Is Gold a Hedge or a Safe Haven?
An Analysis of Stocks, Bonds and Gold

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This version: February 2009

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Abstract

Is gold a hedge against sudden changes in stock and bond returns, or does it instead have a subtly different property, that of being a safe haven? This paper addresses these two interlinked questions. A safe haven is defined as a security that is uncorrelated with stocks and bonds in case of a market crash. This is counterpoised against a hedge, defined as a security that is uncorrelated 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 returns and their relationship with gold returns. We find that gold is a hedge against stocks on average and a safe haven in extreme stock market conditions. This finding suggests that the existence of a safe haven enhances the stability and resiliency of financial markets since it reduces investors' losses at times when a reduction is needed the most. A portfolio analysis further shows that the safe haven property is extremely short-lived so that an investor buying gold one day after a shock loses money.

JEL: G10, G11, G14, G15

Keywords: safe haven, gold, stock-bond correlation, flight-to-quality, prospect theory

Introduction

Financial markets and the variety of financial instruments have grown steadily in both volume and value in recent decades. Moreover, increased interdependence among markets and assets create the potential need for a safe haven. While gold has often been associated with the existence of a safe haven, we are not aware of any study actually testing this hypothesis.

We try to approach the above questions within a broader framework that utilizes the financial system as a starting point. The theoretical argument reads as follows. If there exists an asset, which reduces losses in times of market stress or financial crisis by more than hedge or diversifier assets, the existence of such an asset is expected to benefit and enhance the stability of capital markets by reducing the severity and the duration of extreme market conditions. An asset that fulfils this property is called "haven" asset or safe haven asset and can be clearly distinguished from a hedge and a diversifier.[1]

The focus of a haven asset on times of market stress implies that investors react differently in normal times and extreme adverse market conditions. An almost natural framework for such an analysis is prospect theory since it explicitly analyzes gains and losses. Prospect theory thus provides a useful theoretical basis to analyze the existence of a safe haven. The theory, proposed by Kahneman and Tversky (1979) and refined in Tversky and Kahneman (1992), describes that people evaluate gambles by thinking about gains and losses and not final wealth levels.[2]

After a definition and clear distinction of a safe haven, a hedge and a diversifier, it is tested whether gold is a (safe) haven asset. Gold is chosen as a candidate since anecdotal evidence and the financial media suggest that gold serves as a safe haven in financial markets. While there is no theoretical model which explains why gold is usually referred to as a safe haven asset, one major explanation could be that it was among the first forms of money and was traditionally used as an inflation-hedge. Moreover, gold is said to be uncorrelated with other types of assets which is an important feature in an era of globalization in which correlations increased dramatically among most asset types. These components might have contributed significantly to the role of gold.

The econometric methodology is based on a regression model in which gold returns are regressed on stock and bond returns and two interaction terms that test whether gold indeed serves as a safe haven if stock or bond markets fall or exhibit extreme negative returns. The empirical analysis focuses on three large financial markets (the US, the UK and Germany) with different currencies (US dollar, UK pound and the euro) in order to examine the differences and similarities of the role of gold in these markets.

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[1] A technical definition fully consistent with this more intuitive definition is provided in section 1.

[2] Prospect theory predicts that people process these gains and losses using a value function that is concave for gains and convex for losses. This functional form captures the experimental finding that people, on the one hand, are risk averse over gains, they prefer a certain $100 to a 50:50 bet to win $0 or $200 - but, on the other hand, are risk-seeking over losses, they prefer a 50:50 bet to lose $0 or $200 to a certain loss of $100.

Daily returns are used in order to analyze whether investors react to extreme negative shocks relatively fast and use gold as a safe haven asset.

The econometric model is derived directly from the hypothesis that gold is a safe haven asset conditional on stock and bond market returns. Hence, we condition the return of gold on movements of stocks and bonds, which almost naturally determines the model structure with gold specified as the dependent variable and stock and bond returns specified as the independent variables.

Finally, a portfolio analysis evaluates the evolution of all assets simultaneously in periods in which gold potentially serves as a haven asset. Such an analysis illustrates how profitable it is for investors to buy and sell gold in periods of market turmoil.

Our empirical analysis shows that gold is a safe haven for stocks in the US, in the UK and in Germany[3]. Gold is also a hedge for stocks in the US and the UK. However, gold is nowhere a safe haven for bonds; nor is it a bond hedge in the US or UK. Furthermore, gold is not a safe haven for stocks at all times but only after extreme negative stock market shocks. In addition, the safe haven property is extremely short-lived so that investors buying gold one day after a shock lose money. In other words, gold is a safe haven when it is needed most but is not a safe haven, and is not supposed to be, in periods of rising stock markets.

Studies relevant to this issue are relatively scarce. One strand examines the nature and influences of the gold market, (see as recent examples Tully and Lucey (2007), Lucey, Tully et al. (2006), Faugere and Van Erlach (2006), Capie, Mills et al., 2005) and another examines safe havens (see Kaul and Sapp, 2007 and Upper, 2000). There appears to be only one paper that explicitly analyzes the role of gold as a hedge, that being against the dollar (see Capie, Mills et al., 2005). Capie et al. do not distinguish between average and extreme shocks as they analyze the role of gold as a hedge for exchange rate risk. Finally, there is a study that analyzes the relationship of gold and other asset classes in general (see Baryshevsky, 2004). We are unaware 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 of whether investors flee from stocks into bonds when stock markets exhibit severe losses (see Gulko, 2002, Gonzalo and Olmo, 2005 and Hartmann, Straetmans and de Vries, 2004). The key difference is that this 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.

The remainder of the paper is structured as follows. The first section of the paper outlines the theoretical framework including a definition of a safe haven, a hedge and a diversifier. The second section presents the econometric framework followed by the empirical analysis in the third section. Finally, section 4 summarizes the results and concludes.

[3] While the inclusion of the USA and UK is self evident, being large capital markets that also have important roles in the gold markets, we include Germany as a form of "control". Germany is very similar in industrial and capital composition to the other two countries yet has no role to speak of in terms of gold trading.

1. Theoretical Framework

The theoretical argument, which is the basis for the subsequent analysis can be formulated as follows. If investors add an asset to their portfolios that specifically reduces losses in times of market stress or turmoil by more than hedge or diversifier assets the severity of shocks decreases thereby increasing the stability of capital markets.

We show below that an investor's utility level increases if she buys an asset that reduces losses beyond hedge or diversifier assets, that is, an asset which does not lose value in times of extreme market conditions (e.g. financial crisis) and thus exhibits a zero or negative correlation with a benchmark portfolio in such times. Such an asset will be defined as a safe haven asset. In order to distinguish a safe haven asset from a hedge and a diversifier asset, we explicitly define all three types before we proceed.

Hedge:

A hedge is defined as an asset that is uncorrelated or negatively correlated with another asset or portfolio on average. A strict hedge is (strictly) negatively correlated with another asset or a portfolio on average.

A hedge does not have the (specific) property of reducing losses in times of market stress or turmoil since the asset could exhibit a positive correlation in such periods and a negative correlation in normal times with a negative correlation on average.

Diversifier:

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

Similar to the hedge, the diversifier does not have the (specific) property of reducing losses in extreme adverse market conditions since the correlation property is only required to hold on average.

Safe haven:

A safe haven is defined as an asset that is uncorrelated or negatively correlated with another asset or portfolio in times of market stress or turmoil.

The specific property of a safe haven asset is the non-positive correlation with a portfolio in extreme market conditions. This property does not force the correlation to be positive or negative on average but

only to be zero or negative in specific periods. Hence, in normal times or bullish market conditions the correlation can be positive or negative.

