedge and a safe haven is clearly more pronounced in the second sample period due to the increasing gold price. The results show that gold was neither a hedge nor a safe haven in the US for the first sub-sample. However, gold was a

hedge and a safe haven in the UK and in Germany in that period. The results for the second sample period are similar to the full sample results but more pronounced.

Our findings show that gold is a contemporaneous hedge and safe haven for stocks. For a longer time horizon the evidence is weaker due to lagged effects that diminish or reverse the initial positive effect on the gold price. The fact that gold does not play this role for longer horizons is also linked to the fact that the estimates are economically relatively low. For example, the study of Capie, Mills and Wood (2005) report estimates around -0.3 which is significantly different from the values reported here, around -0.05 for the US and Germany and around -0.15 for the UK.

The empirical finding that gold is a safe haven in the short-run but not in the long-run can also be explained with the existence of a hedge. A hedge is negatively correlated with another asset on average. This implies that if the price of a stock increases the price of the hedge falls. Since asset prices usually rise some time after an extreme negative shock has occurred, a hedge works against a safe haven in the longer run. This is because increasing asset prices lower the price of the hedge on average thereby compensating the additional effect if the hedge is also a safe haven. In other words, since gold is a hedge against stocks, gold cannot be a safe haven in the long run since rising stock prices are associated with lower gold prices on average.[3]

2.1.2. Dynamic Conditional Covariances

This section presents the estimates of the time-varying regression coefficient from equation 1 computed as the dynamic covariance of gold and stock (bond) returns divided by the conditional volatility of stock (bond) returns. The covariance and variances are obtained from the dynamic covariance estimates of a DCC model.

Figure 5 contains the estimates of the time-varying betas of gold on stocks for the US, the UK and Germany. The plot illustrates that there is some variation in the betas. The mean of the estimated betas is -0.0242 for the US, -0.2006 for the UK and -0.1247 for Germany. The US exhibits the highest level on average and also the highest peaks, around the end of 1997, end of 1999, in summer 2001 and around 2004. The UK exhibits similar positive peaks than the US and the largest negative extremes around -0.6 September 2001 and from 2003 until June

[3] A long-run safe haven can only exist if b1=0 and b2<0 in a model rgold(t)=a + b1 rstock(t) + b2 rstock(t,q) + cX(t) + e(t).

2005. The estimated time-varying betas for German stock and gold returns lie between the US and the UK. Extremes are less pronounced in Germany than in the UK and the US. Gold is a hedge for stocks if the regression coefficient is negative. The results show that there are some incidences where the betas are positive, that is, around the Asian crisis end of 1997 for the US and the UK, the end of 1999 for the US and less pronounced for the UK, in August 2001 and in 2004 for all three markets. In order to obtain information about the impact of the volatilities of gold and stock returns on the betas we estimate simple regression models of the betas on gold and stock volatility. The results are different for the US than for the UK and Germany. Gold volatility has a positive impact on the beta and stock volatility a negative influence on the level of beta for the US. For the UK and Germany, gold volatility has a negative impact and stock volatility a positive impact on the level of beta in these countries. The results imply that stock market uncertainty tends to increase the betas in the UK and in Germany but tends to lower the beta in the US. The opposite is true for gold. Increased gold market uncertainty increases the beta in the US and lowers it in the UK and in Germany.

Figure 6 shows the time-varying beta of gold on bond returns for the US, the UK and Germany and illustrates that there is an upward trend of the betas for all three markets which is rather pronounced for UK and less pronounced for the US and Germany. The German beta is negative for the entire sample period with the exception of a brief positive period at the end of the sample period. The UK beta is volatile and fluctuates around zero in the first third of the sample and is mostly positive with high values larger than 1 in the end of the sample. The US beta is also relatively volatile compared to Germany with high betas in the end of the sample.

