Does gold offer a better protection against sovereign debt crisis than other metals?

SAM AGYEI-AMPOMAH [a], DIMITRIOS GOUNOPOULOS[b], KHELIFA MAZOUZ [c1]

This version: January 2013

[1] Sam Agyei-Ampomah and Dimitrios Gounopoulos are from Surrey Business School, University of Surrey, Guildford, GU2 7XH, UK. Khelifa Mazouz is from Management School, University of Bradford, Bradford, BD9 4JL, UK. Ampomah may be reached at tel: +44 1483 683094; email: s.agyei-ampomah@surrey.ac.uk. Gounopoulos may be reached at tel: +44 1483 683119; email: d.gounopoulos@surrey.ac.uk. Mazouz may be reached at tel: + 44 01274 234349; email: k.mazouz@bradford.ac.uk.

Does gold offer a better protection against sovereign debt crisis than other metals?

ABSTRACT

It is a commonly held view that gold protects investors' wealth in the event of negative economic conditions. In this study, we test whether other metals offer similar or better investment opportunities in periods of crisis. Using a sample of 13 sovereign bonds, we show that other precious metals, palladium in particular, offer investors greater compensation for their bond market losses than gold. We also find that industrial metals, especially copper, tend to outperform gold and other precious metals as hedging vehicles and safe haven assets against sovereign bonds. However, the outcome of the hedge and safe haven properties is not always consistent across the different bonds. Finally, our analysis suggests that copper (palladium) is the best performing industrial (precious) metal in the period immediately after negative bond price shocks.

*JEL classification: G*10; G11; G14;

Keywords: Gold; Precious Metals; Industrial Metals; Sovereign Bonds; Hedge; Safe Heaven;

1. Introduction

Gold has been long referred to by the financial media as a safe haven asset. Its characteristics as a financial asset have also been widely explored in the academic literature. McCown and Zimmerman (2006) find that gold has the characteristics of a zero-beta asset that has the ability to hedge against inflation. Capie et al. (2005) also show that gold protects investors wealth against fluctuations in the foreign exchange value of the US dollar. The observed increase in gold value during the recent financial crisis has motivated other researchers to explicitly test its viability as a safe haven from losses in financial markets. Baur and McDermott (2010) show that gold protects investors against stock market shocks in major European countries and the US, but does not serve as a safe haven for Australia, Canada, Japan and emerging stock markets. Similarly, Baur and Lucey (2010) report that gold is a safe haven for stocks, but not for bonds, in the US, the UK and Germany.

The deterioration in government finances, after the credit crisis of 2008, led some investors to use gold as a safe haven in their flight to safety. The extensive use of gold as a hedging vehicle has also sparked the utilization of other precious metals as risk management tools and diversifying commodity portfolios (see, e.g., Sari et al., (2010); Belousova and Dorfleitner (2012))[2]. The race among these metals has enhanced their price comovement (see Pindyck and Rotember, (1990); Hammoudeh and Yuan, (2008), among others). Consistent with the comovement evidence, Daskalaki and Skiadopoulos (2011) show that all major precious metals, including gold, silver, platinum, palladium, and, offer returns of lower correlation with stocks. Erb and Harvey (2006), Roache and Rossi (2010) and Elder et al. (2012) also find that gold and silver prices are counter-cyclical, implying that precious metals other than gold may also protect investors' wealth in the events of negative stock market conditions. Furthermore, whilst a few studies (e.g. Erb and Harvey (2006), Roache and Rossi (2010)) show some evidence of pro-cyclicality in industrial metal prices, observed marked data (see Figure 1 below) suggests that industrial metals also commove with precious metals and their prices exhibit significant increases following the recent sovereign debt crisis. Thus, industrial metals may also serve as a place of safety in the events of negative economic conditions and this leads to the following important questions: (i) to what extent does gold protect investors' wealth against sovereign-debt crisis? (ii) does gold offer a better protection against sovereign-debt crisis than other metals? and (iii) is the

[2] Gold has more characteristics in common with other metals – in particular precious metals – than it does with any of the other commodities. Gold and precious metals can be reused or recycled for new fabrication, which provide an additional source of supply. This is in stark contrast to energy, agricultural and livestock commodities which are spent, consumed, or transformed but are rarely recoverable. Metals also tend to have longer shelf lives and are less susceptible to adverse storage conditions than agricultural commodities. They can also be transported without the need for specialised infrastructures such as in the case of oil or natural gas.

protection, if any, offered by gold and other metals against sovereign credit deteriorations short- or long-lived?

While the hedge and safe haven properties of gold have explicitly been examined in the context of both stock and bond markets (Baur and McDermott (2010) and Baur and Lucey (2010)), the role of other precious and industrial metals as hedging vehicles and safe haven assets has not yet been explicitly explored. Here, we define a hedge as a security that does not commove with the value of the instrument to be hedged on average and a safe haven as a security that does not commove with the hedge instrument during the crisis period (see also Baur and Lucey, 2010). By investigating the relative abilities of industrial and precious metals to protect investors' wealth against sovereign debt crisis, this study makes three important contributions to the literature. First, it details the hedge and safe haven properties of gold and other selected metals against the deteriorations in the credit quality of sovereign bonds. Second, it shows that the outcome of the hedge and safe haven properties of the metals against sovereign bonds is not always consistent across the different bonds. Finally, it examines the performance of metals in periods following large negative bond price changes to evaluate the speed at which investors recover losses from extreme negative bond price movements and the profit (or loss) associated with holding different metals in periods of high bond market turmoil.

Our empirical analysis focuses on sovereign bonds in the US, the UK, the EMU and ten Eurozone countries (Austria, Belgium, France, Greece, Germany, Ireland, Italy, Netherlands, Portugal and Spain) and yields the following interesting findings. First, we find that gold serves as a strong hedge only for bonds in Belgium, Greece, Italy, the Netherlands and Portugal and a strong safe haven for bonds in Finland, Spain and the EMU. Second, precious metals, palladium in particular, outperform gold both as hedging and safe haven assets and investors are better off holding industrial rather than precious metals in the periods of stormy weather. The superiority of industrial metals in protecting investors against losses in the US and European bonds may be attributed to increased demand for these metals from major emerging countries, such as the BRIC, which have not been affect by the recent crisis. Third, we report a strong comovement between gold and the UK and German bonds in periods of high bond market volatility. This evidence is consistent with the "flight to safety" argument, and that investors may view high quality bonds, such as the UK and German bonds, and gold as substitutes in protecting themselves against lower quality bonds. Finally, we find that copper (palladium) is the best performing (precious) metal in the period immediately after extreme negative bond price changes.

The remainder of the paper is structured as follows. Section 2 provides a brief review of the literature on the role of metals in the financial systems. Section 3 presents a summary of the characteristics and the historical performance of metals as financial assets. Section 4 describes the methodology. Section 5 contains the results of our analysis and Section 6 offers our concluding remarks.

2. A brief review of the related literature

Markets did not expect at the time when Greece had the highest credit rating by top agents that its deep debt problems could trigger the European sovereign-debt crisis. The deterioration of government finance after 2008 led to a sudden loss of confidence in both sovereign debt and equity markets and drove the prices of alternative investments, such as gold and the precious metals to record highs[3]. The impressive performance of metals (especially gold) during the economic downturns, in general, and recent European sovereign-debt, in particular, presents a strong motivation to examine the characteristics of these assets and their role in the global financial system.

Several studies examine the volatility characteristics of gold and other major metals. Hammoudeh and Yuan (2008) investigate the volatility properties of gold, silver and copper. They show that gold and silver experience almost the same volatility persistence, which tends to be higher than that of the pro-cyclical copper. Batten et al. (2010) models the monthly price volatilities of precious metals. They show that while monetary variables can explain gold price volatility, they do not seem to be related to silver price movements. They conclude that their findings are consistent with the view that precious metals are too distinct to be considered a single asset class or represented by a single index.

A number of other studies, including Jaffe (1989), Chua et al. (1990) and Draper et al. (2006), focus on the role of metals in portfolio diversification. Their general findings suggest that investments in metals and other commodities help to improve the overall performance of stock and bond portfolios. Draper et al. (2006) show that gold, silver and platinum have low correlations with stock index returns. Their evidence implies that precious metals may provide diversification within broad investment portfolios. Conover et al. (2009) examines the benefits of adding precious metals (gold, silver and platinum) to U.S. equity portfolios. They evaluate different weights (from 5% to 25%) of these metals in a typical portfolio and find that adding a

[3] Bauer (2013) reports that high prices of gold can be linked to a "fear" trade, i.e. the price of gold increases due to investors' fears of weak economic performance. The latter may include higher expected inflation due to lax central bank policies. Purchases of gold motivated by "fear" of higher future inflation or a continued recession can happen anytime but are unlikely to occur in the same month every year.

25% allocation of precious metals in a portfolio consisting of equities substantially improves the portfolio performance. Similarly, Georgiev (2001) and Gibson (2004) find that the incorporation of commodities in the investment universe improves the risk-return characteristics in the mean-variance space.

The role of precious metals in protecting investors' wealth against negative economic conditions has also been widely investigated. Chow et al. (1999) suggest that commodities, including metals, are more attractive when the general financial climate is negative. Edwards and Caglayan (2001) support this position by demonstrating that commodity funds provide higher returns when stocks perform poorly. This evidence suggests that the inclusion of key commodity contracts should provide a positive contribution to more broad-based financial trading and investment. Hooker (2002), Narayan et al. (2010) and Arouri et al. (2011) find evidence of the inflation-hedging ability of gold. Similar evidence is reported by Erb and Harvey, (2006) and Gorton and Rouwenhorst, (2006) in the case of other major precious metals. Draper et al. (2006) also show that precious metals have hedging capability and a potential for playing the role of safe havens, particularly during periods of abnormal stock market volatility. Baur (2013) analyzes monthly gold returns over the period 1980-2010. He finds that September and November are the only months with significantly positive gold price changes. He argues that investors seemed to have learned that some of the most extreme periods of financial turmoil occur in September and October (e.g. the stock market crash in October 1987, the Asian financial crisis in October 1997 and the Global Financial Crisis in September and October 2008) and, therefore, tend to increase their purchases of gold during these months to hedge themselves against the potential financial turmoil (see Bouman and Jacobsen, (2002); Jacobsen and Zhang, (2012))[4].

Erb and Harvey (2006) show that the prices of precious metals and industrial metals react differently to economic shocks. This is because a surprise improvement in economic growth may cause gold and silver prices to drop because of portfolio rebalancing effects, but result in higher industrial metal prices due to greater industrial demand. Roache and Rossi (2010) and Elder et al. (2012) suggest that announcements which reflect an unexpected improvement in the economy[5] tend to have a negative impact on gold and silver prices, but a positive effect on copper. This is attributed to the fact that copper and other industrial metals are important input goods in manufacturing and production related industries (about 70% of the demand for copper comes from electrical and construction industries), and a more sanguine economic climate would

[4] It is also possible that investors buy gold as an insurance against stock market losses before they are heavily invested in stocks, that is, between November and May establishing the "Halloween effect" or the "sell in May and go away effect".

[5] As conveyed by improvements in real activity (e.g., advance retail sales), consumption (e.g., new home sales) and investment (e.g., durable goods orders).

be indicative of greater demand for this industrial metal. use intra-day data to examine the intensity, direction and speed of the impact of U.S. macroeconomic news announcement on the return, volatility and trading volume of metal futures. However, observed market data (see Figure 1 below) suggests that both industrial and precious metals enjoy some price appreciation during crisis periods.

While many studies highlight the potential ability of precious metals (gold in particular) to serve as safe haven against losses in financial markets, this claim has rarely been explicitly tested in the literature. In fact, Baur and McDermott (2010) and Baur and Lucey (2010) appear to be the only studies that directly examine the role of gold as a hedge and safe haven against losses in stock and bond markets. Baur and McDermott (2010) find that gold may act as a stabilizing force for the financial system by reducing losses in the face of extreme negative market shock. They also show that gold is both a hedge and a safe haven for major European markets and the US but not for Australia, Canada, Japan and large emerging markets, such as the BRIC countries. Baur and Lucey (2010) examine the safe haven property in the context of German, UK and US stock and bond markets. They show that gold is a safe haven for stocks, but not bonds. Thus, the ability of gold to serve as a hedging and/or a safe haven asset may vary significantly across different markets and asset classes.

3. Data

Our data sample covers the period from July 1993 to June 2012. Our analysis focuses on this period due to lack of data for some industrial metals before July 1993. Daily data on the closing US dollar prices are collected for each industrial and precious metal. The precious metals used in this study are Gold, Silver, Platinum and Palladium. The industrial metals group consists of Aluminium, Copper, Lead, Nickel, Tin and Zinc. We also collect daily data for the US dollar to pound exchange rate and US dollar to euro exchange rate. We then calculate the closing prices of the metals in pounds and euros using the dollar prices of the metals and the foreign exchange rates. This is done to ensure that the return on the metal and the return on the bond in the subsequent analysis are in the same currency.[6] Figure 1 reports the daily movements of metal prices over the entire sample period. Consistent with the comovement studies (e.g. Pindyck and Rotember, (1990); Hammoudeh and Yuan, (2008)), the figure suggests that metal prices tend to move together over time. Specifically, Figure 1 shows that metal prices were generally stable prior to June 2005. It also shows that all metal prices increased dramatically during the period

[6] For example, when examining the hedge properties of metals against bonds denominated in euros, we use the euro prices to calculate the return on the metals.

2005-2007; declined sharply in 2007; pick up again in July 2008 and started to decline in February 2011.

Closing return index values for 5-year, 10-year and 30-year benchmark bonds for the US, the UK, the EMU benchmark and ten euro-zone countries with the relevant data are collected. The euro-zone countries in our sample are Austria, Belgium, Finland, France, Germany, Greece, Italy, Netherlands, Portugal and Spain. The return index on the benchmark bonds are denominated in the local currency. All the data (dollar closing prices of metals, foreign exchange rate and the return index on benchmark bonds) are obtained from the Datastream database. Benchmark bond data for Greece is only available for 10-year maturities and Finland and Portugal did not have data for the 30-year bond. As a result, we present results mainly for the 10-year bonds but we obtain similar results for the other maturities[7]. The EMU benchmark data starts from January 1999.

Please Insert Figure 1 About Here

---

4. Methodology

There is already strong evidence that gold protects investors, Wallace and Choudhry (1995), Davidson et al.(2003), Bordo and MacDonald (2003), Baur and Lucey (2010) and Baur (2013), but are other precious and industrial metals offer better investment opportunities in periods of crisis? To assess the hedge and safe haven properties of industrial and precious metals against sovereign debt, we use a methodology similar to that of Baur and McDermott (2010). Eqs. (1a), (1b) and (1c) present the principal regression model used to analyse the role of a variety of precious and industrial metals as hedge and/or safe haven investment assets for sovereign bonds. We assume that changes in the precious or industrial metals prices are dependent on changes in the bond market. Further, we speculate that extreme market conditions affect the balance of the relationship.