If the haven asset is negatively correlated with the other asset or portfolio in extreme adverse market conditions, it is (at least partially) compensating the investor for losses since the price of the haven asset rises when the price of the other asset or portfolio falls.

This definition of a safe haven is consistent with the definitions provided by Webster's dictionary[4]. The word 'haven' is defined as follows: a harbour or port, a place of safety and a place offering favourable opportunities or conditions. A safe haven is thus a place of safety that offers favourable opportunities and conditions.[5] The first definition is also 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 typically not built for ships that never leave it. Kaul and Sapp (2007) define a (financial) safe haven as an "*ideal venue to park money during periods of uncertainty…"* The authors define a safe haven asset as an asset that investors purchase when uncertainty increases.

Investor's Utility

In this section, we provide evidence that the utility of an investor increases if she adds a safe haven asset to her portfolio. This is true within an expected utility framework and within prospect theory. Our findings also indicate that the evidence is stronger within the prospect theory framework.

The key characteristic of a safe haven asset is the fact that it is effective in extreme market conditions in contrast to a hedge that is only effective on average but not necessarily in times of market turmoil. We commence with an example of a hedge in normal conditions and then modify the example with a focus on extreme market conditions.

We assume a gamble with equal probabilities (50:50) in which an investor can gain $1500 or loose $1000 of her portfolio. Adding an asset with the properties of a hedge but not a safe haven yields potential gains of $1400 and losses of -$800. Hence, the hedge is effective on average (reduces potential losses). The addition of such an asset would yield a higher utility within both prospect theory and expected utility based on the final wealth level.[6]

Let us now modify the example and assume that the gains are $1500 with a probability of 0.9 and the losses are -$1000 with a probability of 0.1. Under the assumption that a hedge is only effective on average but not necessarily in extreme market conditions with low probabilities (e.g. 10%), adding a hedge to a portfolio with the above payoffs could yield $1400 with a probability of 0.9 and -$1000 with

[4] http://www.merriam-webster.com/

[5] 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.

[6] We use α=0.88 and λ=2.25 for the value function as in Tversky and Kahneman (1992) within the prospect theory framework. For the alternative utility function we assume U=ln(W) where W is the final wealth level and the initial wealth is W=1,500.

a probability of 0.1.[7] In this case, we assume that the hedge lowers the gains and is not effective in extreme market conditions. In contrast, adding a safe haven asset to the exemplary portfolio could yield a payoff of $1400 with a probability of 0.9 and -$800 with a probability of 0.1. Here, the safe haven asset is effective in times of market turmoil. The utility levels are higher with the safe haven asset within both the prospect theory and the expected utility framework. However, the evidence is stronger in the prospect theory framework.[8]

It now remains to be tested empirically whether such a safe haven asset exists. We hypothesize that gold is a safe haven asset.

The econometric framework to test this hypothesis is presented in the next section.

2. Econometric Model

Given that the existence of a safe haven can benefit investors and increase the stability of financial markets, it is important to examine whether such a safe haven asset exists. As noted above, we choose gold as a candidate since anecdotal evidence and the financial media regularly suggest that gold is indeed a safe haven. Hence, this section provides the econometric framework to test whether gold is a hedge, a diversifier or a safe haven.

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. 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, we can distinguish between the two concepts both theoretically and empirically.

2.1 Regression model

Our principal regression model takes the form

$$r_{gold,\,t} = a + \sum b_{0(i)}\, r_{gold,\,t-i} + \sum b_{1(i)}\, r_{stock,\,t-i} + \sum b_{2(i)}\, r_{stock,\,t-i(q)} + \sum c_{1(i)}\, r_{bond,\,t-i} + \\ + \sum c_{2(i)}\, r_{bond,\,t-i(q)} + e_t \qquad (1)$$

where r_{gold}, r_{stock} and r_{bond} are the returns of gold, stock and bond prices, respectively. The terms $r_{stock,\,t(q)}$ and $r_{bond,\,t(q)}$ account for asymmetries of positive and negative (extreme) shocks and are included in order to focus on falling stock and bond markets. In particular, we analyze the role of gold in times of stress or extreme stock or bond market situations and include regressors that contain stock or bond

[7] Relaxing the assumption that a hedge does not reduce losses in extreme market conditions does not change the results qualitatively

[8] The results are not reported in more detail for space consideration but can be obtained from the authors upon request.

returns that are in the q% lower quantile such as the 5%, 2.5% and 1% quantile.[9] If the return is larger than the q% quantile, the value of $r_{stock, t(q)}$ or $r_{bond, t(q)}$ 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 buy gold and bid up the price of gold. If the price of gold is not affected, investors neither purchase nor sell gold in such adverse market conditions.

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 causal relationship running from gold to stock markets, with only weak effects and those concentrated in markets with significant numbers of gold mining stocks (see Davidson et al., 2003)[10]. We are aware of no paper that has examined a relationship between gold and bond returns.

It is important to analyze the relationship among the assets dynamically since lagged stock or bond returns can have a different impact on gold returns than contemporaneous stock or bond returns. 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 longer run. For example, it would not be a safe haven for investors that purchase gold after an extreme negative return shock had occurred. Capie, Mills et al. (2005) also estimate a dynamic regression model and assume the error term to exhibit conditional autoregressive heteroscedasticity modelled via a GARCH process. We follow their framework and specify an asymmetric GARCH process for the errors in equation 1.

We now focus on the contemporaneous version (no lags) of equation 1 to explain the relationship of the model and the hypotheses. If b_1 (c_1) is zero or negative, it implies that gold is a hedge for stocks (bonds) since the assets are uncorrelated with each other on average. Whether gold is a safe haven asset for stocks or bonds is tested via the parameters b_2 and c_2, respectively. If the total effect in (extremely) falling stock or bond markets is non-positive (sum of b_1 and b_2 for stocks and sum of c_1 and c_2 for bonds), gold serves as a safe haven asset for stocks or bonds since they are uncorrelated (sum of coefficients is zero) or negatively correlated (sum of coefficients is negative) with each other. A negative correlation of gold and stocks or gold and bonds in extreme market conditions implies that the price of gold increases in such conditions thereby compensating investors for losses incurred with stock or bond investments.[11]

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

< Insert table 1 about here >

[9] The choice of the quantiles is arbitrary to some degree. However, these quantiles have also been analyzed in other papers such as Bae, Karolyi and Stulz (2003).

[10] We estimated a VAR (no cointegration being found between the series) with 4 lags for each country and found no evidence that gold returns cause (in the Granger sense) either stock or bond returns.

[11] A diversifier asset can be viewed as a weak-form hedge and is thus not considered here in more detail.

The above regression models estimate the unconditional impact of stock and bond returns on the return of gold. In order to examine whether the impact of stocks and bonds on the price of gold is constant we additionally estimate time-varying betas.

3. Empirical Analysis

The data consist of daily prices of MSCI 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 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.

3.1 Descriptive Statistics

Figure 1 presents the prices for the entire sample period for stocks (upper graph), bonds (centre) and gold (bottom graph).

< Insert figure 1 about here >

Stock prices peaked around March 2000 followed by a bear market that ended around March 2003. Bond prices show a different pattern. 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 trend of the price for Gold. Two gold price regimes are easily discerned: the gold price fell until 2000 and increased afterwards.

Table 2 presents the descriptive statistics of the continuously compounded returns of stocks, bonds and gold for the full sample period. The tables show that stocks are generally more risky than stocks while the latter offer higher returns for certain periods indicated by the higher maximum values of stocks as opposed to bonds. Interestingly, gold despite its potentially safe haven property appears relatively risky in terms of the standard deviation and the minimum and maximum values. The largest negative and

positive returns of gold are close the ones of stocks and even exceed the extremes of stocks in some cases.