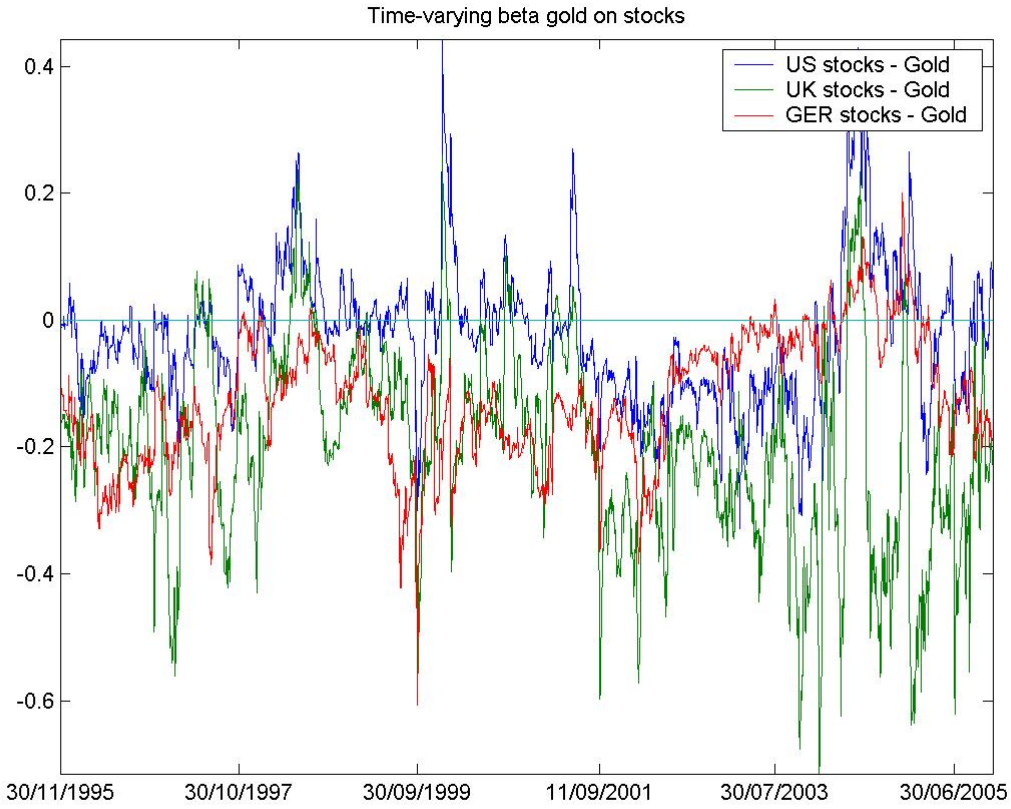

Figure 5: Time-varying beta of a regression of gold on stock returns

Both figures 5 and 6 confirm the findings obtained with the dynamic regression models. On average, gold and stock returns are negatively correlated and gold and bond returns are positively correlated for the US and the UK but not for Germany. Thus, the time-varying beta estimates verify that stocks are a hedge. Since these correlation estimates provide only information about the co-movement of shocks on average as opposed to extreme negative shocks, we cannot derive any conclusion about a safe haven. However, there are two examples that indicate that a constant regression coefficient can be misleading. First, in the Asian crisis in the end of 1997, the betas for gold and stocks are positive for the US and the UK. Second, after September 11, 2001 when stock markets were relatively volatile, the betas are negative for all three markets. The first case is evidence against gold as a safe haven while the second case is clear evidence for gold as a safe haven. Again, these findings are consistent with the results obtained from the sub-sample analysis above and can be explained with the different evolution of the gold price in the first and second part of the sample.