Let $R_{M,t}$ denote the local currency return on the respective metal and $R_{Bond,t}$ be the local currency return on the benchmark bond index. Then, as in Baur and McDermott (2010), we model the return generating process of the metals as:

[7] More details on the results of the 5- and 30-year bonds are available upon request.

$$R_{M,t} = \alpha + \beta_t R_{Bond,t} + e_t \quad (1a)$$

$$\beta_t = \delta_0 + \delta_1 D1 + \delta_2 D5 + \delta_3 D10 \quad (1b)$$

$$\sigma_t^2 = \omega + \theta e_{t-1}^2 + \sigma_{t-1}^2 \quad (1c)$$

where $D1$, *D5* and *D10* are dummy variables, which are used to capture extreme bond market movements, with values of one if the bond return on day *t* falls in the lower 1st, 5th and 10th percentile, respectively, and zero otherwise. The error term, e_t, is assumed to follow a GARCH (1, 1) process with a time varying variance, σ_t^2. The GARCH (1, 1) process is used to control for heteroscedasticity in the data, which is common in daily financial data[8]. The coefficients δ_i (for *i* = 0, 1, 2, 3) measure the hedge and safe haven properties of the metal under consideration. Specifically, a significantly negative estimate for δ_0 would suggest that the metal is a strong hedge against the sovereign bond. If δ_0 is not statistically different from zero, then the metal is considered as weak hedge. However, a metal is not a hedge if δ_0 is positive and statistically significant. Nonlinearities in the hedge property are captured through the parameters δ_1, δ_2 or δ_3. If one of the parameters δ_1, δ_2 or δ_3 is significantly different from zero, this will indicate a non-linear relationship between the metals and the sovereign bonds. For a metal to be considered a safe haven, it must offer protection against extreme adverse market conditions in the sovereign bond market. In other words, a metal would only be viewed as a safe haven in given threshold of extreme shocks when the sum of the relevant exposure coefficients δ_i ($SH_1 = \sum_{i=0}^{1} \delta i$ in the case of negative returns in the lower 1st percentile, $SH_2 = \sum_{i=0}^{2} \delta i$ for the negative returns in the lower 5th percentile and $SH_3 = \sum_{i=0}^{3} \delta i$ for the negative returns in lower 10th percentile) is significantly negative (strong safe haven) or not statistically different from zero (weak safe haven). A metal is not a safe haven if the sum of the exposure coefficients is positive and statistically significant. Thus, we focus on the statistical significance of the sum of the estimates, rather than simply the sum of the estimates, as in Baur and McDermott (2010). We take this approach to control for differences in estimation precision due to differences in the residual variances across the different bonds. It should be noted that coefficient estimates from models with high residual variances suffer from a lack of precision. Such coefficient estimates could be spurious or simply due to chance, regardless of the size and/or direction of the estimates. For these reasons, we focus on the relationships that are statistically significant.

[8] Note that Eqs.(1a), (1b) and (1c) are estimated using weekly and monthly data. Despite some quantitative differences, our final conclusions do not seem to depend on the return frequencies used in the analysis. More details on these results are available upon request.

5. Empirical results

In this section, we present the empirical results on the hedge and/or safe haven properties of precious and industrial metals against the sovereign debt price movements using both individual and portfolio approach. We also use sub-period analysis to test whether the role of metals varies across market conditions. Finally, we assess the speed at which investors recover losses from the sharp decline in bond prices and the profit (or loss) associated with holding metals jointly with sovereign bonds in the crisis periods.

5.1. Individual precious metals

Table 1 presents the estimation results for the models in Eqs.(1a), (1b) and (1c) with individual precious metals as the dependent variables in Eq.(1a). The results indicate that the values and the statistical significance of the hedging coefficients δ_0 vary considerably across bonds and precious metals. The hedging parameters δ_0 indicate that gold is a strong hedge for bonds in Belgium, Greece, Italy, the Netherlands and Portugal and a weak hedge for the rest of sovereign bonds. The statistical significance of the estimates $\square_1$, $\square_2$ and $\square_3$ in Eq.(1b) implies the presence of non-linear relationship between gold and bond returns in many cases, particularly for extreme negative shocks in the lower 10th and 5th percentiles. The safe haven property of gold, which implies that investors that hold gold receive compensation for losses caused by extreme negative bond returns through positive gold returns, seems to depend largely on the magnitude of the negative shock in the bond prices. For this, we use Wald test to investigate the statistical significance of the parameters SH_1, SH_2 and SH_3. For extreme negative bond returns in the lower 1st percentile, gold is not a safe haven for Germany and the EMU benchmark bonds as SH_1 is significantly positive in these two cases, but gold appears to be a weak safe haven for the remaining sovereign bonds. The parameters $SH_2$and SH_3 indicate that gold is mainly a weak safe haven against negative shocks in the lower 5th and 10th percentiles. It only serves as a strong safe haven for bonds in Austria, Belgium, France, Germany and the Netherlands for extreme negative returns in the lower 5th percentile and for the bond in Portugal for negative shocks in the lower 10th percentile.

The sign of the coefficients δ_0 in Table 1 suggests that bond returns are negatively related with silver returns on average and silver is, therefore, a hedge for all sovereign bonds. However, the statistical significance of these coefficients implies that the hedging ability of silver is strong only for bonds in Austria, Belgium, Germany, Italy, Netherlands and Portugal. Our results also suggest that the non-linear relationship is less (more) pronounced in case of silver than that gold for extreme shocks in the 10th and 5th (1st) percentile. The sums of the relevant exposure coefficients δ_i (SH_1, SH_2 and SH_3) imply that silver is, at best, a weak safe haven for the sovereign bonds except those of France and the Netherlands.

Similar results are also reported in the case of platinum and palladium. Specifically, the parameters δ_0 in Table 1 indicate that platinum serves as a hedge for all the sovereign bonds except Greece. The hedging ability of platinum is strong in the cases of bonds in Austria, Belgium, Finland, France, Germany and the UK and weak for the rest of the rest of the bonds. Our findings also suggest that the relationship between platinum and sovereign bonds is mainly linear and non-linearity is only detected in Portuguese bonds for extreme shocks in the lower 1st percentile. Palladium also hedges against all bonds except Greece, with hedging being strong for Austria, Germany, the EMU benchmark and UK bonds. The non-linear relationship between palladium and bond returns is detected in many markets and is more pronounced for extreme shocks in the lower 10th percentile. Platinum is at least a weak safe haven asset for all sovereign bonds, except Greece. The relevant coefficient estimates (SH_1, SH_2 and SH_3) suggest that the safe haven hypothesis in the case of palladium is supported in all markets, except Finland and Portugal in the case of extreme negative returns in the lower 5th percentile.

The above results suggest that the ability of gold to act as a hedging vehicle or a safe haven varies across sovereign bonds and price shocks. Our analysis also show that gold is not the only place for safety or refuge and in many cases other precious metals could offer similar, if not better, protection in the events of negative economic conditions.

Please Insert Table 1 About Here

5.2. Individual industrial metals

Table 2 reports the estimation results for Eqs.(1a), (1b) and (1c) for individual metals as the dependent variable in Eq.(1a). The results suggest that industrial metals offer a much stronger hedge against adverse movements in sovereign debt prices than gold or any other precious metal. The coefficient δ_0 is negative for all sovereign bonds and industrial metals used in the analysis. The magnitude of δ_0 is much larger and statistically significant for the industrial metals than the precious metals, indicating that investors receive better compensation for adverse bond price movements when holding the former than the latter. With the exception of the UK bonds in the case of aluminium and Greek bonds in cases of lead, nickel and zinc, the parameter δ_0 is negative and statistically significant, indicating that industrial metals offer a strong hedge against the adverse movements in the sovereign bond prices.

Please Insert Table 2 About Here

The coefficients $\square_i$ (for i = 1, 2, 3) are significant in many cases, indicating the presence of non-linear relationship between industrial metals and bond returns. The results of the Wald test on SH_1, SH_2 and SH_3 suggest that the safe haven property of industrial metal tends to be stronger than that of precious metals. Apart from Greece and Portugal in the case of Aluminium and Copper, and Finland, Portugal and Spain in the case of Nickel, the individual industrial metals do offer at least a weak safe haven to the sovereign bonds.

Overall, the industrial metals seem to outperform precious metals as hedging vehicles and safe haven assets against losses in the sovereign debt markets.

5.3. The portfolio approach

Table 3 shows the estimates of Eqs.(1a), (1b) and (1c) using equally weighted portfolios of precious metals, industrial metals and all metals as the dependent variable in Eq.(1a), respectively. The purpose of this analysis is to investigate whether investors gain better protection against the adverse movements in the sovereign bonds by holding portfolios rather than individual metals. The coefficient δ_0 in Table 3 implies that the hedging power of the metal portfolio varies considerably across bonds. Specifically, the portfolio of precious metals serves as a strong hedge for bonds in Austria, Belgium, France, Italy, Portugal, the EMU and the UK and a weak hedge for the remaining sovereign bonds. However, the values of δ_0 are negative and statistically significant for all sovereign bonds in the case of both industrial metals and all metals portfolios. We also show that portfolio of industrial metals contains the largest (negative) and highest significant hedging coefficients, δ_0. This result implies that the portfolio of industrial metals outperforms both the portfolio of precious metals and that of all metals in its hedging ability against adverse movements in sovereign bonds. However, some individual industrial metals, such as copper, seem to provide a stronger hedge against all bonds than any of the three portfolios.

Please Insert Table 3 About Here

Table 3 also reports the coefficients $\square_i$ (i = 1, 2, 3) on the dummy variables in Eq.(1b). The results suggest that the non-linear relationship between metals and bonds is more pronounced for industrial metals than precious ones. The parameters SH_1, SH_2 and SH_3 in

Table 3 suggests that the portfolio of precious metals serves a strong safe haven only for Italian bonds for shocks in the lower 1th and 10th percentiles. The portfolio of industrial metals serves as strong safe haven for bonds in Germany, the Netherland and the EMU in the case of negative shocks in the lower 1st percentile and for bonds in the Netherlands, the UK and the US for negative bond returns in the lower 10th percentile. The safe haven property of the portfolio of all metals is shown to be strong only for bonds in the Netherlands and the US for negative bond returns in the lower 5th and 10th percentiles, respectively. Our results, therefore, suggest that industrial metals offer a better protection against the deterioration of the sovereign debt quality than the precious metals.

5.4 Sub-period analysis

To gain a further insight on whether metals protect investors' wealth against the stormy weather, we divide our sample period into three sub-periods, July 1993 to December 2000, January 2001 to December 2006 and January 2007 to June 2012. The last sub-period includes the global financial crisis, which originated as the subprime crisis in 2007 and peaked in September 2008, and the on-going European debt crisis.

Table 4 presents the estimates of Eqs. (1a), (1b) and (1c) for individual precious metals. The exposure estimates δ_0 suggest that the hedging power of precious metals is time varying. The results in Panel A of Table 4 suggest that gold and silver serve as a strong hedge in more markets in the period 1993-2000 than the other two sub-periods. In the period 2001-2006 (see Panel B), the statistical significance of the hedging coefficients disappears almost completely in the cases of gold, silver and platinum, suggesting that these instruments offer only a weak hedge against the adverse movements in the sovereign bond prices. During the same period, palladium serves as a weak hedge for only the US sovereign bond, but does not compensate investors for the adverse bond price movements in other markets. In the period 2007-2012 (see Panel C), gold offers a strong hedge for bonds in Greece, Italy, Portugal and Spain, a weak hedge for bonds in Austria, Belgium, France, the UK and the US and a no hedge for bonds in Finland, Germany and the EMU. The significantly positive comovement between gold and the German bond could also suggest that investors viewed the two as substitutes in their flight to safety following the euro debt crises. Silver's hedging coefficients are mainly negative, but not statistically different from zero, indicating that this metal serves as a weak hedge against losses in the sovereign bond markets. Platinum exhibits significantly positive comovements with bonds in Greece and Spain, but hedges against losses in the rest of the markets (the hedge is strong in Finland, Germany, Netherland, the EMU and the UK, but weak in Austria, Belgium, Italy and the US). Palladium serves as a hedge in all markets, with the hedge being strong in 8 out of the 13 bonds included in the analysis. Thus, palladium outperforms other precious metals in its ability to hedge against the deterioration in the credit quality of sovereign bonds in the period 2007-2012.

Please Insert Table 4 About Here

The results in Table 4 also suggest that the safe haven properties of the precious metals vary over time. In the period 1993-2001 (see Panel A), the safe haven test indicates that gold is largely a weak safe haven with the exception of Greece. In the period 2001-2006 (see Panel B), gold is a strong safe haven for bonds in Finland, France, Germany, Greece, Netherlands, Portugal and the EMU benchmark bond for negative shocks in the lower 5th percentile. Besides gold, palladium also offered some safe haven protection for some bonds during the period. These include Germany, Greece, the UK and the US. Silver and platinum are at best weak safe havens during this period as the safe haven tests are largely not significantly different from zero. In the period 2007-2012 (see Panel C), gold offers a safe haven against Italian and Portuguese bonds. However, we also find a strong comovement between gold and UK, Germany and the EMU benchmark bonds. Thus gold is no safe haven for German and UK bonds. The a strong comovement between gold and the UK and German bonds is consistent with the "flight to safety" argument, and that investors may view high quality bonds, such as the UK and German bonds, and gold as substitutes in protecting themselves against lower quality bonds. Palladium also serves as a strong safe haven against extreme negative shocks in six out of the 13 bonds. For shocks in the lower 1st percentile, palladium offers a safe haven for the bonds in Finland, Germany, Italy, Netherlands, Portugal and the EMU benchmark bond and a weak safe haven for the remaining bonds. Thus, in this period palladium offers greater protection in more markets than the other precious metals.

Table 5 reports the results of the sub-period analysis for the industrial metals. The results show that the time variation in the hedging power is less pronounced for industrial than precious metals. The hedging parameters δ_0 suggest that industrial metals serve at least as a weak hedge. Our results also suggest that copper is the strongest hedging assets and investors are more likely to be protected from losses in the bond markets by holding industrial rather than precious metals. In the period 1993-2000 (see Panel A), industrial metals mainly serve as a weak safe haven against different categories of extreme negative bond returns. However, as shown in panel B, the sums of the relevant exposure coefficients are significantly negative almost across all the bonds for shocks in the lower 10th percentile, during the period 2001-2006. This finding suggests that industrial metals serve as a strong safe haven against extreme bond price fluctuations during this period. In the period 2007-2012 (see panel C), the statistical significance of the safe haven parameters associated with the industrial metals disappears in most cases. However, some industrial metals, particularly copper and lead, still serve as a strong safe haven in more cases than gold. Overall, the safe haven properties of some lesser known metals, such as palladium, copper and lead are much better than those of the popular metals such as gold, silver and aluminium.