< Insert table 2 about here >

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. The differences in the gold returns among the three markets stem from exchange rate movements and show that the British Pound is more volatile in the period under investigation than the EURO and the US Dollar.

The unconditional correlation matrix presented in table 3 illustrates the relationship among stock, bond and gold returns on average. This implies that the results only provide an indication whether gold is a hedge or a diversifier for stocks or bonds but not whether it is a safe haven asset.

Table 3 shows that gold is a hedge for stocks in the US and in the UK (negative correlation) and a diversifier in Germany (positive correlation). Moreover, there is a positive correlation of bond and gold returns in the US and in the UK implying that gold is a diversifier for bonds in these countries. In contrast, gold is a hedge for bonds in Germany due to the negative correlation of both assets.

< Insert table 3 about here >

Finally, the correlation coefficients also indicate that there is a positive relationship between stock market returns between the US and the UK (0.4126), the US and Germany (0.4893) and between the UK and Germany (0.4994). The correlations of bond returns are also positive for all pairs of markets.

This section presented some preliminary statistics illustrating that gold is relatively risky compared to stocks and bonds.

3.2. Econometric Results

This section presents the estimation results for the model specified in equation 1. Table 4 contains the coefficient estimates, standard errors, z-statistics and p-values for all three markets, namely the US, the UK and Germany. The first columns contain the results for the US, followed by the results for the UK and Germany. The table presents the estimates for stock and bond returns on average and for the 5%, 2.5% and 1% quantiles. Below the contemporaneous effects, we show the results for lagged effects. Moreover, we report, in the last rows the parameter estimates for the asymmetric GARCH processes.

< Insert table 4 about here >

The coefficient estimates for the effect of stocks on gold is given by -0.0475 for the US, -0.1821 for the UK and 0.0401 for Germany. All estimates are highly significant at the 1% confidence level. The coefficient estimates for bonds are 0.0069 for the US, 0.0754 for the UK and -0.0528 for Germany.

These estimates imply that gold is a hedge for stocks in the US and in the UK but not in Germany. The opposite effect holds for gold as a hedge for bonds. Gold is a hedge for bonds in Germany but not in the US and in the UK. As noted earlier, this may well reflect the contemporaneous existence of significant markets for all three assets in the UK and USA but not in Germany.

For extreme negative stock returns, the coefficient estimates are positive for the 5% quantile and negative for the 2.5% and 1% quantile in all markets. The overall effect for any quantile is given by the sum of all coefficient estimates up to the chosen quantile. For example, the overall effect for the 1% quantile is the sum of all coefficient estimates that involve stock returns. This leads to a value of -0.0183 for the US, -0.2961 for the UK and -0.0727 for Germany and implies that in situations where stock returns exhibit extreme negative returns that are in the 1% quantile, the gold price increases slightly in the US and in Germany and strongly in the UK.

The fact that the sum of the coefficient estimates is non-positive for the 2.5% and 1% quantile but positive for the 5% quantile for the US and Germany implies that gold only serves as a safe haven for shocks exceeding the 2.5% and 1% threshold (quantile).

The choice of the optimal lag length led to a specification of one lag for the US and no lags for the UK and Germany. Thus, we need to add the lagged effects to the overall contemporaneous effect in the US. The overall effect including the lagged effect is stronger than the contemporaneous effect of -0.0183. The new estimate is -0.0401.

The relevant coefficient estimates for bond returns regarding the safe haven hypothesis show that we cannot reject the safe haven hypothesis for the 5% quantile in the US and in Germany. However, for lower quantiles or more extreme returns the overall effect becomes positive implying that bonds and gold move in the same direction if bonds fall. This also holds for the UK for all quantiles.

The fact that gold is a safe haven for stocks implies that investors that hold gold in normal times and in times of stress receive compensation for losses caused by negative stock returns through positive gold returns. However, what happens if investors purchase gold after an extreme stock market shock has occurred? The sum of the estimates of lagged stock returns and extreme lagged stock returns for the US are negative for the 2.5% and 1% quantile indicating that negative stock returns at t lead to positive gold returns at $t+1$. There is no such effect for the UK and Germany.

Therefore, purchasing gold *after* an extreme stock market shock yields a positive gold return implying that gold also functions as a safe haven for investors that buy gold only after an extreme market shock occurred. Lagged stock and bond returns do not have a significant effect on the price of gold. We therefore exclude them from the regression model for the UK and German. This does not automatically imply that gold does not yield a positive return for lagged extremely negative stock returns in these markets. The effect depends on the evolution of the stock and bond prices after extreme negative returns. We investigate this further below.

Note that the existence of a hedge does not imply the existence of a safe haven. The fact that gold is both a hedge and a safe haven for stocks 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, not a safe haven. 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).

Sub-sample analysis

This section examines whether the results based on the full sample period are also valid in sub-samples. We divide the sample in periods of bull and bear markets in order to investigate the question whether the role of gold is different in these market conditions. In order to minimize the number of sub-samples, we use relatively long periods and neglect shorter periods of opposite market movements. This approach leads to three distinct periods. A bull market regime until March 2000, a bear market regime from March 2000 until March 2003 and a bull market regime from March 2003 until November 2005. The periods are selected by computing the peaks and troughs within the full sample for any market.

The results are presented in table 5 and confirm the hypothesis above. Gold plays a different role in bull and in bear markets, especially in the US. While there is no significant estimate regarding gold as a hedge or a safe haven in bull markets, the estimates are highly significant in a bear market. The estimates for the UK are relatively similar across the three regimes but also show a slightly higher coefficient estimate for the hedge regressor indicating that gold is a stronger hedge for stocks in bear markets than in bull markets. The results for Germany are similar to the findings for the US. While gold is no hedge or safe haven in bull markets, it is a hedge and a safe haven in bear markets.

< Insert table 5 about here >

The fact that the beginning of the bear market (March 2000) coincides with a breakpoint in the evolution of the gold price – the price of gold starts to increase around 2000 – suggests that the role of gold (a safe haven or a hedge) is determined by the evolution of the gold price itself. The falling gold price in the first half of the sample leads to a rejection of the safe haven hypothesis. On the contrary, the increasing gold price in the second half of the sample implies that gold is a safe haven in this period. This is congruent with studies that have shown significant psychological elements of the gold price (see for example Aggarwal and Lucey, 2007).

This section estimated the effect of stocks and bonds on gold conditional on different market conditions and finds that gold exhibits the properties of a safe haven asset in falling stock markets in all three markets analyzed.

Time Varying Beta of Gold

Figure 2 contains the estimates of the time-varying betas[12] of gold on stocks for the US, the UK and Germany. The mean of the estimated betas is -0.11 for the US, -0.24 for the UK and +0.13 for Germany. The US betas fluctuate around zero in the first half of the sample period interrupted by two relatively short periods of significantly increased betas (around 0.2) in the aftermath of the Asian crisis in October 1997 and in the end of the year 1999. A pronounced decline of the beta occurred in October 1999. The beta then persistently deviated from zero (around -0.1) after September 11, 2001 and increased above zero levels only in 2004. The estimates for the UK show a more volatile evolution than for the US and Germany. However, differences in positive and negative beta estimates (regime changes) are less pronounced for the UK and Germany. The UK estimates are negative and the German estimates are positive for most days in the sample.

< Insert figure 2 about here >

Figure 3 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 the UK and less pronounced for the US and Germany.

< Insert figure 3 about here >

An analysis of the average betas in different market regimes (bull and bear markets) yields the following results. All markets exhibit negative gold-stock betas in bear markets. The averages are -0.28 for the US, -0.35 for the US and -0.16 for Germany. For the gold-bond betas the averages are 0.09 for the US, 0.08 for the UK and -0.05 for Germany. In bull markets, the gold-stock betas are around zero for the US, negative for the UK and positive for Germany. The gold-bond betas are negative in the first bull market (sub-sample 1) and positive in the second bull market (sub-sample 3) except for Germany.
An analysis of the statistical significance reveals that bear markets are statistically significantly different to bull markets for the betas of stocks with gold (except UK) and for the betas of bonds with gold. These results are consistent with the regression results for the sub-samples obtained above and confirm the finding that gold is a safe haven for stocks in all three markets analyzed.