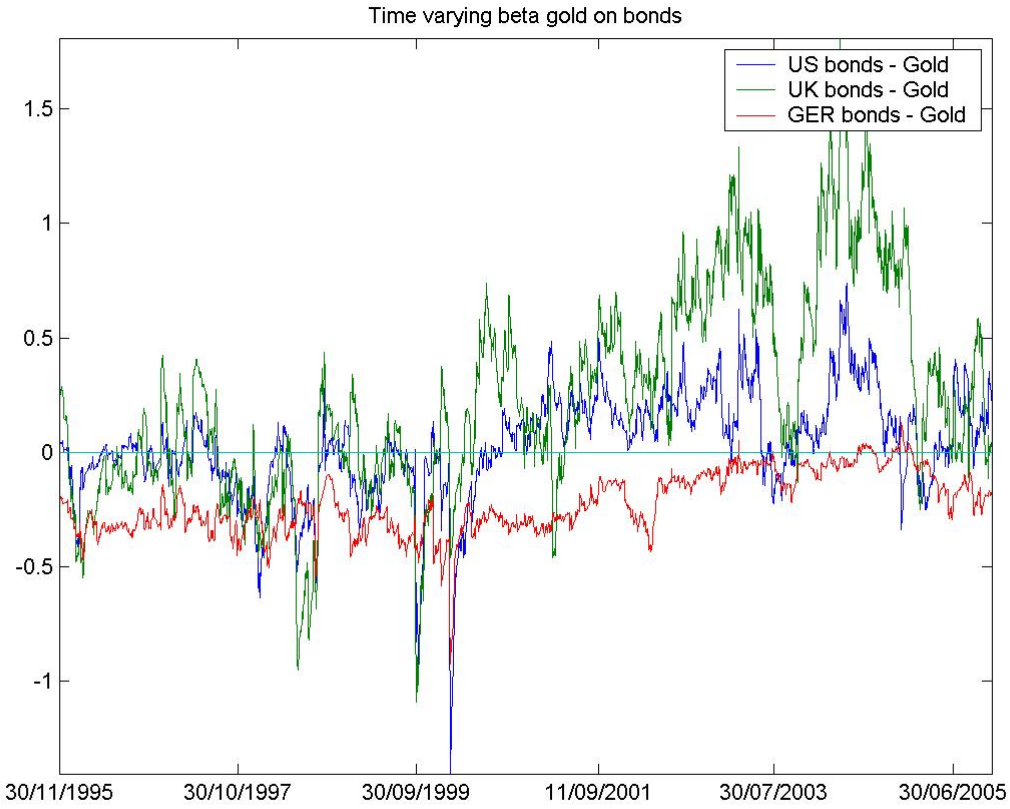

Figure 6: Time-varying beta of a regression of gold on bond returns

The previous analysis examined the role of gold by focussing on extreme negative returns. An alternative approach would be a focus on periods of increased volatility such as during crisis periods, e.g. the Asian crisis 1997 and the period after September 11, 2001. Analyzing the evolution of gold and stocks around these events shows that gold did not loose value after September 11, 2001 but lost significantly during the Asian crisis. Both results are consistent with our previous findings that showed that gold played a different role in the first half of the sample, that is, from 1995 until 2000 compared to the second half of the sample, from 2000 until 2005. This finding also suggests that the question whether gold is a safe haven or a hedge is determined by the evolution of gold. The price was falling in the first half of the sample leading to a rejection of the safe haven hypothesis. On the contrary, the price was rising in the second half of the sample implying that gold is a safe haven in this period.

2.3. Portfolio Analysis

This section analyzes the average cumulated return of a portfolio comprising gold and stocks at the time after the occurrence of an extreme negative stock return for the next 50 trading days. The aim is to illustrate the change in a portfolio comprising gold and stocks thus explaining the differences in the short and in the long-run found in the dynamic regression models above. Much work on gold advocates its use as a diversifier, particularly in times of stress or market turmoil. Examples include Sherman (1982), Johnson and Soenen (1997), David, Paul and Robert (2006) and Lucey, Tully and Poti (2006). However, as we have seen above, the implicit assumption of gold as both a hedge and a haven is not necessarily valid.

This section also shows the average evolution of stock and gold returns after an extreme negative stock market shock. In other words, are extreme negative shocks followed by another negative shock or a positive shock? How does gold react to the initial shock at t and t+1? This information is hidden in the regression model and in the conditional correlation estimates.