Please Insert Table 5 and 6 About Here

Table 6 presents the results of the sub-period analysis for the various portfolios of metals. As portfolios, industrial metals serve as a stronger hedge for more markets than precious metals. The portfolio of industrial metals is a strong safe haven in all the markets but the US in the period 2001-06 but largely a weak safe haven in the later period 2007-12. On the other hand, the portfolio is only a weak safe haven in both periods. Thus, in general, the portfolio of industrial metals provides a better protection for investors' losses in the sovereign bond market, particularly in periods of high bond market turmoil than the portfolio of precious metals.

5.5 The post-shock performance

The dummy coefficients in Eq.(1b) focus on the correlation between bonds and metals on the day of the shock and does not tell us anything about the post-shock performance of these assets. This section analyses the average cumulative returns of portfolios comprising of individual sovereign bonds and the individual metals over a period of 20 trading days (approximately one calendar month) following extreme negative bond returns. The analysis sheds some light on the speed at which investors recover losses from declining bond prices and the profit (or loss) associated with holding metals with sovereign bonds in the crisis periods.

To save space, we only report the average cumulative returns of the equally weighted portfolios of the bonds with the various metals following extreme negative bond returns in the lower 5th percentile, and for the cases of the EMU benchmark, the UK and the US bonds[9]. Figure 2 shows the average cumulative returns of portfolios consisting of individual sovereign bonds and metals. It shows that palladium consistently outperforms gold and other precious metals in its ability to compensate investors for losses in the sovereign bond markets. Investors

[9] Despite some quantitative differences, our conclusions remain largely valid for other sovereign bonds and negative shocks in the lower 10th and 1st percentiles. The details of this further analysis are available upon request.

who hold gold, silver, platinum and palladium, respectively, with the EMU sovereign bonds enjoy their first positive returns of 0.09%, 0.1%, 0.05% and 0.03% in about 15, 13, 13 and 9 days following extreme negative shocks in the lower 5^{th} percentile. Similar findings are reported when individual precious metals are held with the UK or the US sovereign bonds. Specifically, while the returns associated with a portfolio of palladium and UK sovereign bond begin to turn positive 8 days after extreme shocks, the portfolio that includes silver turns positive after 19 days. The other two portfolios comprising the UK sovereign bond and gold or silver remain negative throughout the post-shock period covered in the analysis. Figure 2 also shows that investors in the US sovereign bonds recover their losses from extreme negative price movements more quickly by holding palladium than any other precious metals. In short, our results palladium (gold) offers investors the highest (lowest) compensation for their losses in the sovereign bond market.

Please Insert Figures 2, 3 and 4 About Here

Figure 3 presents the average cumulative returns of portfolios consisting of individual bonds and industrial metals over a period of 20 trading days subsequent to extreme negative bond returns in the lower 5^{th} percentile. The figure shows that copper generates higher post-shock returns than any other industrial metals. It also shows investors recover their bond market losses more quickly by holding copper with their sovereign bonds. The results in Figures 2 and 3 also imply that copper is the best metal to be held with the US sovereign bond and it generates higher returns than palladium, the best performing precious metal, in the first 8 and 10 days following extreme negative shocks in EMU and the UK sovereign bonds, respectively. Figure 4 implies that metals seem to offer better protection against the adverse movements in the bond prices when held individually than as a portfolio. It also shows that the portfolio of precious metals outperform (underperform) that of industrial metals after extreme negative shocks in the EMU and the UK (the US) sovereign bonds.

Overall, this analysis suggests that i) metals offer a better protection against the negative movements in the sovereign bond market when held individually than as portfolios; ii) all precious metals and many industrial metals outperform gold in its ability to protect investors against losses in the sovereign debt market; and iii) copper (palladium) is the best performing (precious) metal in the period immediately after negative bond price shocks.

6. Conclusion

This study provides new evidence on the role of precious and industrial metals as hedging vehicles and safe heaven assets. In particular we document that gold is a strong hedge for sovereign bonds of countries with serious debt issues (i.e. Greece, Italy and Portugal). The safe heaven property of gold depends on the magnitude of the extreme negative bond price movement. Importantly, gold is not the only place of safety and it is worth it for individual and financial institutions investing in other precious and industrial metals in the event of negative economic conditions. This translates that industrial metals offer a much stronger hedge against the adverse movements in sovereign debt prices than gold or any other precious metals. Outperformance of industrial metals is attributed to their global increasing popularity and demand as they are seen as key indicators of the health of the global economy.

In addition this study shows that portfolio of industrial metals outperform portfolio of precious metals and that of all other metals in its hedging ability against the adverse movement in sovereign bonds. In terms of sub-period analysis, there is strong evidence that industrial metals provide a better compensation for investor losses particularly in periods of high bond market turmoil. Palladium, copper and lead serve as a strong safe heaven as they are able to hedge against the deterioration in the credit quality during the recent financial crises.

In response to the issues raised in the introduction, the findings of this paper imply that: (1) gold is a good investment opportunity during financial crises periods but other precious and even more industrial metals constitute better investment alternatives; (2) investors are better off holding industrial rather than precious metals in the periods of stormy weather; (3) metals have the ability to protect investors wealth against sovereign crises. Overall, gold and the other metals provide a hedge against sovereign bonds but their safe haven properties varies across the different bonds. Thus, for investors interested in using metals as a safe haven for sovereign bonds, a tactical allocation strategy that manages the bond-metal composition may be necessary.

References

Arouri, M.E.H., J. Jouini, and D.K. Nguyen, 2011, Volatility spillovers between oil prices and stock sector returns: Implications for portfolio management *Journal of International Money and Finance* 30, 1387-1405.

Batten, J.A., C. Ciner, and B.M. Lucey, 2010, The macroeconomic determinants of volatility inpreciousmetals markets, *Resources Policy* 35, 65-71.

Baur, D.G., 2013, The autumn effect of gold, *Research in International Business and Finance* 27, 1-13.

Baur, D.G. , and T.K. McDermott, 2010, Is gold a safe haven? International evidence, *Journal of Banking and Finance* 34, 1886-1898.

Baur, D.G., and B.M. Lucey, 2010, Is gold a hedge or a safe haven? An analysis of stocks, bonds and gold, *Financial Review* 45, 217-229.

Belousova, J., Dorfleitner, G., 2012, On the diversification benefits of commodities from the perspective of euro investors, *Journal of Banking and Finance* 36, 2455-2472.

Bordo, M.D., and R. MacDonald, 2003, The inter-war gold exchange standard: Credibility and monetary independence, *Journal of International Money and Finance* 22, 1-32.

Bouman, S., and B. Jacobsen, 2002, The halloween indicator – sell in may and go away: Another puzzle, *American Economic Review* 92, 1618–1635.

Capie, F., T.C. Mills, and G. Wood, 2005, Gold as a hedge against dollar, *Journal of International Financial Markets, Institutions and Money* 15, 343-352.

Chow, G., E. Jacquier, M. Kritzman, and K. Lowry, 1999, Optimal portfolios in good and bad times., *Financial Analysts Journal* 65–73.

Chua, J.H. , G. Sick, and R.S. Woodward, 1990, Diversifying with gold stocks, *Financial Analysts Journal* 46, 76-79.

Conover, C. M., G. R. Jensen, R. R. Johnson, and J. M. Mercer, 2009, Can precious metals make your portfolio shine?, *Journal of Investing* 18, 75–86.

Daskalaki, C., and G. Skiadopoulos, 2011, Should investors include commodities in their portfolios after all? New evidence *Journal of Banking & Finance* 35, 2606-2626.

Davidson, S., R. Faff, and D. Hillier, 2003, Gold factor exposures in international asset pricing, *International Financial Markets Institutional and Money* 13, 271-289.

Draper, P., R.W. Faff, and D. Hillier, 2006, Do precious metals shine? An investment perspective, *Financial Analysts Journal* 62, 98–106.

Edwards, E.R., and M.O. Caglayan, 2001, Hedge fund and commodity investments in bull and bear markets., *Journal of Portfolio Management* 97–108.

Elder, J., H. Miao, and S. Ramchander, 2012, Impact of macroeconomic news on metal futures, *Journal of Banking & Finance* 36.

Erb, C.B., and C. Harvey, 2006, The tactical and strategic value of commodity futures, *Financial Analysts Journal* 62, 69–97.

Erb, C.B., and C.R. Harvey, 2006, The strategic and tactical value of commodity futures, *Financial Analysts Journal* 62, 69–97.

Georgiev, G., 2001, Benefits of commodity investments, *The Journal of Alternative Investments* 4, 40-48.

Gibson, R.C., 2004, The rewards of multiple-asset-class investing, *Journal of Financial Panning* 17, 58-71.

Gorton, G.B., and G.K. Rouwenhorst, 2006, Facts and fantasies about commodity futures, *Financial Analysts Journal* 62, 47–68.

Hammoudeh, S., and Y. Yuan, 2008, Metal volatility in presence of oil and interest rate shocks, *Energy Economics* 30, 606−620.

Hooker, M.A., 2002, Are oil shocks inflationary? Asymmetric and nonlinear specifications versus changes in regime, *Journal of Money Credit Banking* 34, 540–61.

Jacobsen, B. , and C.Y. Zhang, 2012, Are monthly seasonals real? A three century perspective, *Working paper, Massey University*.

Jaffe, J.F., 1989, Gold and gold stocks as investments for institutional portfolios, *Financial Analyst Journal* 45, 53-59.

jacMcCown, J.R., and J.R. Zimmerman, 2006, Is gold a zero beta asset? Analysis of the investment potential of precious metals, *working paper*.

Narayan, P. K., S. Narayan, and X. Zheng, 2010, Gold and oil futures markets: Are markets efficient?, *Applied Energy* 87, 3299-3303.

Pindyck, R.S. , and J.J. Rotember, 1990, The excess co-movement of commodity prices, *Economic Journal* 100, 1173-1189.

Roache, S.K., and M. Rossi, 2010, The effects of economic news on commodity prices: Is gold just another commodity., *The Quarterly Review of Economics and Finance* 50, 377–385.

Sari, R., S. Hammoudeh, and U. Soytas, 2010, Dynamics of oil price, precious metal prices, and exchange rate, *Energy Economics* 32, 351-362.

Wallace, M.S., and T. Choudhry, 1995, The gold standard: Perfectly integrated world markets or slow adjustment of prices and interest rates?, *Journal of International Money and Finance* 14, 349-371.

Table 1: Hedge and safe haven characteristics of precious metals – Full sample period

This table reports estimation results for the models in Eqs.(1a), (1b) and (1c) for the full sample period, with individual precious metals as the dependent variables in Eq.(1a). SH1 tests the hypothesis $\delta_0 + \delta_1 = 0$, SH2 tests the hypothesis $\delta_0 + \delta_1 + \delta_2 = 0$, SH3 tests the hypothesis $\delta_0 + \delta_1 + \delta_2 + \delta_3 = 0$.

	Gold							Silver						
Bond	δ_0	δ_1	δ_2	δ_3	**SH1**	**SH2**	**SH3**	δ_0	δ_1	δ_2	δ_3	**SH1**	**SH2**	**SH3**
Austria	0.008	0.193	-2.062***	1.917***	0.201	-1.860***	0.057	-0.207**	0.596**	-0.047	-0.281	0.389	0.342	0.061
Belgium	-0.107***	0.081	-1.902***	1.877***	-0.026	-1.929***	-0.052	-0.194**	0.376	0.165	-0.269	0.182	0.346	0.077
Finland	0.013	0.239	-0.029	-0.162	0.252	0.223	0.062	-0.070	0.456**	-0.050	-0.408*	0.386	0.336	-0.072
France	-0.055	-0.092	-1.761***	1.782***	-0.148	-1.909***	-0.126	-0.117	0.292	0.404	-0.521**	0.175	0.579**	0.058
Germany	0.019	0.184	-1.834***	1.692***	0.203*	-1.630***	0.062	-0.239***	0.115	0.052	-0.095	-0.124	-0.072	-0.167
Greece	-0.068***	0.063	-0.130	0.124	-0.005	-0.135	-0.011	0.001	0.005	0.081	-0.083	0.006	0.087	0.005
Italy	-0.141***	-0.002	-0.047	0.097	-0.143	-0.190	-0.093	-0.233***	-0.128	0.081	0.016	-0.360**	-0.279	-0.263**
Netherlands	-0.118***	0.161	-2.030***	2.063***	0.043	-1.987***	0.077	-0.110	0.656**	-0.318	-0.118	0.546*	0.228	0.110
Portugal	-0.073***	-0.076	0.174	-0.120	-0.149*	0.025	-0.095***	-0.130***	0.024	0.280	-0.233	-0.106	0.175	-0.058
Spain	-0.045	0.145	-0.111	-0.048	0.100	-0.011	-0.059	-0.058	0.007	0.383	-0.392*	-0.050	0.333	-0.059
EMU	0.110	0.336*	-0.303	-0.010	0.446**	0.143	0.133	-0.122	0.568*	-0.260	-0.111	0.446	0.186	0.075
UK	-0.025	0.130	-0.118	0.083	0.105	-0.013	0.070	-0.131*	0.490**	-0.101	-0.104	0.359	0.258	0.154
US	-0.026	0.088	0.028	-0.036	0.061	0.090	0.054	-0.008	0.171	-0.118	-0.031	0.163	0.045	0.014

	Platinum							Palladium						
Bond	δ_0	δ_1	δ_2	δ_3	**SH1**	**SH2**	**SH3**	δ_0	δ_1	δ_2	δ_3	**SH1**	**SH2**	**SH3**
Austria	-0.116*	0.202	0.258	-0.255	0.086	0.343	0.089	-0.155*	0.247	0.048	-0.505**	0.092	0.140	-0.365**
Belgium	-0.098*	0.231	-0.248	0.225	0.133	-0.115	0.110	-0.049	-0.124	0.202	-0.395*	-0.173	0.029	-0.367**
Finland	-0.106**	0.234	-0.243	0.114	0.128	-0.115	-0.001	-0.123	0.029	0.830***	-0.947***	-0.094	0.736**	-0.211
France	-0.116**	0.144	-0.088	0.121	0.028	-0.059	0.061	-0.055	-0.302	0.391	-0.530**	-0.356	0.035	-0.496***
Germany	-0.173***	0.168	-0.154	0.136	-0.005	-0.159	-0.023	-0.279***	0.064	0.304	-0.487**	-0.215	0.089	-0.398**
Greece	0.063*	-0.032	-0.019	0.065	0.030	0.011	0.076**	0.094*	-0.138	0.165	-0.089	-0.045	0.120	0.032
Italy	-0.073*	-0.063	0.004	0.013	-0.135	-0.131	-0.119	-0.006	-0.042	0.231	-0.377**	-0.048	0.183	-0.194
Netherlands	-0.079	0.168	-0.227	0.101	0.089	-0.138	-0.038	-0.137	-0.316	-0.207	-0.157	-0.453*	-0.660**	-0.817***
Portugal	-0.043	-0.195**	0.131	0.023	-0.238***	-0.107	-0.084*	0.028	0.059	0.429*	-0.519**	0.087	0.516**	-0.003
Spain	0.027	-0.038	0.111	-0.161	-0.011	0.100	-0.061	-0.006	-0.439**	0.715***	-0.448**	-0.446**	0.269	-0.178
EMU	-0.104	0.365	-0.238	0.099	0.261	0.023	0.122	-0.323***	0.653*	0.097	-0.410	0.330	0.426	0.016
UK	-0.113**	0.057	-0.056	0.078	-0.056	-0.112	-0.034	-0.173**	0.142	-0.360	0.101	-0.031	-0.391	-0.290
US	-0.017	-0.072	-0.056	0.065	-0.090	-0.146	-0.081	-0.079	0.348*	-0.634***	0.187	0.268	-0.365	-0.178

***, **, * represent significance of the estimates at the 1%, 5% and 10% level, respectively.

Table 2: Hedge and safe haven characteristics of industrial metals – Full sample period

This table reports estimation results for the models in Eqs.(1a), (1b) and (1c) for the full sample period, with individual industrial metals as the dependent variables in Eq.(1a). SH1 tests the hypothesis $\delta_0 + \delta_1 = 0$, SH2 tests the hypothesis $\delta_0 + \delta_1 + \delta_2 = 0$, SH3 tests the hypothesis $\delta_0 + \delta_1 + \delta_2 + \delta_3 = 0$.