3.3. Portfolio Analysis

This section analyzes the average cumulated return of a portfolio comprising gold and stocks for the period spanning 50 trading days after the occurrence of an extreme negative stock return. The aim is to illustrate the change in a portfolio comprising gold and stocks through time. It also reveals the average evolution of stock and gold returns after an extreme negative stock market shock. In other words, are

[12] The beta is computed with a rolling window of 6 months. An alternative estimation with the dynamic conditional correlation (DCC) estimator proposed by Engle (2002) yields similar but more volatile results.

extreme negative shocks followed by another negative shock or a positive shock? How does gold react to the initial shock at t and $t + x$ trading days? Note that this information does not emerge either from the regression model or from the time-varying beta estimates. Moreover, since this analysis is not based on the estimates obtained with the regression models as specified above it also serves as an implicit robustness check.

Figure 4 shows the average cumulated gold and stock returns after an extreme negative stock return smaller than the 5% quantile for the US, the UK and Germany (panels 1-3). The plot shows that the return of gold is positive on the day an extreme negative shock in the stock market occurs. However, the gold price declines in the days following the extreme negative shock and the initial positive effect is reduced to zero after about 15 days. This effect can be observed for the US and the UK. There is no positive effect of the gold price with a shock to the stock market in Germany.[13]

< Insert figure 4 about here >

Figure 5 shows the results for the 1% quantile. 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 becomes negative after less than 10 days and after 1 day in Germany. These results show that gold is a safe haven only in the short-run and that it loses value in the longer run.

< Insert figure 5 about here >

Figure 6 presents the results of the effects if an investor starts to purchase gold only one day after the occurrence of an extreme negative shock. The graph illustrates that investors lose money in the short-run because stock prices significantly increase on the day following a large negative shock and in the longer run because the price of gold decreases after about 15 trading days. This finding is consistent with investor overreaction and a subsequent correction of stocks. The findings also suggest that investors start to sell gold as soon as the market corrects itself and the safe haven asset is no longer needed.[14]

< Insert figure 6 about here >

The empirical finding that gold is a safe haven for a relatively short period of time after an extreme negative shock occurred can be explained with the property that gold is also a hedge for stocks. A hedge correlates negatively with another asset on average. This implies that if the price of one asset increases the price of the hedge asset falls. Since stock and bond prices usually rise some time after an extreme

[13] Results are qualitatively similar for the 2.5% quantile.
[14] We thank an anonymous referee for the comments concerning investor reactions.

negative shock has occurred, the existence of a hedge works against a safe haven asset in the longer run. For example, if increasing stock prices lower the price of gold on average this also holds for the period after an extreme negative stock return occurred. However, this finding is no evidence against the existence of gold as a safe haven asset since such an asset is not supposed to be a haven during the period of rising markets.

This section illustrated the evolution of the value of a portfolio comprising stocks and gold through time. We find that gold only works as a safe haven asset for around 15 days and only if investors hold gold before the occurrence of an extreme shock. If investors purchase gold one day after an extreme shock occurred, they lose money.

3.4. Specification Issues

The analysis above has focussed on the question whether gold is a safe haven and a hedge for stocks and bonds. The findings emerge from a regression model, with a time-varying covariance estimator that is used to compute the influence of stocks and bonds on the price of gold and a simple portfolio analysis. All types of analyses yield similar results qualitatively, that is, gold is a safe haven for stocks in all markets and a hedge in the US and in the UK. However, some issues deserve further discussions that are centred on the regression model framework.

Heteroscedasticity and autocorrelation require a GARCH-type process for the error term. Not accounting for these return characteristics yields very different results. For example, the coefficient estimate for the US stock return on the gold return obtained with OLS is -0.0556 and -0.0475 estimated with the GARCH process. For the 5% quantile, the OLS estimate is 0.0072 and 0.1130 for the GARCH specification. These differences are considerable and representative for the other coefficients and markets.

In contrast, the choice of the GARCH model, that is, a GARCH(1,1) or an asymmetric GARCH model did not change the coefficient estimates qualitatively. The same is true for the inclusion or exclusion of lagged regressors. The qualitative results do not change if lagged stock and bond returns are included or excluded in the model.

Finally, one could argue that the parameter estimates are biased due to endogeneity and omitted variables. Endogeneity could be present because of a feedback effect running from gold to stocks or bonds and an omitted variables bias could be present if other variables affect both gold and stock or bond returns. Such variables could be interest rates, inflation or volatility.

As an alternative to the univariate models specified above we also estimated a panel model with the gold returns on the left hand side and the stock and bond prices of all markets on the right hand side. This model led to similar results regarding the question whether gold is a hedge for stocks and bonds, which is one indication that the univariate models do not suffer from endogeneity and omitted variables.

Another indication provides the analysis of the average cumulated gold and stock returns after an extreme negative stock return. The figures show a relatively constant gold price which rules out any significant feedback effect running from gold to stocks.

4. Conclusions

This paper analyzes the role of a safe haven asset in financial markets and provides evidence that investors benefit from the existence of a safe haven asset. The paper then analyzes whether gold works as a safe haven asset in financial markets. Moreover, a safe haven asset is distinguished from a hedge and a diversifier asset, which provide diversification benefits on average but not necessarily when they are needed most, that is, in times of market turmoil.

Our empirical results show that gold is a safe haven for stocks. However, gold is generally not a safe haven for bonds in any market. Moreover, gold only functions as a safe haven for a limited period of time, around 15 trading days. In the longer run, gold is not a safe haven, that is, investors that hold gold more than 15 trading days after an extreme negative shock lose money with their gold investment. This finding suggests that investors buy gold on days of extreme negative returns and sell it when market participants regained confidence and volatility decreased. The results also show that there is a large difference as to whether investors hold gold at all times or purchase gold only after an extreme negative shock occurred. The latter strategy decreases the value of an investor's portfolio. Future research could extend the number of stock and bond markets analyzed and examine the role of exchange rates for the safe haven hypothesis.

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Table 1: Summary hypotheses gold as a hedge and gold as a safe haven,

Equation: $r_{Gold,\,t} = a + b_1\, r_{stock,\,t} + b_2\, r_{stock,\,t(q)} + c_1\, r_{bond,\,t} + c_2\, r_{bond,\,t(q)} + e_t$

	Hypothesis	***Parameter Implication***
Hypothesis 1	Gold is a **hedge** for stocks. The gold price and the stock price do not co-move on average.	$b_1 \leq 0$
Hypothesis 1*	Gold is a **hedge** for bonds. The gold price and the bond price do not co-move on average.	$c_1 \leq 0$
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.	$b_1 + b_2 \leq 0$
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.	$c_1 + c_2 \leq 0$

Table 2: Descriptive Statistics: Stock, bond and gold returns.