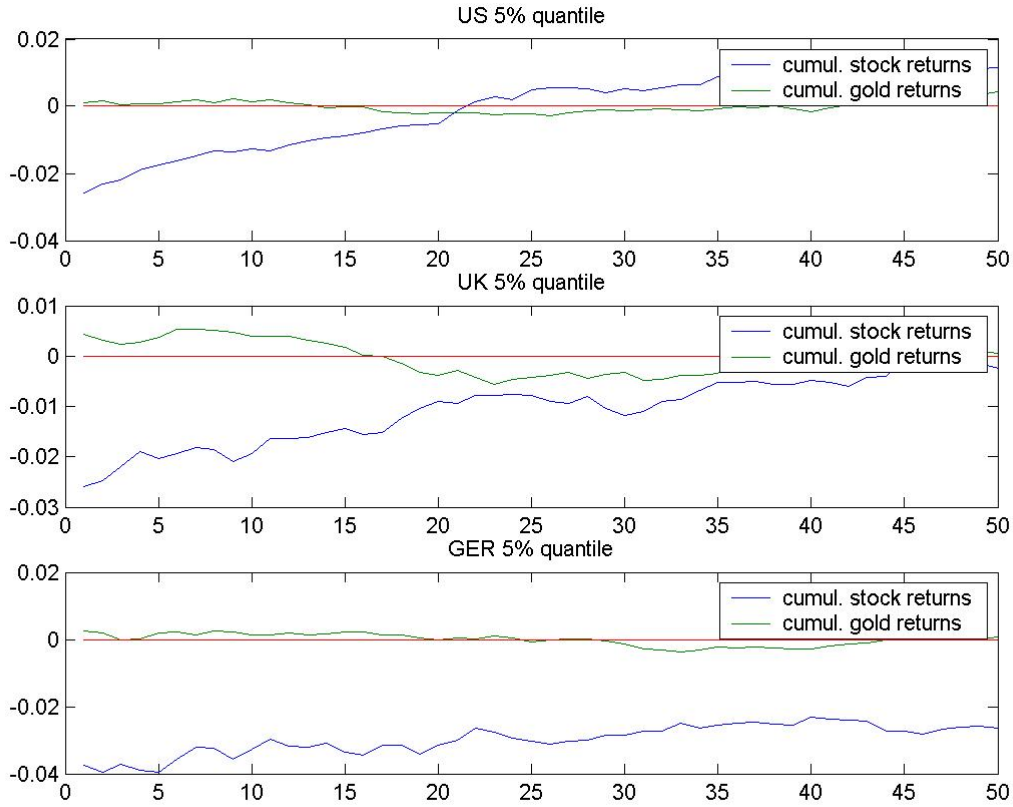

Figure 7: Portfolio analysis: The figure shows how stock and gold returns evolve for different investment horizons (x-axis). Period 1 is the time where an extreme negative stock return occurs and the vertical axis contains the average cumulated returns from period 1.

Figure 7 shows the average cumulated gold and stock returns after an extreme negative stock return smaller than the 5% quantile. The plot shows that the contemporaneous effect is positive for the US, the UK and Germany, that is, negative stock returns are associated with positive gold returns. The cumulated gold returns turn negative about 15 trading days after the initial shock in the US and in the UK and about 20 trading days in Germany. The plot also shows that the price of gold slightly increases after the initial shock for one period while it is falling in the UK and in Germany. Furthermore, the clear positive trend of cumulated stock returns in the US and in the UK shows that extreme negative stock returns are followed by positive stock returns.

The picture is similar for the 2.5% quantile, with details shown in the appendix.

Figure 9 shows the results for the 1% quantile that are different compared to figures 7 and 8. The cumulated gold return increases slightly only at the time of the initial shock and then stays around zero in the US and in Germany. It is clearly positive in the UK and turns

negative about 15 trading days after the initial shock. In the US, the gold price turns negative about 10 days and in Germany about 15 days after the extreme negative shock.

These results show that gold is only a safe haven contemporaneously, that is, in the short-run. In the long-run gold loses value and is therefore not a safe haven. Moreover, investors that do not already hold gold and only purchase gold the day after an extreme shock either lose money directly due to a falling stock price or lose money relatively due to increasing stock prices right the day after the extreme negative shock. Figure 10 shows the evolution of stock and gold returns the day after a shock that is smaller than its 5% quantile.