	Aluminium							Copper						
Bond	δ_0	δ_1	δ_2	δ_3	**SH1**	**SH2**	**SH3**	δ_0	δ_1	δ_2	δ_3	**SH1**	**SH2**	**SH3**
Austria	-0.460***	0.214	0.136	-0.014	-0.246	-0.110	-0.124	-0.771***	0.485**	0.570**	-0.311	-0.286	0.283	-0.028
Belgium	-0.387***	0.207	0.208	-0.065	-0.180	0.028	-0.037	-0.602***	0.335	0.245	-0.066	-0.268	-0.022	-0.088
Finland	-0.357***	0.335**	0.101	-0.009	-0.022	0.079	0.070	-0.680***	0.588***	0.389	-0.110	-0.091	0.297	0.187
France	-0.263***	0.293*	0.009	-0.165	0.030	0.039	-0.127	-0.586***	0.215	0.181	0.011	-0.370	-0.189	-0.178
Germany	-0.435***	0.216	0.130	-0.006	-0.219	-0.088	-0.094	-0.872***	0.100	0.698***	-0.130	-0.772***	-0.074	-0.204
Greece	-0.072***	0.037	0.422***	-0.360***	-0.035	0.387***	0.027	-0.069***	-0.069	0.521***	-0.336**	-0.138*	0.383**	0.047
Italy	-0.207***	0.168	-0.134	0.231*	-0.039	-0.173	0.059	-0.396***	0.288	0.189	0.127	-0.109	0.081	0.207*
Netherlands	-0.367***	0.150	-0.175	0.122	-0.216	-0.392*	-0.269**	-0.828***	0.254	0.026	0.221	-0.574**	-0.548*	-0.327
Portugal	-0.129***	0.203**	0.290*	-0.358***	0.075	0.365**	0.007	-0.168***	0.199	0.292	-0.310*	0.032	0.324*	0.014
Spain	-0.237***	0.385***	0.096	-0.188	0.148	0.244	0.056	-0.405***	0.384*	0.414*	-0.342*	-0.021	0.393	0.051
EMU	-0.474***	0.389*	0.323	-0.323*	-0.085	0.238	-0.085	-1.092***	0.055	0.701**	-0.238	-1.036***	-0.336	-0.574***
UK	-0.080	-0.059	0.270	-0.304**	-0.139	0.131	-0.173*	-0.421***	0.306	0.421**	-0.288	-0.115	0.307	0.019
US	-0.169***	0.049	-0.001	-0.051	-0.120	-0.121	-0.172**	-0.392***	0.253*	-0.150	0.023	-0.139	-0.290	-0.267**

	Lead							Nickel						
Bond	δ_0	δ_1	δ_2	δ_3	**SH1**	**SH2**	**SH3**	δ_0	δ_1	δ_2	δ_3	**SH1**	**SH2**	**SH3**
Austria	-0.680***	0.572**	0.269	-0.030	-0.108	0.161	0.131	-0.821***	0.773***	0.196	0.078	-0.049	0.148	0.225
Belgium	-0.522***	0.418	0.397	-0.078	-0.104	0.293	0.215	-0.502***	0.552*	0.198	-0.060	0.050	0.248	0.188
Finland	-0.701***	0.504**	0.093	0.309	-0.198	-0.105	0.204	-0.597***	0.941***	-0.044	0.073	0.344	0.300	0.374**
France	-0.492***	0.305	0.370	-0.142	-0.187	0.183	0.041	-0.538***	0.299	-0.242	0.326	-0.239	-0.481	-0.155
Germany	-0.763***	0.296	0.541*	-0.066	-0.467	0.074	0.008	-0.820***	0.404	0.556*	-0.039	-0.415	0.140	0.101
Greece	-0.056	0.028	0.210	-0.142	-0.028	0.182	0.040	-0.028	0.152	0.171	-0.220	0.124	0.296	0.076
Italy	-0.348***	0.365*	-0.221	0.361	0.017	-0.204	0.157	-0.298***	0.251	0.067	0.141	-0.047	0.019	0.160
Netherlands	-0.824***	0.329	0.151	0.262	-0.494*	-0.343	-0.082	-0.738***	0.381	-0.390	0.442	-0.357	-0.747*	-0.305
Portugal	-0.199***	0.166	0.312	-0.259	-0.033	0.278	0.019	-0.138**	0.267	0.388	-0.428*	0.129	0.517**	0.090
Spain	-0.433***	0.467*	0.264	-0.087	0.034	0.298	0.211	-0.295***	0.423	0.980***	-0.862***	0.127	1.107***	0.245
EMU	-0.979***	0.241	0.525	-0.045	-0.739**	-0.214	-0.259	-0.988***	0.265	0.249	-0.123	-0.723	-0.474	-0.597
UK	-0.335***	-0.104	0.464*	-0.252	-0.439*	0.026	-0.226	-0.246**	0.010	0.239	-0.248	-0.236	0.004	-0.245
US	-0.372***	-0.079	0.016	0.109	-0.451**	-0.436**	-0.327**	-0.347***	-0.003	-0.219	-0.023	-0.350*	-0.569**	-0.591***

Table 2 cont'd

	Tin							Zinc						
Bond	δ_0	δ_1	δ_2	δ_3	**SH1**	**SH2**	**SH3**	δ_0	δ_1	δ_2	δ_3	**SH1**	**SH2**	**SH3**
Austria	-0.607***	0.401**	0.396	0.054	-0.206	0.190	0.244	-0.599***	0.844***	-0.028	0.043	0.245	0.217	0.259*
Belgium	-0.483***	-0.054	0.470*	0.014	-0.537**	-0.067	-0.054	-0.419***	0.185	0.330	-0.032	-0.234	0.096	0.065
Finland	-0.501***	0.342*	0.186	0.177	-0.159	0.027	0.205	-0.494***	0.578***	0.380	-0.140	0.083	0.463*	0.323**
France	-0.366***	0.359	-0.276	0.325	-0.007	-0.283	0.042	-0.391***	0.389*	-0.081	0.158	-0.002	-0.082	0.076
Germany	-0.626***	0.228	0.341	0.142	-0.398*	-0.057	0.085	-0.664***	0.521***	0.239	0.068	-0.143	0.096	0.164
Greece	-0.067*	0.023	0.243	-0.184	-0.045	0.198	0.014	-0.043	0.071	0.251	-0.263	0.028	0.280	0.016
Italy	-0.294***	0.145	-0.026	0.337*	-0.149	-0.175	0.162	-0.261***	0.152	0.298	0.039	-0.110	0.188	0.227**
Netherlands	-0.458***	0.050	0.184	-0.035	-0.408*	-0.224	-0.259	-0.571***	0.514**	-0.068	0.131	-0.058	-0.125	0.005
Portugal	-0.168***	-0.079	0.179	0.021	-0.247*	-0.068	-0.047	-0.159***	-0.030	0.566***	-0.332*	-0.188	0.378**	0.046
Spain	-0.349***	0.338*	0.348*	-0.163	-0.010	0.338	0.175	-0.294***	0.447**	0.391*	-0.326*	0.153	0.544**	0.217
EMU	-0.849***	0.028	0.377	0.134	-0.821**	-0.444	-0.310	-0.943***	0.355	0.174	0.031	-0.587*	-0.413	-0.382*
UK	-0.111*	-0.141	0.297	-0.262	-0.253	0.044	-0.218	-0.250***	0.030	0.590***	-0.480***	-0.220	0.370*	-0.110
US	-0.133***	0.058	0.154	-0.295*	-0.075	0.079	-0.216**	-0.320***	0.086	-0.126	0.090	-0.234	-0.360**	-0.270***

***, **, * represent significance of the estimates at the 1%, 5% and 10% level, respectively.

Table 3: Hedge and safe haven characteristics of portfolio of metals – Full sample period

This table reports estimation results for the models in Eqs.(1a), (1b) and (1c) for the full sample period, with portfolio of metals as the dependent variables in Eq.(1a). SH1 tests the hypothesis $\delta_0 + \delta_1 = 0$, SH2 tests the hypothesis $\delta_0 + \delta_1 + \delta_2 = 0$, SH3 tests the hypothesis $\delta_0 + \delta_1 + \delta_2 + \delta_3 = 0$.

	Portfolio of Industrial Metals						
Bond	δ_0	δ_1	δ_2	δ_3	**SH1**	**SH2**	**SH3**
Austria	-0.660***	0.574***	0.260	-0.049	-0.086	0.174	0.125
Belgium	-0.477***	0.280	0.347*	-0.120	-0.197	0.150	0.030
Finland	-0.575***	0.567***	0.186	0.034	-0.007	0.179	0.213**
France	-0.428***	0.299	0.083	-0.027	-0.129	-0.046	-0.073
Germany	-0.709***	0.296*	0.468**	-0.034	-0.413**	0.055	0.020
Greece	-0.054*	0.025	0.292**	-0.224	-0.029	0.262*	0.039
Italy	-0.291***	0.248*	0.023	0.184	-0.043	-0.020	0.164
Netherlands	-0.639***	0.242	0.017	0.137	-0.397**	-0.380	-0.244*
Portugal	-0.151***	0.134	0.337**	-0.294**	-0.016	0.321**	0.027
Spain	-0.328***	0.463***	0.402**	-0.355**	0.135	0.537***	0.182
EMU	-0.879***	0.202	0.419*	-0.096	-0.678***	-0.259	-0.355*
UK	-0.244***	0.008	0.366**	-0.289**	-0.235	0.131	-0.159
US	-0.266***	0.107	-0.020	-0.085	-0.159	-0.179	-0.264***

	Portfolio of Precious Metals						
Bond	δ_0	δ_1	δ_2	δ_3	**SH1**	**SH2**	**SH3**
Austria	-0.127**	0.362**	0.038	-0.252	0.235	0.273	0.021
Belgium	-0.112**	0.138	0.014	-0.073	0.026	0.040	-0.034
Finland	-0.050	0.266*	0.026	-0.296**	0.216	0.243	-0.054
France	-0.083*	-0.007	0.147	-0.187	-0.090	0.057	-0.130
Germany	-0.160***	0.128	0.022	-0.103	-0.032	-0.010	-0.113
Greece	0.020	-0.012	0.033	-0.018	0.008	0.041	0.023
Italy	-0.110***	-0.091	-0.007	0.031	-0.201*	-0.209	-0.177**
Netherlands	-0.077	0.214	-0.278	0.045	0.137	-0.141	-0.096
Portugal	-0.070**	-0.033	0.181	-0.118	-0.103	0.078	-0.040
Spain	-0.018	-0.096	0.280*	-0.249*	-0.114	0.166	-0.083
EMU	-0.106*	0.462**	-0.167	-0.072	0.356	0.189	0.118
UK	-0.092*	0.172	-0.130	0.027	0.080	-0.051	-0.024
US	0.021	0.040	-0.139	0.002	0.061	-0.078	-0.077

	Portfolio of Industrial and Precious Metals						
Bond	δ_0	δ_1	δ_2	δ_3	**SH1**	**SH2**	**SH3**
Austria	-0.463***	0.508***	0.149	-0.080	0.045	0.195	0.115
Belgium	-0.360***	0.261*	0.170	-0.032	-0.099	0.071	0.038
Finland	-0.363***	0.448***	0.170	-0.126	0.085	0.254	0.129
France	-0.291***	0.204	0.104	-0.069	-0.086	0.017	-0.052
Germany	-0.491***	0.329***	0.252	-0.041	-0.162	0.090	0.049
Greece	-0.038*	0.001	0.233**	-0.172*	-0.037	0.196*	0.024
Italy	-0.218***	0.128	0.057	0.086	-0.090	-0.033	0.053
Netherlands	-0.429***	0.212	-0.106	0.160	-0.216	-0.322*	-0.162
Portugal	-0.140***	0.063	0.309***	-0.223**	-0.078	0.231**	0.008
Spain	-0.224***	0.295**	0.335**	-0.275**	0.070	0.406***	0.131
EMU	-0.581***	0.333**	0.187	-0.106	-0.247	-0.061	-0.167
UK	-0.184***	0.095	0.137	-0.130	-0.089	0.048	-0.082
US	-0.159***	0.065	0.000	-0.088	-0.095	-0.094	-0.182***

***, **, * represent significance of the estimates at the 1%, 5% and 10% level, respectively.

Table 4: Hedge and safe haven characteristics of precious metals – sub period analysis

This table reports estimation results for the models in Eqs.(1a), (1b) and (1c) for the three sub-periods, with individual precious metals as the dependent variables in Eq.(1a). SH1 tests the hypothesis $\delta_0 + \delta_1 = 0$, SH2 tests the hypothesis $\delta_0 + \delta_1 + \delta_2 = 0$, SH3 tests the hypothesis $\delta_0 + \delta_1 + \delta_2 + \delta_3 = 0$. Panel A presents results for the period July 1993 to December 2000, Panel B presents results for the period January 2001 to December 2006 and Panel C presents results for the period January 2007 to June 2012.