Returns	Mean	Std.Dev.	Min.	Max.	Skewness	Kurtosis
Stocks						
US	0.0003	0.0114	-0.0697	0.0561	-0.1033	6.1231
UK	0.0002	0.0109	-0.0601	0.0559	-0.2087	5.9710
Germany	0.0003	0.0154	-0.0867	0.0745	-0.2279	5.8477
Bonds						
US	0.0003	0.0056	-0.0312	0.0203	-0.4245	4.4749
UK	0.0003	0.0047	-0.0351	0.0323	-0.1380	5.5756
Germany	0.0004	0.0050	-0.0343	0.0253	-0.4568	5.5113
Gold						
in USD	0.0001	0.0080	-0.0582	0.0738	0.5452	11.5999
in GBP	0.0001	0.0104	-0.0449	0.0768	0.3396	6.5998
in EURO	0.0001	0.0082	-0.0665	0.0685	0.2123	10.9541

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

	US stocks	UK stocks	German stocks	US bonds	UK bonds	German bonds	Gold in USD	Gold in GBP	Gold in EURO
US stocks	1.0000	0.4126	0.4893	-0.0748	-0.0487	-0.0181	-0.0706	-0.1013	0.0357
UK stocks		1.0000	0.7243	-0.1221	-0.1345	-0.1053	-0.1301	-0.2125	0.0533
German stocks			1.0000	-0.1891	-0.1671	-0.1087	-0.1533	-0.2189	0.0530
US bonds				1.0000	0.4806	0.4938	0.0241	0.0616	-0.0496
UK bonds					1.0000	0.7522	0.0713	0.1066	-0.0461
German bonds						1.0000	0.0806	0.1210	-0.0433
Gold in USD							1.0000	0.8930	0.7492
Gold in GBP								1.0000	0.4850
Gold in EURO									1.0000

* All correlation coefficients are statistically significant at the 10% level except the pairs (US stocks, German bonds) and (US stocks, Gold in USD).

Table 4: Estimation Results for the US, the UK and Germany. Panel 1 shows the coefficient estimates, standard error, z-statistic and p-value for the US market, panel 2 for the UK market and panel 3 for Germany. The lag length and the GARCH model is selected with the Akaike and Schwarz information criteria. Only for the US market the first lags are statistically significant and improve the model fit. For the UK and Germany, contemporaneous stock and bond returns are sufficient. An asymmetric GARCH model with a threshold is selected for all markets.
The results show that stocks are a hedge in the US and in the UK but not in Germany. In contrast, bonds are not a hedge in the US and in the UK but only in Germany. Stocks are a safe haven in all markets with stronger evidence in the UK and in Germany. Bonds are not a safe haven in any of the three markets.

Equation:

$$r_{Gold,\,t} = a + b_1\, r_{stock,\,t} + b_2\, r_{stock,\,t(q)} + c_1\, r_{bond,\,t} + c_2\, r_{bond,\,t(q)} + e_t$$

$$h_t = \alpha e^2_{t-1} + \gamma\, e^2_{t-1} D(e_{t-1<0}) + \beta\, h_{t-1}$$

Panel 1: USA (US$)					**Panel 2: UK (£)**					**Panel 3: GER (€)**				
Gold	**Coeff. Est.**	**Std. Err.**	**t-stat.**		**Gold**	**Coeff. Est.**	**Std. Err.**	**t-stat.**		**Gold**	**Coeff. Est.**	**Std. Err.**	**t-stat.**	
b_1	-0.0475	0.0147	-3.23	***	b_1	-0.1821	0.0199	-9.15	***	b_1	0.0401	0.0108	3.72	***
b_2 (5%)	0.1130	0.0322	3.51	***	b_2 (5%)	0.0722	0.0504	1.43		b_2 (5%)	0.0754	0.0327	2.31	**
b_2 (2.50%)	-0.0793	0.0499	-1.59		b_2 (2.50%)	-0.0204	0.0593	-0.34		b_2 (2.50%)	-0.0857	0.0392	-2.18	**
b_2 (1%)	-0.0046	0.0470	-0.10		b_2 (1%)	-0.1659	0.0375	-4.42	***	b_2 (1%)	-0.1026	0.0297	-3.46	***
c_1	0.0069	0.0284	0.24		c_1	0.0754	0.0370	2.04	**	c_1	-0.0528	0.0325	-1.62	*
c_2 (5%)	-0.0434	0.0843	-0.51		c_2 (5%)	0.1184	0.1176	1.01		c_2 (5%)	-0.0631	0.0959	-0.66	
c_2 (2.50%)	0.1029	0.1123	0.92		c_2 (2.50%)	0.0678	0.1692	0.40		c_2 (2.50%)	0.3216	0.1357	2.37	**
c_2 (1%)	-0.0581	0.1024	-0.57		c_2 (1%)	-0.0342	0.1682	-0.20		c_2 (1%)	-0.0818	0.1292	-0.63	
1 lag														
b_1	0.0078	0.0136	0.58											
b_2 (5%)	0.0094	0.0406	0.23											
b_2 (2.50%)	-0.0758	0.0532	-1.42											
b_2 (1%)	0.0116	0.0466	0.25											
c_1	-0.0155	0.0278	-0.56											
c_2 (5%)	0.1875	0.0721	2.60	***										
c_2 (2.50%)	-0.2070	0.1220	-1.70	*										
c_2 (1%)	0.1032	0.1263	0.82											
Conditional Volatility					**Conditional Volatility**					**Conditional Volatility**				
α	0.0313	0.0077	4.05	***	α	0.0349	0.0084	4.14	***	α	0.0245	0.0066	3.72	***
γ	0.0849	0.0097	8.75	***	γ	0.0543	0.0103	5.27	***	γ	0.0798	0.0092	8.70	***
β	0.9096	0.0064	141.38	***	β	0.9228	0.0078	117.67	***	β	0.9076	0.0064	141.43	***

The parameters governing the conditional volatility are given by α (the ARCH term), γ (the asymmetric component) and β (the GARCH term).

Table 5: Sub-sample analysis for the US, the UK and Germany
The panels below show the estimation results for three different periods: a bull market from November 1995 until March 2000, a bear market from March 2000 until March 2003 and a bull market from March 2003 until November 2005. Panel 1-3 show the coefficient estimates, z-statistic and p-value for the US, the UK and Germany, respectively. The estimation results show that gold is exhibits a negative correlation with the stock markets in the bear market consistent with the safe haven hypothesis of gold for stocks.

Equation:

$$r_{Gold,\,t} = a + b_1\, r_{stock,\,t} + b_2\, r_{stock,\,t(q)} + c_1\, r_{bond,\,t} + c_2\, r_{bond,\,t(q)} + e_t$$

$$h_t = \alpha e^2_{t-1} + \gamma\, e^2_{t-1} D(e_{t-1<0}) + \beta\, h_{t-1}$$

Panel 1: US

	Bull market (- March 2000)			*Bear Market (- March 2003)*			*Bull market (March 2003 -)*		
	Coeff. Est.	**t-stat.**		**Coeff. Est.**	**t-stat.**		**Coeff. Est.**	**t-stat.**	
b_1	0.0082	0.41		-0.0915	-4.51	***	0.0188	0.44	
b_2 (5%)	-0.0086	-0.19		0.3018	7.22	***	-0.3999	-1.11	
b_2 (2.50%)	0.0644	0.93		-0.2129	-3.60	***	-0.0846	0.00	
b_2 (1%)	0.0678	1.14		-0.1162	-1.45		0.7870	0.00	
c_1	-0.1299	-3.75	***	0.1232	2.32	**	0.1822	2.83	***
c_2 (5%)	0.0258	0.27		-0.3155	-1.37		0.0521	0.32	
c_2 (2.50%)	-0.0034	-0.02		0.3306	1.31		0.2249	0.81	
c_2 (1%)	0.0246	0.16		0.0235	0.12		-0.4613	-1.59	
α	0.1254	5.31	***	0.0403	1.48		-0.0477	-3.76	***
γ	0.1245	3.90	***	0.2165	4.90	***	-0.0046	-0.14	
β	0.7840	45.19	***	0.7688	21.03	***	0.5193	1.58	

The parameters governing the conditional volatility are given by α (the ARCH term), γ (the asymmetric component) and β (the GARCH term).