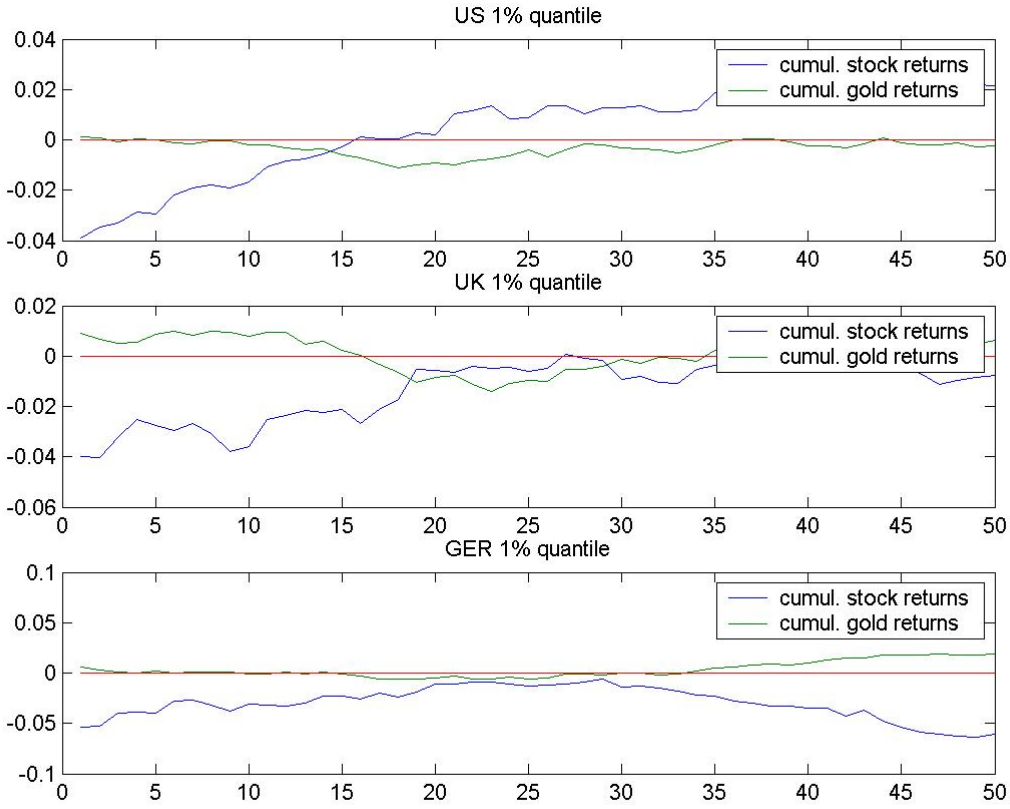

Figure 9: Portfolio analysis: The figure shows how stock and gold returns evolve for different investment$ horizons (x-axis). Period 1 is the time where an extreme negative stock return (1% quantile) occurs and the vertical axis contains the average cumulated returns from period 1.

Figure 10 illustrates that investors who start purchasing gold the day after an extreme negative shock lose money after about 15 trading days and almost immediately one day after the shock because stock prices increase after a large negative shock.