Panel A: July 1993 to December 2000

	Gold							Silver						
Bond	δ_0	δ_1	δ_2	δ_3	**SH1**	**SH2**	**SH3**	δ_0	δ_1	δ_2	δ_3	**SH1**	**SH2**	**SH3**
Austria	-0.096*	0.043	0.142	-0.025	-0.053	0.089	0.063	-0.542***	0.165	0.254	-0.133	-0.377	-0.123	-0.256
Belgium	-0.122**	0.138	0.090	-0.008	0.015	0.105	0.098	-0.476***	0.680*	-0.366	0.294	0.204	-0.161	0.133
Finland	-0.090**	0.097	0.219*	-0.167	0.007	0.226	0.059	-0.134	0.077	0.622*	-0.730**	-0.056	0.566	-0.164
France	-0.111**	0.009	-0.098	0.089	-0.102	-0.199	-0.111	-0.203*	0.509	0.291	-0.455	0.305	0.596	0.141
Germany	-0.109**	0.209	-0.041	0.016	0.100	0.059	0.075	-0.604***	0.118	-0.027	0.334	-0.486	-0.513	-0.179
Greece	-0.439	1.277***	1.434**	-0.810	0.838	2.272***	1.462***	-0.799***	-0.111	-0.570	1.941***	-0.911	-1.481*	0.460
Italy	-0.093**	0.022	-0.060	0.070	-0.071	-0.130	-0.061	-0.395***	0.038	-0.311	0.430	-0.357	-0.668**	-0.238
Netherlands	-0.165***	0.161	-0.156	0.212	-0.003	-0.159	0.052	-0.257*	0.791*	-0.245	-0.147	0.533	0.288	0.141
Portugal	-0.082*	-0.099	0.155	-0.037	-0.181	-0.026	-0.063	-0.375***	-0.021	0.259	-0.110	-0.397	-0.138	-0.248*
Spain	0.055	0.020	0.165	-0.271**	0.075	0.239*	-0.031	-0.151	-0.396	0.710**	-0.480	-0.547*	0.162	-0.318
EMU	-0.988***	0.795	-0.568*	0.556	-0.193	-0.761	-0.205	-0.998***	0.666	-1.006**	1.464***	-0.332	-1.338	0.127
UK	-0.045	-0.127	-0.094	0.149	-0.172	-0.266*	-0.116	-0.236**	0.254	0.029	-0.105	0.018	0.047	-0.058
US	-0.083**	0.122	-0.242**	0.078	0.038	-0.204	-0.126	-0.049	-0.058	-0.195	-0.110	-0.106	-0.301	-0.411

	Platinum							Palladium						
Bond	δ_0	δ_1	δ_2	δ_3	**SH1**	**SH2**	**SH3**	δ_0	δ_1	δ_2	δ_3	**SH1**	**SH2**	**SH3**
Austria	-0.197**	0.113	0.333	-0.280	-0.084	0.249	-0.030	-0.198	0.225	-0.469	0.202	0.027	-0.442	-0.240
Belgium	-0.198**	0.338	-0.210	0.147	0.140	-0.070	0.077	-0.148	0.233	-0.141	-0.054	0.085	-0.057	-0.111
Finland	-0.058	0.230	-0.048	-0.137	0.173	0.125	-0.012	-0.073	-0.125	0.990***	-0.909***	-0.198	0.792***	-0.118
France	-0.112*	0.035	0.042	-0.017	-0.078	-0.035	-0.052	-0.038	0.023	0.187	-0.337	-0.015	0.172	-0.165
Germany	-0.206**	0.401*	-0.274	0.109	0.195	-0.079	0.030	-0.185	0.031	0.202	-0.258	-0.154	0.048	-0.210
Greece	0.099	1.263	0.556	-0.629	1.361	1.917	1.288	0.306	1.587**	0.574	-1.455*	1.893**	2.466**	1.011
Italy	-0.145***	0.079	-0.144	0.062	-0.065	-0.209	-0.147	-0.117	0.011	-0.212	0.092	-0.106	-0.319	-0.226
Netherlands	-0.017	0.144	-0.030	-0.214	0.127	0.096	-0.117	-0.057	-0.052	-0.380	0.027	-0.110	-0.490	-0.463*
Portugal	-0.106	-0.202	0.174	-0.036	-0.308	-0.135	-0.170	-0.148	-0.027	0.142	-0.030	-0.174	-0.033	-0.063
Spain	0.010	-0.132	0.398*	-0.492***	-0.122	0.275	-0.217*	-0.203*	-0.499**	0.386	0.059	-0.701***	-0.315	-0.256
EMU	-0.258	1.120*	-0.535	0.201	0.863	0.328	0.529	-0.127	0.966	0.427	-0.097	0.838	1.265	1.167
UK	-0.087	0.058	-0.109	0.039	-0.029	-0.138	-0.098	-0.056	0.017	-0.479*	0.283	-0.039	-0.518	-0.235
US	0.005	-0.021	-0.199	0.127	-0.015	-0.215	-0.088	-0.004	0.097	-0.707**	0.521*	0.092	-0.614	-0.094

Table 4 cont'd

Panel B: January 2001 to December 2006

	Gold							Silver						
Bond	δ_0	δ_1	δ_2	δ_3	**SH1**	**SH2**	**SH3**	δ_0	δ_1	δ_2	δ_3	**SH1**	**SH2**	**SH3**
Austria	-0.134	0.138	-1.036	0.750	0.004	-1.032	-0.282	0.015	0.676	-0.565	0.089	0.691	0.126	0.215
Belgium	-0.004	0.313	-1.430	0.937	0.309	-1.121	-0.184	0.032	0.498	-0.362	-0.053	0.530	0.169	0.116
Finland	-0.150	0.318	-4.245***	3.891***	0.168	-4.077***	-0.187	0.025	0.804*	-0.779	0.162	0.829*	0.050	0.213
France	-0.026	0.171	-3.883***	3.464***	0.145	-3.737***	-0.274	0.040	0.679	-0.425	-0.123	0.718	0.293	0.170
Germany	-0.170	0.750	-4.238***	3.567***	0.580	-3.659***	-0.091	0.006	0.490	-0.494	0.154	0.496	0.003	0.157
Greece	-0.067	0.261	-3.672***	3.221***	0.194	-3.478***	-0.257	0.019	0.868*	-0.520	-0.167	0.887*	0.367	0.200
Italy	0.211	0.395	-0.690	-0.288	0.606	-0.083	-0.372	-0.124	0.311	-0.407	0.083	0.187	-0.220	-0.136
Netherlands	-0.005	0.331	-3.472***	2.984***	0.326	-3.146***	-0.161	0.016	0.660	-0.551	0.057	0.676	0.125	0.182
Portugal	0.047	0.132	-3.969***	3.462***	0.179	-3.790***	-0.328	-0.023	0.635	-0.674	0.291	0.612	-0.062	0.229
Spain	-0.017	0.220	-1.293	0.820	0.204	-1.090	-0.270	-0.009	0.550	-0.575	0.183	0.541	-0.034	0.149
EMU	-0.019	0.153	-4.421***	4.051***	0.134	-4.287***	-0.236	0.020	0.508	-0.472	0.096	0.528	0.057	0.153
UK	0.004	0.064	-0.237	0.089	0.067	-0.170	-0.081	0.077	-0.037	0.049	-0.029	0.040	0.088	0.059
US	0.148**	-0.011	0.087	0.117	0.136	0.223	0.340***	0.076	0.299	-0.331	0.272	0.375	0.044	0.315**

	Platinum							Palladium						
Bond	δ_0	δ_1	δ_2	δ_3	**SH1**	**SH2**	**SH3**	δ_0	δ_1	δ_2	δ_3	**SH1**	**SH2**	**SH3**
Austria	0.067	0.017	-0.107	-0.092	0.084	-0.023	-0.115	0.641***	0.151	-1.903**	0.553	0.792	-1.111	-0.558
Belgium	0.023	-0.063	-0.648	0.485	-0.040	-0.688	-0.203	0.637***	0.316	-2.028***	0.531	0.953	-1.075	-0.543
Finland	0.049	-0.047	-0.442	0.286	0.003	-0.439	-0.153	0.734***	-0.044	-1.295	0.096	0.690	-0.605	-0.509
France	0.021	-0.192	-0.392	0.304	-0.171	-0.563	-0.259	0.674***	-0.250	-1.148	0.094	0.424	-0.724	-0.631
Germany	0.006	-0.173	-0.551	0.534	-0.167	-0.719	-0.185	0.586***	-0.485	-1.806**	0.694	0.102	-1.704*	-1.010***
Greece	0.036	0.049	-0.740*	0.504	0.085	-0.655	-0.151	0.698***	0.353	-2.566***	1.012	1.050	-1.515*	-0.503
Italy	0.119	-0.321	-0.130	-0.050	-0.202	-0.332	-0.383	0.742***	0.163	-1.031	-0.347	0.905	-0.126	-0.473
Netherlands	0.008	-0.101	-0.598	0.509	-0.093	-0.691	-0.182	0.631***	0.633	-2.467***	1.069	1.264*	-1.203	-0.134
Portugal	0.038	-0.130	-0.370	0.245	-0.092	-0.462	-0.217	0.774***	1.103	-1.917**	0.136	1.876**	-0.041	0.095
Spain	0.040	-0.275	-0.087	0.103	-0.235	-0.321	-0.219	0.607***	-0.102	-1.344	0.268	0.505	-0.839	-0.571
EMU	0.007	-0.121	-0.725*	0.654*	-0.114	-0.840	-0.186	0.595***	-0.407	-2.043**	0.846	0.188	-1.855**	-1.009***
UK	-0.020	-0.825*	0.046	0.277	-0.845*	-0.799	-0.522	0.358*	-0.069	-1.213*	0.258	0.289	-0.924	-0.666*
US	-0.040	0.085	-0.369*	0.204	0.045	-0.324	-0.121	0.208	-0.465	-0.293	-0.207	-0.257	-0.549	-0.756***

Table 4 cont'd

Panel C: January 2007 to June 2012

	Gold							Silver						
Bond	δ_0	δ_1	δ_2	δ_3	**SH1**	**SH2**	**SH3**	δ_0	δ_1	δ_2	δ_3	**SH1**	**SH2**	**SH3**
Austria	0.099	0.093	-0.227	0.014	0.192	-0.035	-0.021	-0.064	1.495**	0.806	-1.156**	1.431**	2.238***	1.082*
Belgium	-0.106	-0.214	0.222	-0.026	-0.320	-0.098	-0.124	-0.136	-0.231	0.691	-0.397	-0.367	0.324	-0.073
Finland	0.255**	-0.417	-0.267	0.089	-0.162	-0.429	-0.341	-0.173	-0.708	-0.642	0.375	-0.881	-1.523**	-1.148**
France	0.072	0.068	-0.364	0.261	0.140	-0.223	0.038	-0.194	0.567	0.462	-0.344	0.374	0.835	0.492
Germany	0.294***	0.525	-0.316	0.034	0.820**	0.504	0.538**	-0.180	0.730	-0.362	0.043	0.550	0.188	0.231
Greece	-0.030**	0.156***	-0.065	-0.058	0.126**	0.061	0.003	0.014	0.123	-0.167	0.058	0.137	-0.030	0.028
Italy	-0.129**	-0.474**	0.191	0.052	-0.602***	-0.411	-0.360**	-0.054	-0.626	-0.296	0.498	-0.680	-0.975	-0.477
Netherlands	0.252**	-0.083	-0.259	0.132	0.169	-0.090	0.042	-0.061	0.336	-0.289	0.014	0.275	-0.014	0.001
Portugal	-0.073**	-0.203**	-0.069	0.188	-0.276***	-0.346**	-0.157***	-0.071	-0.137	-0.363	0.471*	-0.207	-0.570*	-0.099
Spain	-0.106*	0.281*	-0.220	-0.012	0.175	-0.045	-0.057	-0.005	-0.008	-0.005	0.023	-0.012	-0.017	0.006
EMU	0.294***	0.525	-0.315	0.034	0.819**	0.504	0.538**	-0.178	0.729	-0.362	0.042	0.551	0.189	0.231
UK	0.108	1.098**	0.005	-0.120	1.207***	1.212**	1.092**	-0.119	1.918**	0.461	-0.687	1.799**	2.260***	1.574**
US	-0.018	0.112	-0.193	0.159	0.094	-0.099	0.060	-0.155	-0.589	-0.154	0.294	-0.744	-0.898	-0.604

	Platinum							Palladium						
Bond	δ_0	δ_1	δ_2	δ_3	**SH1**	**SH2**	**SH3**	δ_0	δ_1	δ_2	δ_3	**SH1**	**SH2**	**SH3**
Austria	-0.179	0.702	0.021	0.353	0.524	0.545	0.898	-0.711***	1.273	0.163	-0.109	0.562	0.725	0.616
Belgium	0.066	0.343	-0.116	0.163	0.409	0.293	0.456	-0.164	0.648	0.974	-0.954*	0.484	1.459*	0.504
Finland	-0.327***	0.192	-0.406	0.578	-0.136	-0.542	0.037	-1.021***	-0.970	0.498	0.008	-1.991**	-1.494*	-1.485**
France	-0.222*	0.346	-0.041	0.471	0.124	0.083	0.554	-0.661***	-0.192	0.283	0.106	-0.853	-0.570	-0.464
Germany	-0.358***	-0.355	-0.218	0.690*	-0.713	-0.931*	-0.241	-1.088***	-0.812	0.830	-0.152	-1.899***	-1.069	-1.221**
Greece	0.072**	0.042	-0.258**	0.225**	0.114	-0.144	0.081**	0.056	-0.123	-0.276*	0.361**	-0.067	-0.344**	0.018
Italy	0.096	-0.456	-0.662**	0.887***	-0.360	-1.022***	-0.134	-0.052	-0.787*	0.759*	0.092	-0.838*	-0.079	0.013
Netherlands	-0.272**	0.541	-0.820*	0.832**	0.269	-0.551	0.280	-0.908***	-0.790	0.470	0.030	-1.698***	-1.229	-1.199***
Portugal	-0.027	-0.280**	-0.535***	0.738***	-0.307**	-0.842***	-0.104	-0.020	-0.376*	-0.206	0.557**	-0.396*	-0.602**	-0.046
Spain	0.158*	0.100	-0.039	0.059	0.258	0.218	0.277	-0.071	-0.301	0.141	0.567	-0.371	-0.230	0.337
EMU	-0.357***	-0.355	-0.218	0.689*	-0.712	-0.930*	-0.241	-1.086***	-0.812	0.830	-0.153	-1.899***	-1.068	-1.221**
UK	-0.209**	-0.088	0.247	-0.091	-0.296	-0.049	-0.140	-0.838***	0.342	0.233	-0.098	-0.496	-0.263	-0.360
US	-0.064	-0.339	-0.028	0.328	-0.403	-0.431	-0.102	-0.445***	0.403	0.045	0.154	-0.041	0.004	0.158

***, **, * represent significance of the estimates at the 1%, 5% and 10% level, respectively.

Table 5: Hedge and safe haven characteristics of industrial metals – sub-period analysis

This table reports estimation results for the models in Eqs.(1a), (1b) and (1c) for the three sub-periods, with individual industrial metals as the dependent variables in Eq.(1a). SH1 tests the hypothesis $\delta_0 + \delta_1 = 0$, SH2 tests the hypothesis $\delta_0 + \delta_1 + \delta_2 = 0$, SH3 tests the hypothesis $\delta_0 + \delta_1 + \delta_2 + \delta_3 = 0$. Panel A presents results for the period July 1993 to December 2000, Panel B presents results for the period January 2001 to December 2006 and Panel C presents results for the period January 2007 to June 2012.