Panel 2: UK

	Bull market (- March 2000)			*Bear Market (- March 2003)*			*Bull market (March 2003 -)*		
	Coeff. Est.	**t-stat.**		**Coeff. Est.**	**t-stat.**		**Coeff. Est.**	**t-stat.**	
b_1	-0.1369	-5.23	***	-0.1733	-5.18	***	-0.1631	-2.44	**
b_2 (5%)	0.0628	0.98		0.0533	0.68		0.0970	0.28	
b_2 (2.50%)	-0.0649	-0.93		-0.0263	-0.24		-0.0391	-0.10	
b_2 (1%)	0.0507	0.74		-0.1057	-1.19		0.5120	4.13	***
c_1	-0.0977	-2.61	***	0.3231	3.59	***	0.6862	2.53	***
c_2 (5%)	-0.1247	-0.88		0.0970	0.24		-0.4004	-1.11	
c_2 (2.50%)	0.0656	0.24		0.4727	0.99		-0.1762	-0.35	
c_2 (1%)	0.3708	1.32		-0.6251	-1.61		0.0009	1.74	*
α	0.0999	3.68	***	0.0988	2.33	**	0.0188	0.54	
γ	0.1420	4.08	***	-0.0197	-0.47		-0.1030	-2.23	**
β	0.7246	24.91	***	0.6754	5.36	***	-0.4224	-1.19	

The parameters governing the conditional volatility are given by α (the ARCH term), γ (the asymmetric component) and β (the GARCH term).

Panel 3: Germany

	Bull market (- March 2000)			*Bear Market (- March 2003)*			*Bull market (March 2003 -)*		
	Coeff. Est.	**t-stat.**		**Coeff. Est.**	**t-stat.**		**Coeff. Est.**	**t-stat.**	
b_1	0.1011	5.6800	***	-0.0193	-0.9600		0.0622	2.49	**
b_2 (5%)	0.1432	1.7800	*	0.0156	0.3400		0.0949	0.90	
b_2 (2.50%)	-0.1213	-1.4500		-0.0993	-1.7500	*	-0.0456	-0.42	
b_2 (1%)	-0.0470	-0.7300		-0.0436	-0.7300		#		
c_1	-0.0574	-1.1600		-0.2159	-3.1200	***	-0.0208	-0.32	
c_2 (5%)	0.0415	0.2500		-0.1441	-0.7900		-0.2363	-1.16	
c_2 (2.50%)	0.1996	0.9700		0.0681	0.1900		0.4700	1.25	
c_2 (1%)	-0.1032	-0.6400		0.2713	0.7800		-0.1559	-0.44	
α	0.0268	3.4300	***	0.0053	0.2600		0.0762	2.57	***
γ	0.0731	6.3200	***	0.0807	2.6700	***	-0.0978	-2.82	***
β	0.9352	176.8400	***	0.8560	15.8600	***	-0.7045	-5.14	***

regressor dropped due to collinearity
The parameters governing the conditional volatility are given by α (the ARCH term), γ (the asymmetric component) and β (the GARCH term).

Figure 1: Stock, bond and gold prices from 30/11/1995 until 30/06/2005
The figure presents the evolution of the stock prices (top panel), bond prices (intermediate panel) and the gold price (bottom panel) for three countries (the US, the UK and Germany).

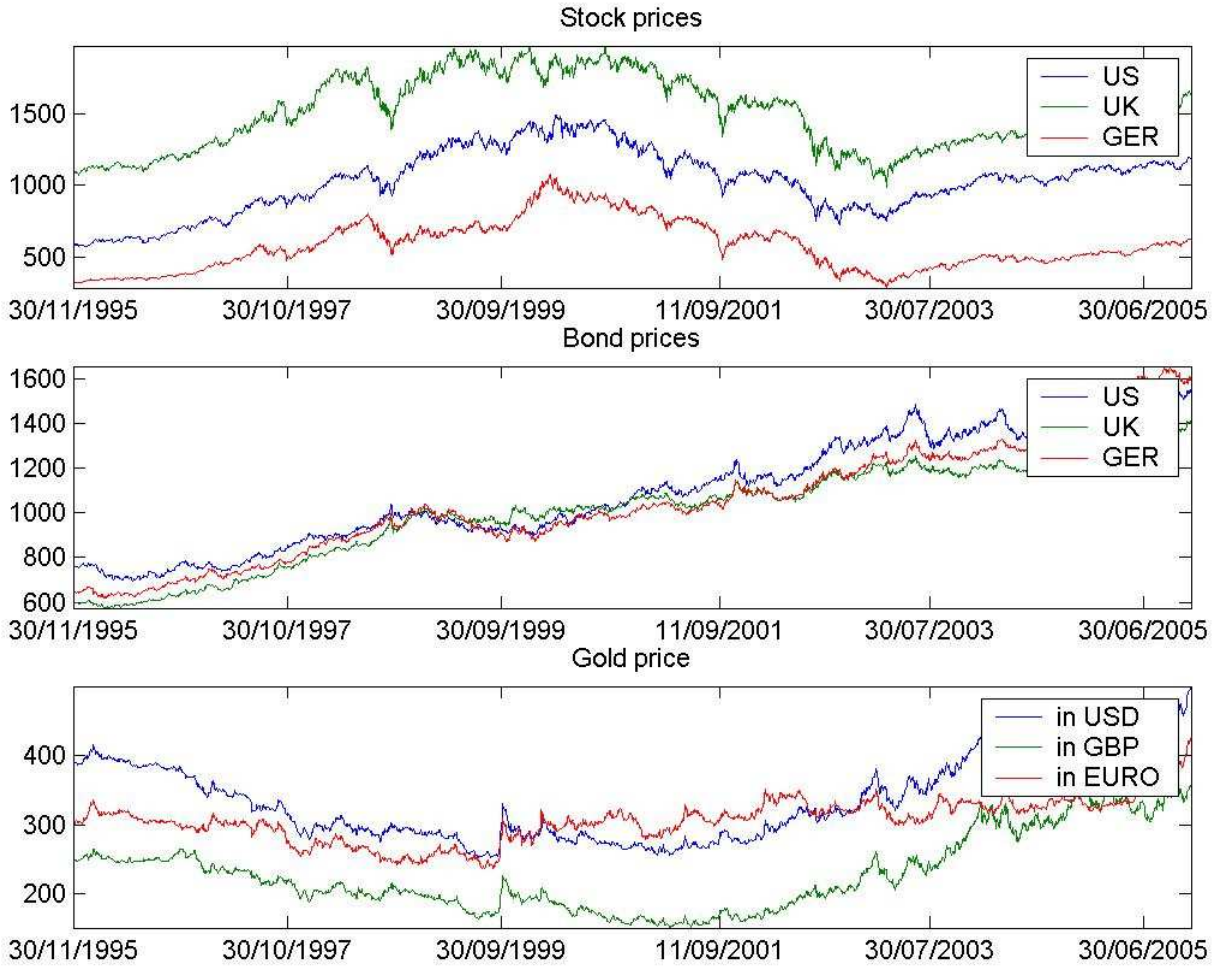

Figure 2: Time-varying beta of a regression of gold on stock returns
The figure shows the time-varying gold-stock beta of the US, the UK and German markets. The graph illustrates that beta varies significantly and is negative in the bear market between March 2000 and March 2003 consistent with the safe haven hypothesis for gold.