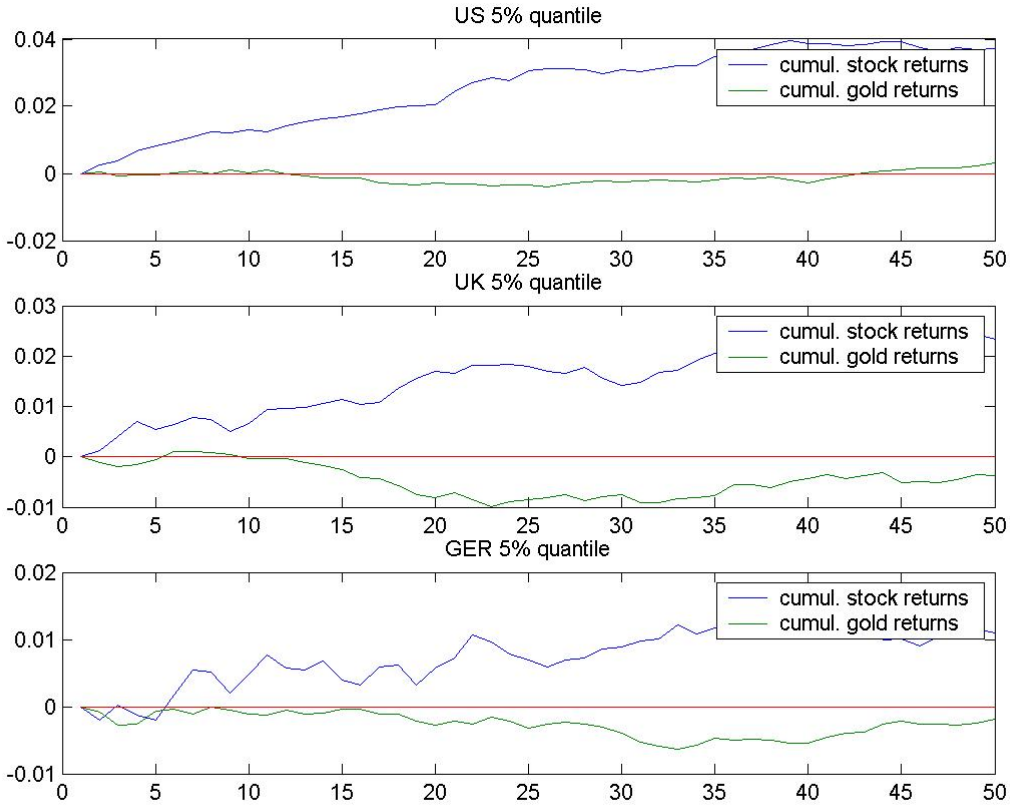

Figure 10: Portfolio analysis: The figure shows how stock and gold returns evolve for different investment horizons (x-axis). Period 1 is the time where an extreme negative stock return (1% quantile) occurs and the vertical axis contains the average cumulated returns from period 1.

3. Conclusions

This paper analyzes the role of gold in financial markets. More specifically, it studies the question whether gold is a hedge or a safe haven for stocks or bonds. Our empirical results show that gold is a hedge and a safe haven for stocks in all markets for the entire sample period. However, gold is generally not a hedge or a safe haven for bonds in any market. Moreover, gold only functions as a hedge and a safe haven in the short-run. In the long-run, gold is no safe haven, that is, investors that hold gold more than 15 trading days after an extreme negative shock loose money. The results also show that there is a large difference as to whether investors hold gold or purchase gold after an extreme negative shock occurred. In addition, since the price of gold in the US increases when stock prices fall, gold has the potential to compensate investors for losses with stocks thereby positively influencing market sentiment and the resiliency of the financial system.