Panel A: July 1993 to December 2000

	Aluminium							Copper						
Bond	δ_0	δ_1	δ_2	δ_3	**SH1**	**SH2**	**SH3**	δ_0	δ_1	δ_2	δ_3	**SH1**	**SH2**	**SH3**
Austria	-0.484***	-0.395*	0.706**	-0.002	-0.879***	-0.173	-0.175*	-0.550***	0.195	0.677	-0.041	-0.355	0.322	0.280
Belgium	-0.307***	-0.149	0.223	0.118	-0.456*	-0.232	-0.114	-0.408***	0.217	0.328	0.106	-0.190	0.137	0.244
Finland	-0.181**	-0.350**	0.991***	-0.456*	-0.530***	0.461*	0.005	-0.278***	0.147	0.514	-0.059	-0.131	0.383	0.324*
France	-0.145*	-0.144	0.341	-0.227	-0.289	0.053	-0.174	-0.317***	-0.189	0.097	0.367	-0.506	-0.410	-0.042
Germany	-0.430***	-0.057	0.296	0.187	-0.487**	-0.191	-0.004	-0.559***	0.259	0.066	0.506	-0.300	-0.233	0.272
Greece	-0.352	0.364	-0.119	0.553	0.012	-0.108	0.446	-0.454**	-0.173	0.913	-0.241	-0.627	0.286	0.045
Italy	-0.108	-0.153	0.008	0.277	-0.261	-0.253	0.024	-0.178*	0.109	0.444	-0.107	-0.068	0.375	0.268*
Netherlands	-0.183*	-0.294	0.279	-0.143	-0.478*	-0.198	-0.341***	-0.428***	-0.051	-0.258	0.570*	-0.479	-0.737	-0.167
Portugal	-0.040	-0.067	0.108	-0.035	-0.107	0.001	-0.034	-0.106	0.133	0.095	-0.029	0.027	0.122	0.093
Spain	-0.203**	0.274	-0.108	0.015	0.070	-0.038	-0.023	-0.230**	0.494	-0.084	-0.066	0.264	0.180	0.114
EMU	-0.726***	0.635	0.663	0.056	-0.092	0.571	0.627	-0.817***	-0.430	0.505	0.235	-1.247	-0.742	-0.508
UK	-0.026	-0.110	0.036	-0.058	-0.137	-0.100	-0.158	-0.131	-0.056	0.190	-0.019	-0.186	0.004	-0.015
US	-0.154**	0.210	-0.201	-0.028	0.056	-0.145	-0.173	-0.173*	-0.043	-0.596**	0.324	-0.216	-0.812***	-0.488**

	Lead							Nickel						
Bond	δ_0	δ_1	δ_2	δ_3	**SH1**	**SH2**	**SH3**	δ_0	δ_1	δ_2	δ_3	**SH1**	**SH2**	**SH3**
Austria	-0.454***	0.358	0.033	0.518	-0.095	-0.063	0.456	-0.587***	0.351	0.539	0.313	-0.236	0.303	0.616***
Belgium	-0.267*	0.411	0.100	0.204	0.145	0.244	0.449	-0.245	0.328	0.119	0.282	0.083	0.202	0.484*
Finland	-0.272**	0.040	0.477	0.055	-0.232	0.245	0.300	-0.256*	0.254	0.499	0.004	-0.002	0.497	0.501**
France	-0.281**	-0.151	-0.038	0.523	-0.432	-0.470	0.053	-0.172	-0.552	0.478	0.136	-0.724*	-0.246	-0.110
Germany	-0.359***	0.683*	0.105	0.193	0.324	0.429	0.622**	-0.435***	0.402	1.021**	-0.336	-0.032	0.988**	0.653***
Greece	-0.395	-0.004	-0.757	1.467**	-0.399	-1.157	0.310	-0.342	0.045	0.379	-0.158	-0.297	0.082	-0.076
Italy	-0.168	-0.003	-0.044	0.264	-0.171	-0.215	0.049	-0.093	-0.060	0.071	0.148	-0.152	-0.081	0.067
Netherlands	-0.518***	0.148	-0.083	0.626*	-0.370	-0.453	0.172	-0.352**	-0.055	-0.373	0.743*	-0.408	-0.780	-0.038
Portugal	-0.271***	-0.019	-0.061	0.466	-0.290	-0.351	0.115	0.029	0.093	0.130	-0.104	0.122	0.252	0.149
Spain	-0.280**	0.579	-0.271	0.345	0.299	0.028	0.373	-0.078	0.396	0.641	-0.737*	0.318	0.959**	0.222
EMU	-0.405*	0.959	0.222	0.040	0.554	0.776	0.816*	-0.676**	0.399	0.610	0.038	-0.276	0.334	0.372
UK	-0.064	-0.251	0.322	-0.213	-0.315	0.007	-0.206	0.049	-0.312	-0.291	0.207	-0.264	-0.555	-0.348
US	-0.155	0.111	-0.122	-0.037	-0.044	-0.166	-0.203	-0.166	0.022	-0.591	0.197	-0.143	-0.735*	-0.538**

Table 5 cont'd

	Tin							Zinc						
Bond	δ_0	δ_1	δ_2	δ_3	**SH1**	**SH2**	**SH3**	δ_0	δ_1	δ_2	δ_3	**SH1**	**SH2**	**SH3**
Austria	-0.364***	-0.244	0.636**	0.246	-0.608**	0.028	0.274	-0.446***	0.552**	0.259	0.209	0.106	0.365	0.575***
Belgium	-0.247**	-0.344	0.655**	0.079	-0.591**	0.064	0.143	-0.244*	0.225	0.242	0.209	-0.020	0.223	0.432**
Finland	-0.189**	-0.161	0.150	0.376	-0.350	-0.201	0.176	-0.177*	-0.221	1.050***	-0.331	-0.398	0.652**	0.321**
France	-0.038	-0.168	0.188	0.031	-0.206	-0.018	0.012	-0.161	0.117	-0.363	0.610**	-0.044	-0.407	0.203
Germany	-0.388***	0.242	-0.150	0.674**	-0.146	-0.296	0.377***	-0.385***	0.542**	-0.136	0.489	0.157	0.021	0.510***
Greece	-0.189	0.593	-0.673	0.642	0.404	-0.269	0.373	-0.461	0.738	-0.650	0.617	0.277	-0.373	0.244
Italy	-0.007	-0.051	0.478**	-0.243	-0.058	0.420*	0.178	-0.033	-0.055	0.611**	-0.247	-0.088	0.523**	0.276**
Netherlands	-0.055	-0.413	0.561	-0.224	-0.468	0.093	-0.131	-0.262*	0.157	-0.311	0.565	-0.105	-0.416	0.150
Portugal	-0.129	-0.389**	0.308	0.374	-0.518**	-0.210	0.164*	-0.089	-0.211	0.213	0.260	-0.300	-0.087	0.173
Spain	-0.151*	0.240	-0.257	0.404*	0.089	-0.168	0.236	-0.081	0.456	0.063	-0.152	0.375	0.438	0.287
EMU	-0.495***	0.705	-0.568	0.848	0.210	-0.358	0.490	-0.612***	0.410	0.107	0.199	-0.202	-0.095	0.103
UK	0.131*	-0.636***	0.385	-0.285	-0.505**	-0.120	-0.405***	-0.069	-0.209	0.268	-0.104	-0.278	-0.010	-0.114
US	-0.008	-0.135	-0.207	-0.028	-0.143	-0.350	-0.378***	-0.142*	-0.015	-0.560**	0.327	-0.157	-0.717***	-0.390***

Panel B: January 2001 to December 2006

	Aluminium							Copper						
Bond	δ_0	δ_1	δ_2	δ_3	**SH1**	**SH2**	**SH3**	δ_0	δ_1	δ_2	δ_3	**SH1**	**SH2**	**SH3**
Austria	-0.702***	0.256	0.191	-0.789***	-0.446	-0.255	-1.044**	-1.044***	0.284	0.564	-1.093**	-0.759	-0.196	-1.289***
Belgium	-0.712***	0.375	-0.038	-0.603**	-0.338	-0.376	-0.979**	-1.063***	0.182	0.367	-0.745	-0.881*	-0.514	-1.259***
Finland	-0.723***	0.486	-0.173	-0.632**	-0.237	-0.410	-1.042**	-1.078***	0.614	0.454	-1.101**	-0.464	-0.010	-1.112***
France	-0.677***	0.437	-0.378	-0.391	-0.239	-0.618	-1.009**	-1.014***	0.642	0.042	-0.716	-0.371	-0.329	-1.046***
Germany	-0.706***	0.559	-0.561*	-0.192	-0.148	-0.709	-0.901**	-0.994***	0.413	0.567	-1.065**	-0.581	-0.014	-1.078***
Greece	-0.758***	0.353	0.247	-0.869***	-0.405	-0.158	-1.027**	-1.077***	0.671	0.244	-0.961**	-0.406	-0.162	-1.123***
Italy	-0.735***	0.142	-0.097	-0.345	-0.593*	-0.690**	-1.036***	-1.187***	0.487	0.765	-0.981**	-0.700	0.065	-0.916***
Netherlands	-0.682***	0.787	-0.372	-0.524*	0.104	-0.267	-0.791*	-0.990***	0.631	0.796*	-1.436***	-0.359	0.437	-0.999***
Portugal	-0.737***	0.783	-0.613*	-0.341	0.046	-0.567	-0.908	-1.023***	0.308	0.685	-1.301***	-0.715	-0.030	-1.331***
Spain	-0.718***	0.551	-0.472	-0.338	-0.167	-0.639	-0.977***	-1.129***	0.505	0.173	-0.644	-0.624	-0.451	-1.095***
EMU	-0.697***	0.486	-0.271	-0.430	-0.212	-0.483	-0.912**	-0.987***	0.421	0.628	-1.153**	-0.566	0.062	-1.091***
UK	-0.292***	0.127	0.049	-0.502*	-0.164	-0.116	-0.618***	-0.616***	-0.086	0.257	-0.469	-0.703	-0.446	-0.915***
US	-0.027	0.215	-0.117	-0.114	0.188	0.071	-0.043	-0.301***	0.533**	0.099	-0.243	0.232	0.332	0.089

Table 5 cont'd

	Lead							Nickel						
Bond	δ_0	δ_1	δ_2	δ_3	**SH1**	**SH2**	**SH3**	δ_0	δ_1	δ_2	δ_3	**SH1**	**SH2**	**SH3**
Austria	-0.802***	0.253	0.690	-1.229**	-0.549	0.141	-1.088**	-0.741***	0.410	0.038	-1.357*	-0.331	-0.294	-1.651**
Belgium	-0.876***	0.138	0.078	-0.402	-0.738	-0.660	-1.062**	-0.787***	-0.067	-0.559	-0.495	-0.854	-1.414	-1.909***
Finland	-0.858***	0.200	0.293	-0.755	-0.657	-0.365	-1.119**	-0.733***	0.590	-0.273	-1.105	-0.143	-0.417	-1.522**
France	-0.856***	0.460	-0.375	-0.312	-0.397	-0.771	-1.083**	-0.698***	0.793	-0.717	-0.791	0.096	-0.622	-1.412**
Germany	-0.832***	0.451	-0.077	-0.414	-0.381	-0.457	-0.871*	-0.779***	0.668	-0.759	-0.541	-0.111	-0.870	-1.411**
Greece	-0.860***	0.222	0.193	-0.715	-0.637	-0.444	-1.159**	-0.797***	0.688	-0.554	-0.877	-0.109	-0.663	-1.540**
Italy	-0.875***	0.275	0.762	-1.089*	-0.600	0.161	-0.928**	-0.851***	0.276	0.171	-1.011	-0.575	-0.404	-1.415**
Netherlands	-0.764***	0.456	0.290	-0.983*	-0.308	-0.018	-1.001**	-0.699***	0.715	-0.323	-1.122	0.015	-0.308	-1.429**
Portugal	-0.877***	0.487	-0.147	-0.537	-0.389	-0.536	-1.074*	-0.674**	0.177	0.183	-1.513**	-0.497	-0.314	-1.827***
Spain	-0.950***	0.490	-0.221	-0.194	-0.460	-0.680	-0.875*	-0.808***	0.927	-0.609	-0.857	0.120	-0.489	-1.346**
EMU	-0.832***	0.496	-0.151	-0.394	-0.336	-0.487	-0.880*	-0.769***	0.630	-0.561	-0.724	-0.139	-0.700	-1.424**
UK	-0.594***	-0.021	-0.029	0.181	-0.615	-0.644	-0.463	-0.279	-0.315	0.381	-1.009	-0.594	-0.214	-1.223
US	-0.220*	0.023	-0.136	0.236	-0.198	-0.334	-0.098	-0.094	-0.297	0.375	-0.670	-0.391	-0.015	-0.685***