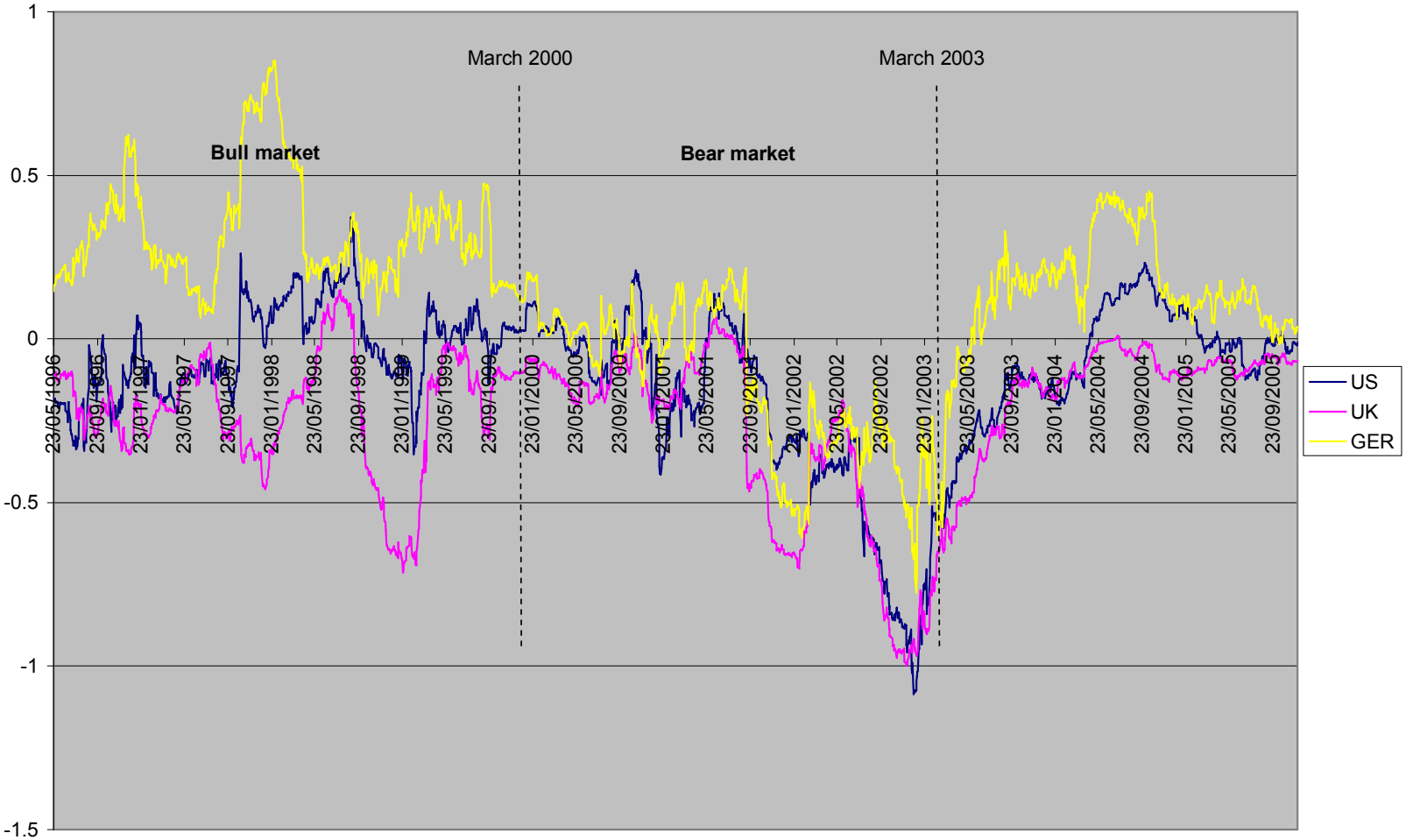

Figure 3: Time-varying beta of a regression of gold on bond returns
The figure shows the time-varying gold-bond beta of the US, the UK and German markets. The graph illustrates that beta varies significantly and is positive in the bear market between March 2000 and March 2003 for the US and the UK and negative for the German market.

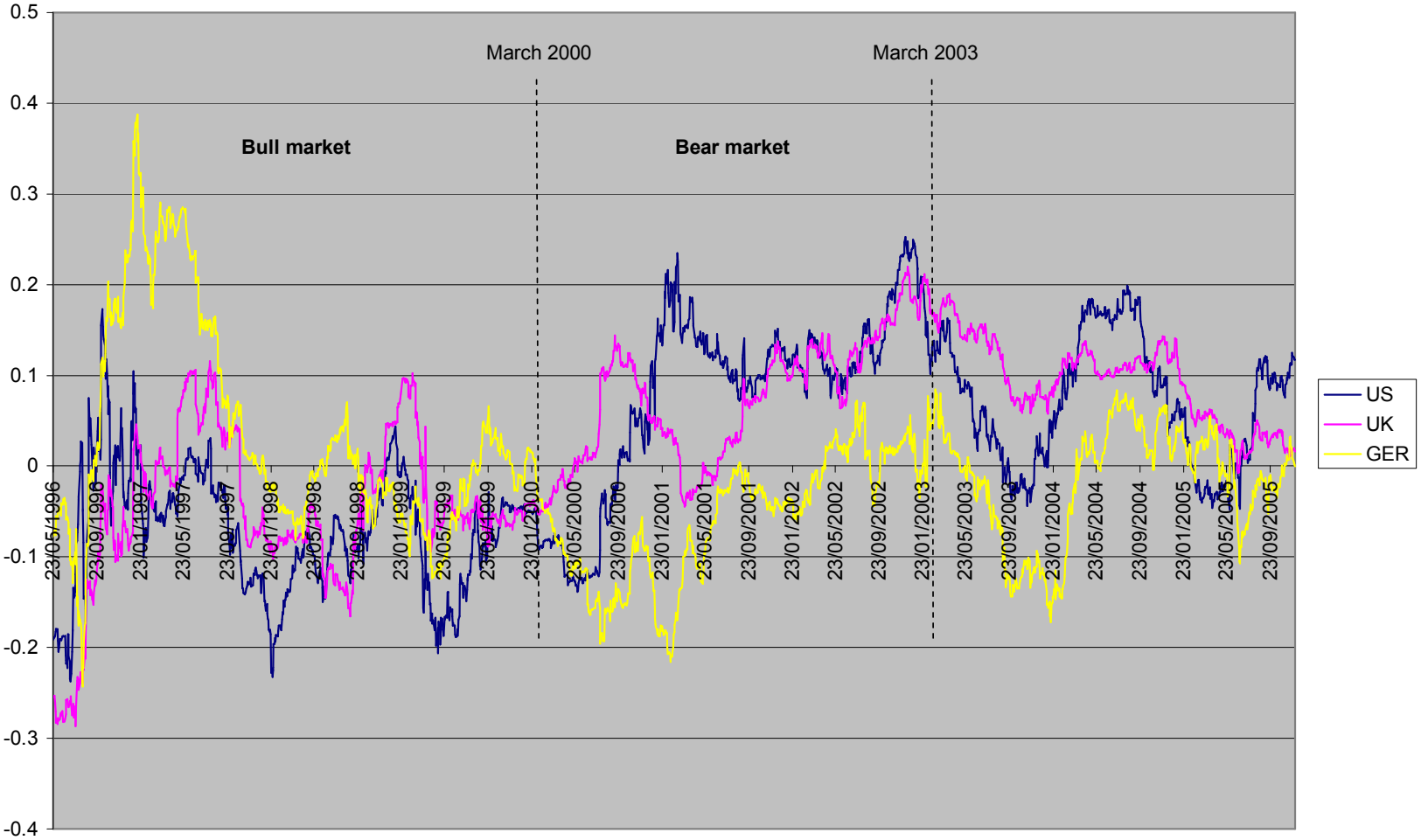

Figure 4: Portfolio analysis.
The figure shows how stock returns and gold returns evolve for different investment horizons (x-axis). Period 1 is the time where an extreme negative stock return (in the 5% quantile) occurs. The vertical axis contains the average cumulated stock and gold returns. The top panel presents the US market, the intermediate panel the UK market and the bottom panel the German market. The time-series show that the return of gold is positive on the day an extreme negative shock in the stock market occurs and declines in the days following the extreme negative shock. The stock market returns tend to be positive after an extreme negative shock leading to an upward trend in the cumulated returns of stocks.