Appendix

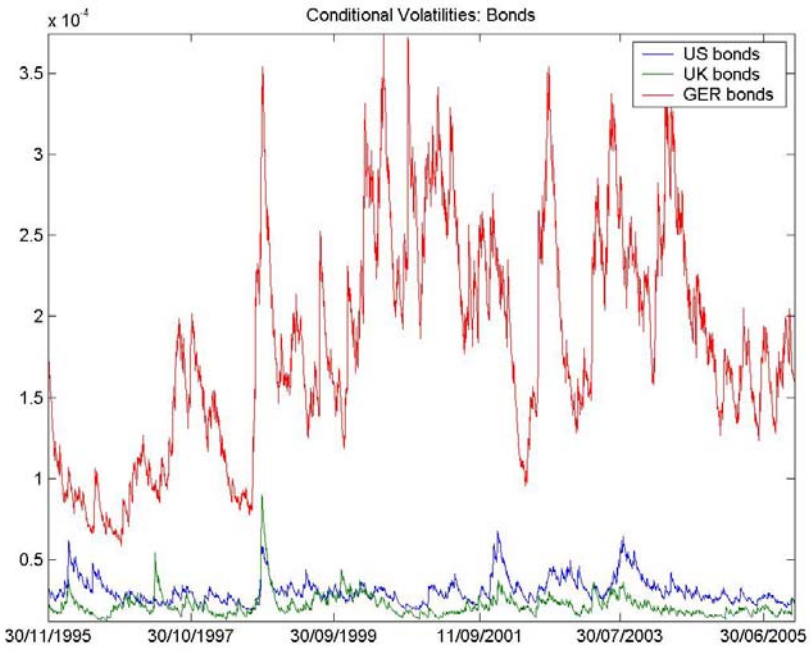

Figure 3: Conditional volatilities (GARCH(1,1)) of bonds

	q1	US		UK		GER	
		Coeff.	**t-stat.**	**Coeff.**	**t-stat.**	**Coeff.**	**t-stat.**
	const.	0.0001	0.3442	0.0001	0.5029	0.0002	1.2330
	y(t-1)	0.0125	0.3049	0.0564	1.9215	0.0081	0.1917
	y(t-2)	0.0198	0.9043	0.0033	0.1420	0.0024	0.1146
hedge	**s(t)**	-0.0542	-3.4279	-0.1871	-8.3343	-0.0437	-3.4896
	s(t-1)	0.0072	0.4681	0.0410	2.0478	0.0256	2.0152
	s(t-2)	0.0299	1.8850	0.0013	0.0662	0.0018	0.1565
hedge	**b(t)**	0.0275	0.6722	0.1690	3.1381	-0.2023	-12.5948
	b(t-1)	0.0865	2.5822	-0.0346	-0.7802	0.0149	0.9837
	b(t-2)	0.0746	2.3163	0.1124	2.3144	0.0323	2.2013
safe haven	**s(t,q)**	0.0390	0.6544	-0.0849	-0.8359	-0.0542	-0.9773
	s(t-1,q)	-0.0061	-0.1473	0.0619	0.8733	0.0640	1.3530
	s(t-2,q)	0.0087	0.1439	0.0088	0.1402	0.0154	0.5206
safe haven	**b(t,q)**	0.0065	0.0764	-0.0083	-0.0657	0.1349	2.5654
	b(t-1,q)	0.0679	0.8079	0.0497	0.3964	-0.0525	-1.1956
	b(t-2,q)	-0.0708	-0.8254	0.1417	0.9852	-0.0401	-0.9611
contemporaneous							
hedge	**stocks**	-0.0542	-3.4279	-0.1871	-8.3343	-0.0437	-3.4896
	bonds	0.0275	0.6722	0.1690	3.1381	-0.2023	-12.5948
safe haven	**stocks**	-0.0152		-0.2720		-0.0979	

bonds	0.0340	0.1607	-0.0674

Table 6: OLS Regression: Gold on stocks and bonds including extreme negative shocks (1% quantile). T-statistic is based on Newey-West standard errors with 5 lags.

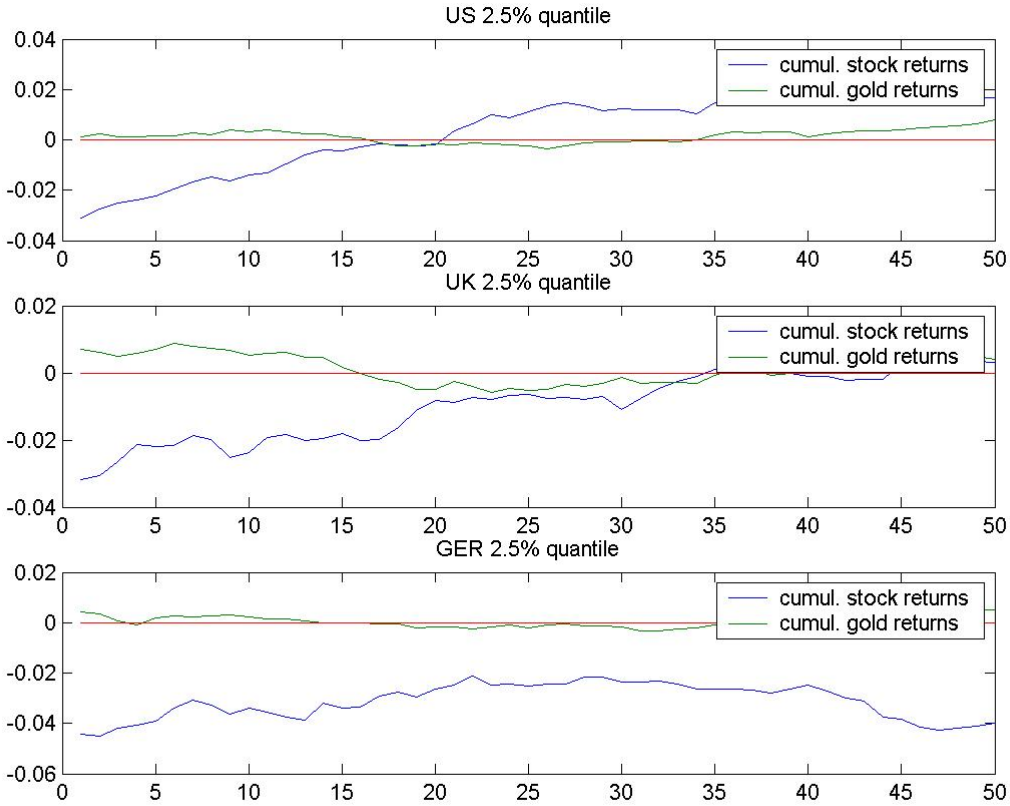

Figure 8: Portfolio analysis: The figure shows how stock and gold returns evolve for different investment horizons (x-axis). Period 1 is the time where an extreme negative stock return (2.5% quantile) occurs and the vertical axis contains the average cumulated returns from period 1.

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Institute for International Integration Studies
The Sutherland Centre, Trinity College Dublin, Dublin 2, Ireland