	Tin							Zinc						
Bond	δ_0	δ_1	δ_2	δ_3	**SH1**	**SH2**	**SH3**	δ_0	δ_1	δ_2	δ_3	**SH1**	**SH2**	**SH3**
Austria	-1.005***	0.285	0.511	-0.639	-0.720	-0.209	-0.848*	-0.935***	0.326	0.061	-0.483	-0.609	-0.548	-1.031***
Belgium	-0.992***	0.094	0.544	-0.525	-0.898*	-0.354	-0.879**	-0.957***	0.173	0.034	-0.288	-0.784*	-0.750	-1.038***
Finland	-1.004***	0.597	0.352	-0.641	-0.407	-0.055	-0.696	-0.941***	0.553	0.124	-0.660	-0.389	-0.265	-0.924**
France	-0.846***	0.719	0.313	-0.810	-0.127	0.185	-0.624	-0.890***	0.592	-0.364	-0.248	-0.297	-0.661	-0.909***
Germany	-0.915***	0.496	0.105	-0.376	-0.419	-0.315	-0.691*	-0.910***	0.582	-0.151	-0.323	-0.329	-0.480	-0.803**
Greece	-0.932***	0.602	0.642	-1.030*	-0.331	0.311	-0.719	-0.959***	0.573	-0.062	-0.523	-0.386	-0.448	-0.971***
Italy	-1.043***	0.170	0.956*	-0.797	-0.873	0.083	-0.714	-1.060***	0.495	0.246	-0.435	-0.565	-0.319	-0.754**
Netherlands	-0.905***	0.624	0.510	-0.878	-0.282	0.228	-0.650*	-0.871***	0.595	0.312	-0.862*	-0.275	0.037	-0.826**
Portugal	-0.931***	0.543	0.442	-0.850	-0.389	0.054	-0.796*	-0.914***	0.298	0.404	-0.846*	-0.615	-0.211	-1.057***
Spain	-0.961***	0.802*	0.065	-0.472	-0.160	-0.095	-0.567	-0.950***	0.531	0.029	-0.441	-0.419	-0.390	-0.831***
EMU	-0.901***	0.419	0.490	-0.714	-0.482	0.009	-0.706*	-0.903***	0.607	-0.133	-0.389	-0.296	-0.429	-0.818**
UK	-0.392***	-0.222	0.111	-0.286	-0.614	-0.503	-0.789*	-0.446***	0.322	-0.226	-0.118	-0.124	-0.350	-0.468
US	-0.011	0.312	0.191	-0.456	0.301	0.493	0.036	-0.294***	0.154	-0.108	0.125	-0.139	-0.248	-0.123

Table 5 cont'd

Panel C: January 2007 to June 2012

	Aluminium							Copper						
Bond	δ_0	δ_1	δ_2	δ_3	**SH1**	**SH2**	**SH3**	δ_0	δ_1	δ_2	δ_3	**SH1**	**SH2**	**SH3**
Austria	-0.178*	0.458	-0.666*	0.590*	0.28	-0.385	0.205	-0.883***	0.261	-0.628	1.001**	-0.622	-1.250**	-0.250
Belgium	-0.168*	0.177	0.060	0.226	0.009	0.069	0.295	-0.458***	-0.118	0.701	-0.170	-0.576	0.124	-0.046
Finland	-0.247**	0.845**	-0.194	0.340	0.598	0.404	0.744**	-1.155***	0.028	-0.145	0.732*	-1.127*	-1.272*	-0.540
France	-0.112	0.707*	-0.819**	0.516*	0.594	-0.225	0.291	-0.699***	0.665	-0.295	0.224	-0.033	-0.329	-0.105
Germany	-0.198**	0.208	0.564	-0.278	0.011	0.575	0.297	-1.188***	-0.698	0.482	0.477	-1.886***	-1.404**	-0.927**
Greece	-0.020	0.032	0.044	-0.023	0.011	0.055	0.032	-0.007	-0.028	-0.136	0.224*	-0.035	-0.171	0.053
Italy	-0.070	-0.009	-0.260	0.397*	-0.079	-0.339	0.058	-0.254***	-0.463	0.401	0.347	-0.717*	-0.317	0.031
Netherlands	-0.180*	1.587***	-0.259	0.346	1.407***	1.148***	1.494***	-1.146***	0.295	-0.193	0.936**	-0.851	-1.044*	-0.109
Portugal	-0.049	0.039	0.065	-0.070	-0.01	0.055	-0.015	-0.061	-0.003	-0.097	0.147	-0.065	-0.162	-0.015
Spain	-0.058	0.049	-0.132	0.212	-0.009	-0.141	0.071	-0.294***	-0.077	-0.191	0.602*	-0.371	-0.562	0.040
EMU	-0.197**	0.208	0.564	-0.279	0.012	0.576	0.297	-1.187***	-0.698	0.482	0.476	-1.885***	-1.403**	-0.927**
UK	-0.043	-0.183	-0.243	0.157	-0.226	-0.470	-0.312	-0.801***	0.125	0.449	-0.251	-0.676	-0.227	-0.478
US	-0.452***	0.151	-0.605***	0.516***	-0.301	-0.906***	-0.390**	-0.995***	0.256	-0.176	0.369	-0.740**	-0.916**	-0.547**

	Lead							Nickel						
Bond	δ_0	δ_1	δ_2	δ_3	**SH1**	**SH2**	**SH3**	δ_0	δ_1	δ_2	δ_3	**SH1**	**SH2**	**SH3**
Austria	-1.099***	0.747	-0.370	0.786	-0.352	-0.722	0.064	-1.155***	0.509	-1.161	1.689***	-0.646	-1.807*	-0.118
Belgium	-0.599***	0.182	0.828	-0.014	-0.417	0.411	0.397	-0.697***	-0.084	0.394	0.547	-0.781	-0.387	0.160
Finland	-1.475***	-0.239	-0.073	0.843	-1.713*	-1.786	-0.944	-1.246***	0.570	-0.600	0.978*	-0.676	-1.276	-0.297
France	-0.818***	1.492	-0.047	-0.249	0.674	0.626	0.377	-1.023***	0.512	-0.646	0.865	-0.51	-1.156	-0.291
Germany	-1.591***	-1.385*	0.230	1.149**	-2.976***	-2.746***	-1.597**	-1.254***	-1.203	-0.008	1.131**	-2.457**	-2.464**	-1.334
Greece	-0.007	-0.047	0.007	0.084	-0.055	-0.048	0.036	0.028	0.024	0.279	-0.256	0.052	0.331*	0.075
Italy	-0.245***	-0.150	0.406	0.233	-0.395	0.012	0.244	-0.347***	-0.125	-0.404	1.049**	-0.471	-0.875	0.174
Netherlands	-1.550***	0.208	0.224	1.031*	-1.342	-1.118	-0.088	-1.241***	-0.220	-0.933	1.608***	-1.461	-2.395**	-0.787
Portugal	-0.090	0.092	-0.328	0.327	0.002	-0.325	0.002	-0.132*	0.053	-0.220	0.340	-0.079	-0.299	0.041
Spain	-0.377***	0.655	-0.464	0.668	0.278	-0.186	0.482	-0.379***	0.217	0.256	0.256	-0.162	0.093	0.349
EMU	-1.589***	-1.384*	0.230	1.146**	-2.973***	-2.743***	-1.597**	-1.257***	-1.203	-0.008	1.135**	-2.460**	-2.468**	-1.333
UK	-0.987***	0.840	0.213	-0.435	-0.147	0.066	-0.369	-0.889***	0.676	0.329	-0.125	-0.212	0.116	-0.009
US	-1.175***	0.157	0.167	0.218	-1.017**	-0.851	-0.633*	-1.019***	0.480	-0.147	0.317	-0.538	-0.685	-0.368

Table 5 cont'd

	Tin							Zinc						
Bond	δ_0	δ_1	δ_2	δ_3	**SH1**	**SH2**	**SH3**	δ_0	δ_1	δ_2	δ_3	**SH1**	**SH2**	**SH3**
Austria	-0.775***	1.074**	-0.604	1.172*	0.299	-0.305	0.867**	-0.665***	1.138	-0.741	0.529	0.473	-0.269	0.260
Belgium	-0.501***	-0.964*	1.033**	0.250	-1.465***	-0.432	-0.181	-0.212	0.098	1.310**	-0.923	-0.115	1.195	0.272
Finland	-0.940***	-0.532	-0.160	1.110*	-1.472*	-1.632*	-0.521	-1.016***	0.575	-0.148	0.459	-0.44	-0.588	-0.129
France	-0.740***	0.880*	-0.758	1.158*	0.14	-0.617	0.541	-0.552***	1.179	-0.132	-0.135	0.627	0.495	0.360
Germany	-0.945***	-0.703	-0.061	1.172***	-1.648**	-1.709**	-0.537	-1.112***	-0.576	0.207	0.649	-1.689**	-1.482*	-0.833
Greece	-0.011	-0.051	0.259	-0.172	-0.062	0.198	0.026	0.031	-0.013	-0.041	0.029	0.018	-0.023	0.006
Italy	-0.392***	-0.253	-0.362	1.128***	-0.646	-1.007*	0.120	-0.258***	-0.412	0.463	0.295	-0.67	-0.206	0.089
Netherlands	-0.841***	-0.278	-0.278	1.031*	-1.119	-1.397	-0.366	-0.949***	0.930	-0.137	0.588	-0.019	-0.156	0.432
Portugal	-0.045	0.002	-0.332	0.282	-0.043	-0.375	-0.093	-0.079	0.061	-0.254	0.295	-0.018	-0.271	0.024
Spain	-0.408***	-0.284	0.576	0.244	-0.692	-0.116	0.128	-0.293***	0.434	-0.178	0.415	0.141	-0.037	0.377
EMU	-0.943***	-0.702	-0.062	1.170***	-1.646**	-1.708**	-0.537	-1.108***	-0.575	0.206	0.644	-1.683**	-1.477*	-0.833
UK	-0.541***	0.720	0.245	-0.261	0.179	0.424	0.163	-0.711***	0.979	0.457	-0.938*	0.269	0.726	-0.212
US	-0.836***	0.834*	0.289	-0.057	-0.002	0.286	0.230	-1.066***	0.724*	0.101	0.234	-0.342	-0.241	-0.007

***, **, * represent significance of the estimates at the 1%, 5% and 10% level, respectively.

Table 6: Hedge and safe haven characteristics of portfolio of metals – sub-period analysis

This table reports estimation results for the models in Eqs.(1a), (1b) and (1c) for the three sub-periods , with portfolio of metals as the dependent variables in Eq.(1a). SH1 tests the hypothesis $\delta_0 + \delta_1 = 0$, SH2 tests the hypothesis $\delta_0 + \delta_1 + \delta_2 = 0$, SH3 tests the hypothesis $\delta_0 + \delta_1 + \delta_2 + \delta_3 = 0$. Panel A presents results for the period July 1993 to December 2000, Panel B presents results for the period January 2001 to December 2006 and Panel C presents results for the period January 2007 to June 2012.

Panel A: July 1993 to December 2000

	Portfolio of Industrial Metals						
Bond	δ_0	δ_1	δ_2	δ_3	**SH1**	**SH2**	**SH3**
Austria	-0.534***	0.264	0.466	0.194	-0.270	0.197	0.391***
Belgium	-0.326***	0.244	0.302	0.089	-0.082	0.220	0.309*
Finland	-0.281***	0.035	0.651**	-0.117	-0.246	0.405	0.288**
France	-0.211***	-0.139	0.124	0.200	-0.350	-0.226	-0.026
Germany	-0.484***	0.416*	0.269	0.223	-0.068	0.201	0.424***
Greece	-0.423**	0.351	-0.498	0.853	-0.072	-0.570	0.283
Italy	-0.114	0.051	0.283	-0.039	-0.063	0.220	0.181*
Netherlands	-0.346***	-0.063	-0.066	0.371	-0.408	-0.474	-0.104
Portugal	-0.127*	0.045	0.030	0.171	-0.081	-0.051	0.120
Spain	-0.191**	0.462**	0.024	-0.080	0.271	0.295	0.216
EMU	-0.632***	0.528	0.201	0.219	-0.104	0.097	0.316
UK	-0.025	-0.233	0.119	-0.069	-0.258	-0.139	-0.208
US	-0.143**	-0.034	-0.355*	0.114	-0.177	-0.533***	-0.419***

	Portfolio of Precious Metals						
Bond	δ_0	δ_1	δ_2	δ_3	**SH1**	**SH2**	**SH3**
Austria	-0.246***	0.221	0.116	-0.147	-0.025	0.091	-0.246***
Belgium	-0.202***	0.419*	-0.206	0.052	0.217	0.011	-0.202***
Finland	-0.039	0.129	0.383**	-0.515***	0.090	0.473***	-0.039
France	-0.096	0.113	0.116	-0.219	0.018	0.134	-0.096
Germany	-0.235***	0.203	0.086	-0.113	-0.031	0.055	-0.235***
Greece	-0.209	1.027**	0.401	-0.197	0.818	1.219**	-0.209
Italy	-0.194***	0.039	-0.212	0.192	-0.155	-0.367**	-0.194***
Netherlands	-0.109	0.267	-0.230	0.005	0.158	-0.072	-0.109
Portugal	-0.167***	-0.025	0.269	-0.148	-0.192	0.077	-0.167***
Spain	-0.050	-0.322**	0.523***	-0.364**	-0.372**	0.151	-0.050
EMU	-0.371**	0.574	0.103	0.151	0.203	0.306	-0.371**
UK	-0.111*	-0.048	-0.110	0.130	-0.160	-0.270	-0.111*
US	0.006	0.132	-0.320*	0.113	0.138	-0.182	0.006

	Portfolio of Industrial and Precious Metals						
Bond	δ_0	δ_1	δ_2	δ_3	**SH1**	**SH2**	**SH3**
Austria	-0.440***	0.245	0.297	0.136	-0.195	0.102	0.237**
Belgium	-0.307***	0.327*	0.049	0.167	0.020	0.069	0.236
Finland	-0.194***	0.052	0.638***	-0.324*	-0.141	0.497**	0.172*
France	-0.154***	-0.054	0.269	-0.058	-0.208	0.061	0.002
Germany	-0.389***	0.461***	0.161	0.099	0.072	0.233	0.332***
Greece	-0.324**	0.663**	-0.190	0.423	0.338	0.148	0.572***
Italy	-0.134**	0.063	0.121	0.024	-0.070	0.051	0.075
Netherlands	-0.273***	0.008	-0.162	0.344*	-0.264	-0.426*	-0.082
Portugal	-0.142**	0.013	0.195	0.008	-0.129	0.066	0.075
Spain	-0.143**	0.224	0.290	-0.246	0.081	0.371*	0.125
EMU	-0.516***	0.700	-0.003	0.223	0.184	0.181	0.404
UK	-0.057	-0.099	0.004	0.003	-0.156	-0.151	-0.148
US	-0.091*	0.008	-0.333**	0.076	-0.083	-0.416***	-0.339***

Table 6 cont'd

Panel B: January 2001 to December 2006

Portfolio of Industrial Metals

Bond	δ_0	δ_1	δ_2	δ_3	**SH1**	**SH2**	**SH3**
Austria	-0.825***	0.282	0.248	-0.821**	-0.543	-0.295	-1.116***
Belgium	-0.853***	0.120	-0.026	-0.392	-0.733	-0.758	-1.151***
Finland	-0.842***	0.452	0.017	-0.674*	-0.390	-0.373	-1.047**
France	-0.775***	0.524	-0.289	-0.462	-0.251	-0.540	-1.002**
Germany	-0.798***	0.493	-0.205	-0.401	-0.305	-0.510	-0.911**
Greece	-0.871***	0.492	-0.036	-0.653*	-0.379	-0.415	-1.068**
Italy	-0.930***	0.360	0.399	-0.682*	-0.571	-0.171	-0.853***
Netherlands	-0.768***	0.561	0.195	-0.914**	-0.207	-0.012	-0.925***
Portugal	-0.805***	0.380	0.141	-0.847**	-0.425	-0.284	-1.131***
Spain	-0.872***	0.578	-0.246	-0.365	-0.294	-0.540	-0.906***
EMU	-0.790***	0.480	-0.080	-0.533	-0.311	-0.391	-0.924**
UK	-0.405***	-0.058	0.110	-0.310	-0.462	-0.352	-0.662**
US	-0.155**	0.203	0.051	-0.184	0.048	0.099	-0.085