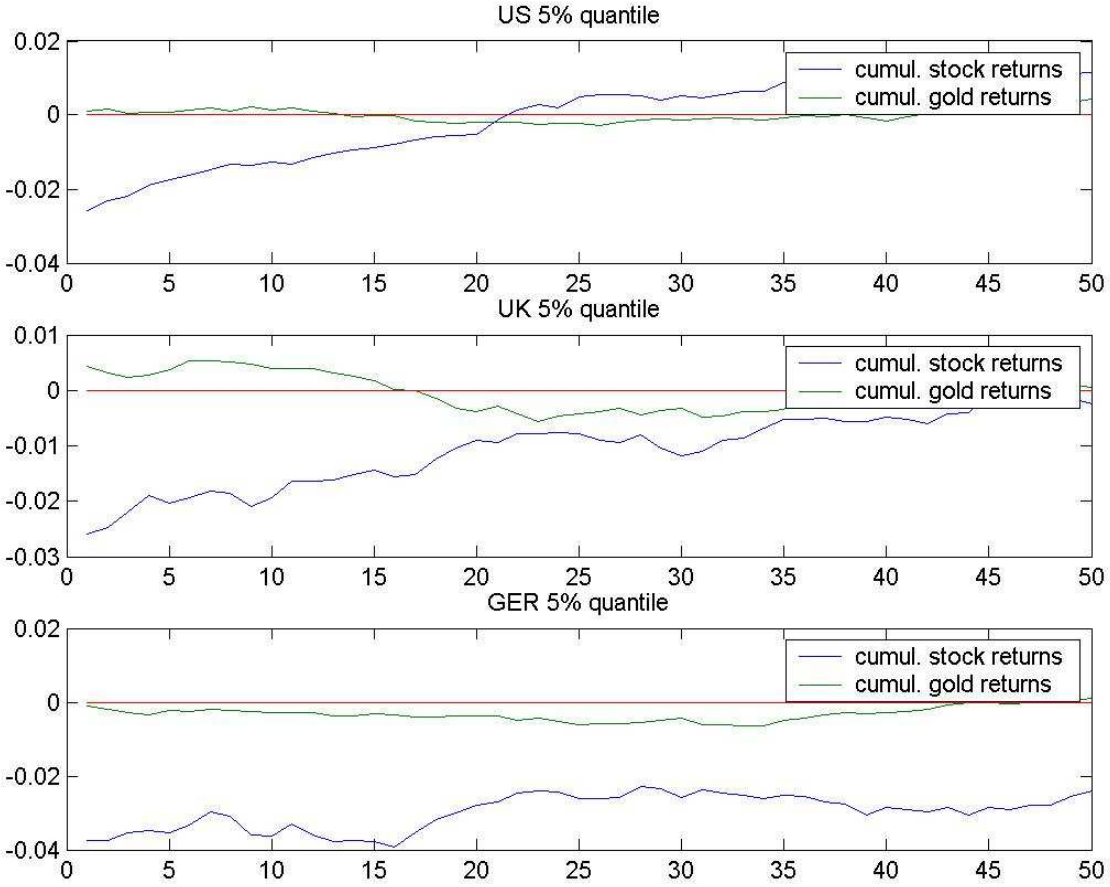

Figure 5: Portfolio analysis:
The figure shows how stock returns and gold returns evolve for different investment horizons (x-axis). Period 1 is the time where an extreme negative stock return (in the 1% quantile) occurs. The vertical axis contains the average cumulated stock and gold returns. Top panel presents the US market, the intermediate panel the UK market and the bottom panel the German market. The time-series show that the return of gold is positive on the day an extreme negative shock in the stock market occurs and declines in the days following the extreme negative shock. The stock market returns tend to be positive after an extreme negative shock leading to an upward trend in the cumulated returns of stocks (except for Germany).

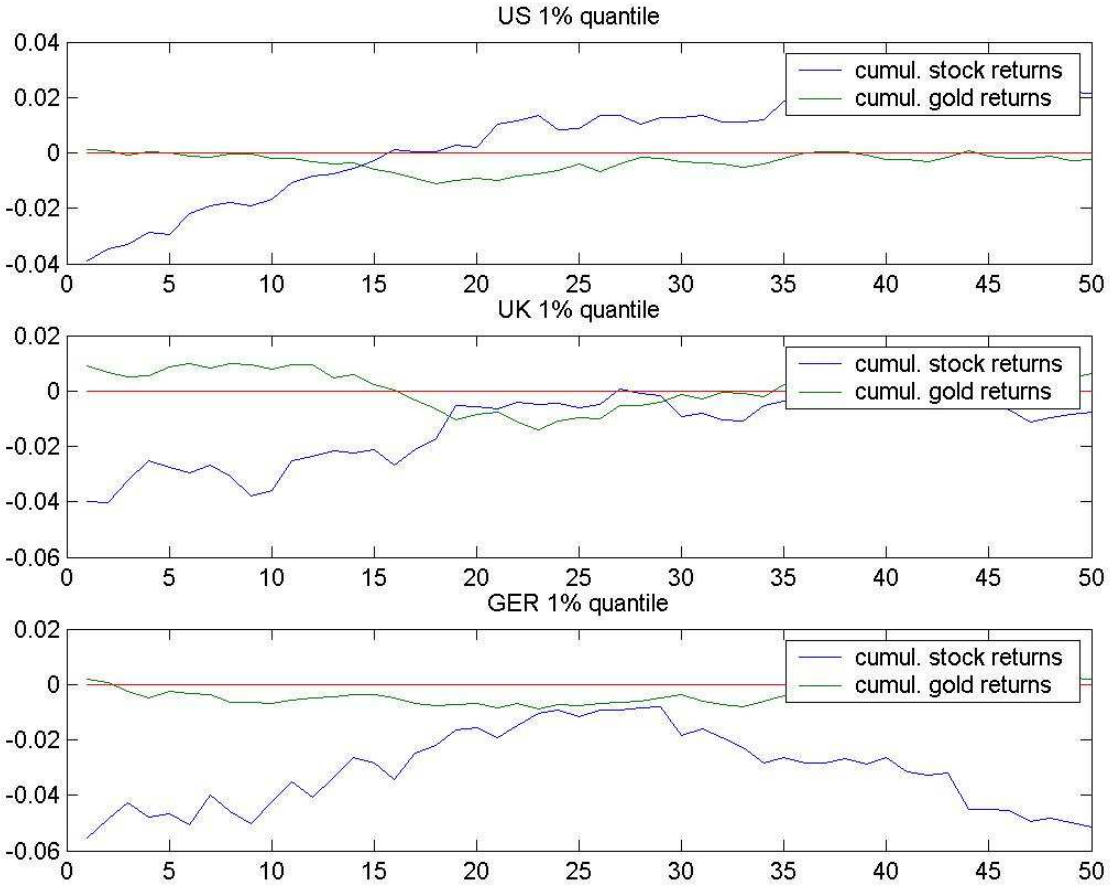

Figure 6: Portfolio analysis
The figure shows how stock and gold returns evolve for different investment horizons (x-axis) one day after an extreme negative stock return shock occurred. Day *T=0* is the time where an extreme negative stock return (5% quantile). The top panel presents the US market, the intermediate panel the UK market and the bottom panel the German market. The time-series show that the return of gold declines in the days following the extreme negative shock. The returns of the stock markets tend to be positive after an extreme negative shock.