Portfolio of Precious Metals

Bond	δ_0	δ_1	δ_2	δ_3	**SH1**	**SH2**	**SH3**
Austria	0.088	0.087	-0.526	0.195	0.175	-0.350	-0.155
Belgium	0.070	0.090	-0.829**	0.471	0.161	-0.668	-0.198
Finland	0.103	0.182	-0.550	0.191	0.284	-0.266	-0.075
France	0.095	0.068	-0.410	0.104	0.163	-0.247	-0.143
Germany	0.050	-0.226	-0.611	0.499	-0.176	-0.787	-0.288
Greece	0.098	0.385	-1.028**	0.473	0.483	-0.545	-0.072
Italy	0.125	-0.135	-0.143	-0.149	-0.010	-0.153	-0.303
Netherlands	0.079	0.162	-0.792*	0.437	0.241	-0.550	-0.113
Portugal	0.092	0.179	-0.698	0.328	0.271	-0.427	-0.099
Spain	0.078	-0.135	-0.322	0.135	-0.056	-0.378	-0.244
EMU	0.051	-0.192	-0.732	0.584	-0.141	-0.872*	-0.288
UK	0.076	-0.497*	-0.263	0.240	-0.421	-0.684*	-0.443**
US	0.106	-0.090	-0.211	0.120	0.016	-0.195	-0.075

Portfolio of Industrial and Precious Metals

Bond	δ_0	δ_1	δ_2	δ_3	**SH1**	**SH2**	**SH3**
Austria	-0.445***	0.207	0.040	-0.491*	-0.238	-0.198	-0.689**
Belgium	-0.479***	0.136	-0.344	-0.027	-0.343	-0.687	-0.714**
Finland	-0.467***	0.366	-0.232	-0.275	-0.101	-0.333	-0.608*
France	-0.424***	0.379	-0.363	-0.201	-0.045	-0.407	-0.609**
Germany	-0.454***	0.263	-0.395	-0.019	-0.191	-0.586	-0.605**
Greece	-0.475***	0.462	-0.387	-0.223	-0.012	-0.399	-0.622*
Italy	-0.511***	0.231	0.126	-0.417	-0.280	-0.154	-0.571**
Netherlands	-0.427***	0.440	-0.194	-0.367	0.013	-0.181	-0.548*
Portugal	-0.437***	0.296	-0.128	-0.420	-0.141	-0.268	-0.689**
Spain	-0.486***	0.311	-0.188	-0.223	-0.176	-0.364	-0.587**
EMU	-0.447***	0.270	-0.367	-0.069	-0.177	-0.544	-0.613**
UK	-0.240***	-0.237	-0.026	-0.037	-0.477	-0.503	-0.540**
US	-0.066	0.089	-0.013	-0.071	0.023	0.010	-0.061

Table 6 cont'd

Panel C: January 2007 to June 2012

Portfolio of Industrial Metals

Bond	δ_0	δ_1	δ_2	δ_3	SH1	SH2	SH3
Austria	-0.777***	0.721	-0.537	0.766*	-0.056	-0.593	0.172
Belgium	-0.422***	-0.141	0.760	-0.060	-0.563	0.198	0.138
Finland	-1.040***	0.160	-0.279	0.818**	-0.880	-1.159	-0.341
France	-0.639***	0.766	-0.147	0.171	0.128	-0.019	0.151
Germany	-1.073***	-0.948	0.431	0.621*	-2.021***	-1.590**	-0.969*
Greece	0.006	-0.008	0.073	-0.031	-0.002	0.071	0.039
Italy	-0.222***	-0.238	0.088	0.496	-0.460	-0.372	0.124
Netherlands	-1.007***	0.202	-0.113	0.854**	-0.805	-0.917	-0.064
Portugal	-0.055	0.035	-0.178	0.189	-0.021	-0.199	-0.010
Spain	-0.282***	0.141	-0.072	0.456	-0.141	-0.213	0.243
EMU	-1.072***	-0.948	0.431	0.620*	-2.020***	-1.589**	-0.969*
UK	-0.680***	0.562	0.167	-0.192	-0.118	0.049	-0.144
US	-0.955***	0.458	-0.114	0.353	-0.497	-0.611*	-0.258

Portfolio of Precious Metals

Bond	δ_0	δ_1	δ_2	δ_3	SH1	SH2	SH3
Austria	-0.202*	0.896	0.165	-0.245	0.695	0.860	0.615
Belgium	-0.084	0.174	0.389	-0.280	0.090	0.479	0.199
Finland	-0.291**	-0.445	-0.292	0.237	-0.736	-1.028*	-0.791**
France	-0.239**	0.207	0.142	0.058	-0.032	0.110	0.168
Germany	-0.320***	0.102	-0.147	0.189	-0.218	-0.365	-0.176
Greece	0.022	0.088	-0.234**	0.159*	0.111	-0.124	0.035
Italy	-0.040	-0.660*	-0.033	0.437	-0.700*	-0.733*	-0.296
Netherlands	-0.237*	-0.021	-0.322	0.274	-0.258	-0.580	-0.306
Portugal	-0.057	-0.287**	-0.251	0.495***	-0.344***	-0.594***	-0.100
Spain	0.012	0.067	0.044	0.016	0.079	0.123	0.139
EMU	-0.319***	0.102	-0.147	0.188	-0.217	-0.364	-0.176
UK	-0.251**	0.836	0.222	-0.293	0.585	0.807	0.515
US	-0.138*	-0.082	-0.135	0.221	-0.220	-0.355	-0.134

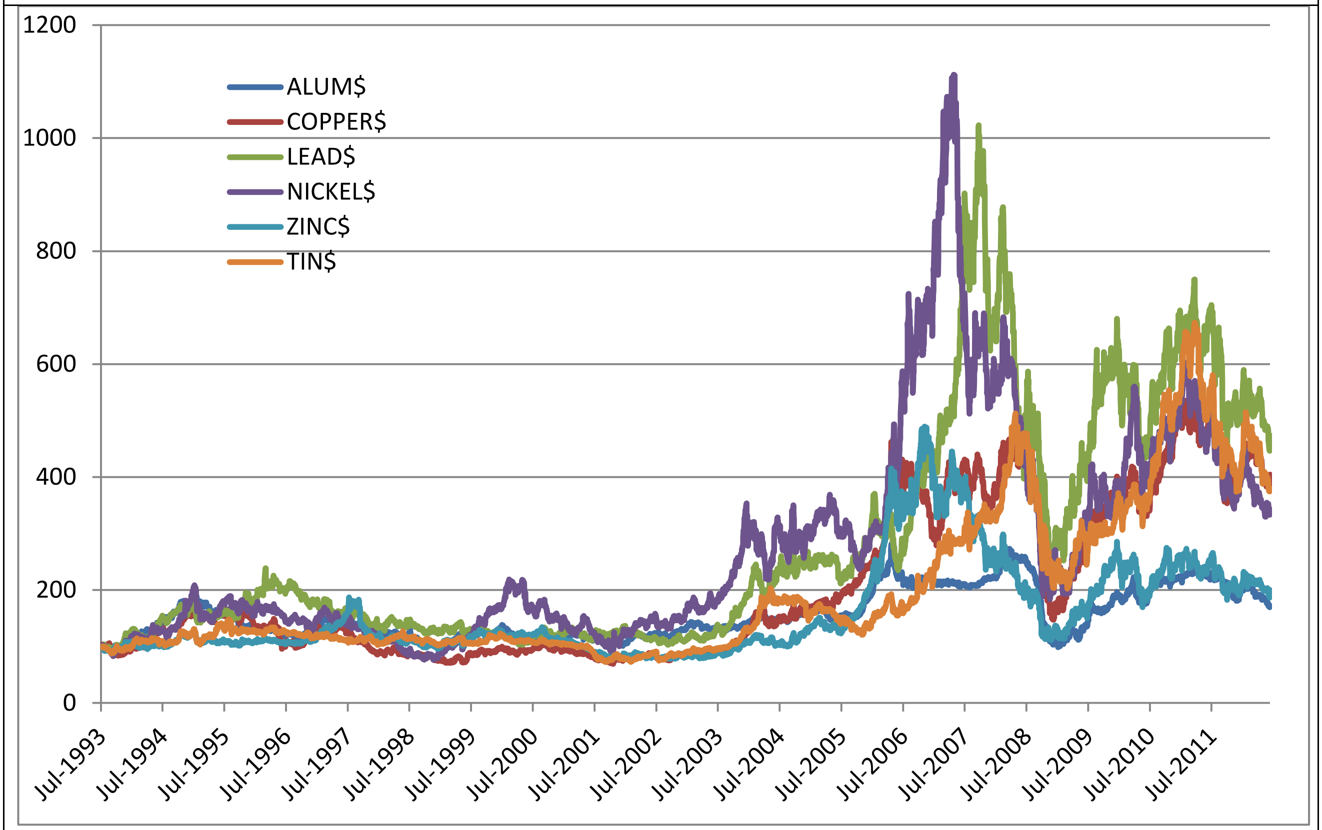
Portfolio of Industrial and Precious Metals

Bond	δ_0	δ_1	δ_2	δ_3	SH1	SH2	SH3
Austria	-0.615***	0.799*	-0.186	0.370	0.184	-0.002	0.368
Belgium	-0.364***	-0.079	0.726*	-0.134	-0.442	0.284	0.149
Finland	-0.780***	-0.087	-0.190	0.570*	-0.867	-1.056*	-0.486
France	-0.533***	0.621	-0.036	0.172	0.088	0.052	0.224
Germany	-0.809***	-0.335	0.155	0.489*	-1.143**	-0.989**	-0.500
Greece	0.009	0.033	-0.062	0.051	0.043	-0.019	0.032
Italy	-0.193**	-0.398	0.086	0.474*	-0.590*	-0.504	-0.031
Netherlands	-0.750***	0.132	-0.113	0.645*	-0.618	-0.731	-0.087
Portugal	-0.078**	-0.060	-0.218	0.307	-0.138	-0.356*	-0.049
Spain	-0.217***	0.058	-0.010	0.347	-0.159	-0.169	0.178
EMU	-0.807***	-0.335	0.154	0.488*	-1.142**	-0.988**	-0.500
UK	-0.483***	0.722**	0.141	-0.230	0.239	0.380	0.150
US	-0.654***	0.259	-0.220	0.474**	-0.395	-0.615**	-0.141

***, **, * represent significance of the estimates at the 1%, 5% and 10% level, respectively.

Figure 1: Dollar price indices of industrial and precious metals - July 1993 t0 June 2012 (July 1993 = 100).

Panel A: Dollar Price Indices of the Six Industrial Metals – July 1993 to June 2012



Panel B: Dollar Price Indices of the Four Precious Metals – July 1993 to June 2012

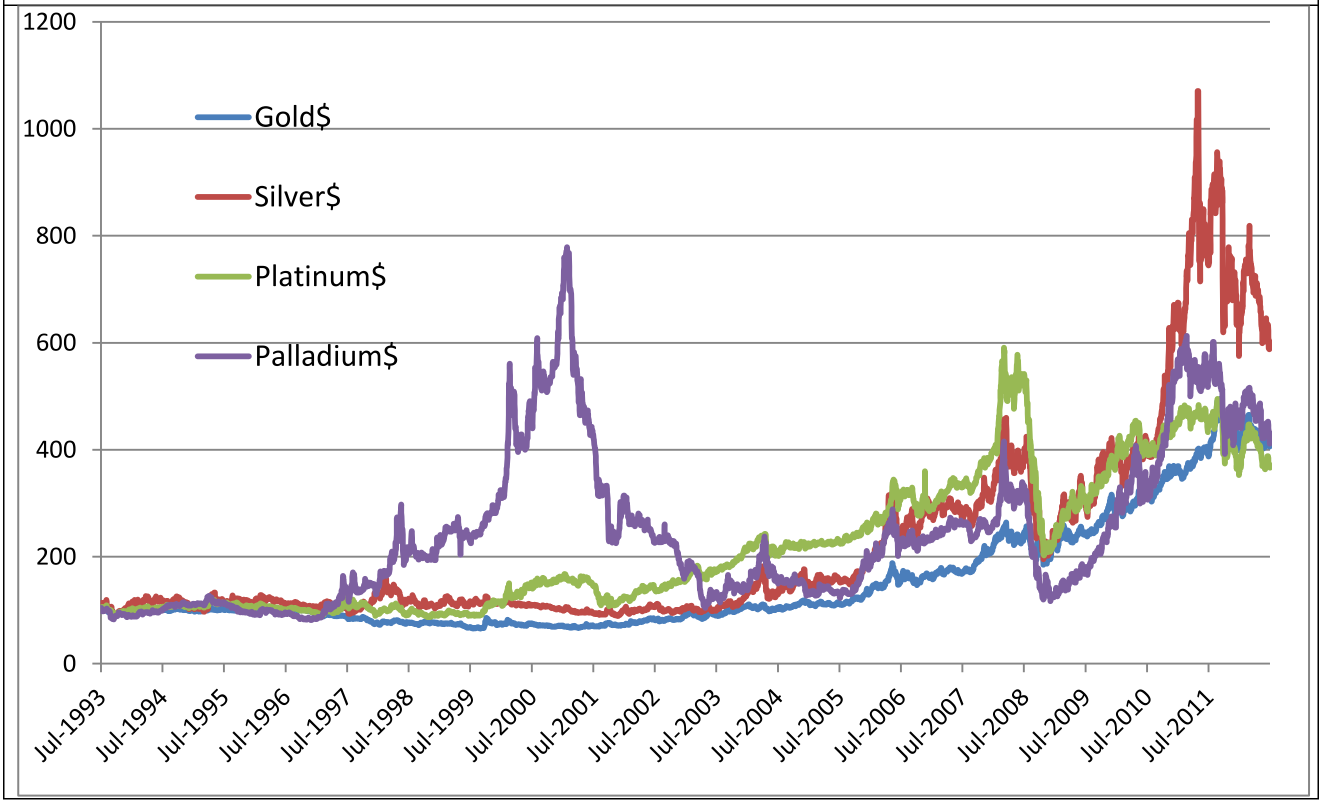
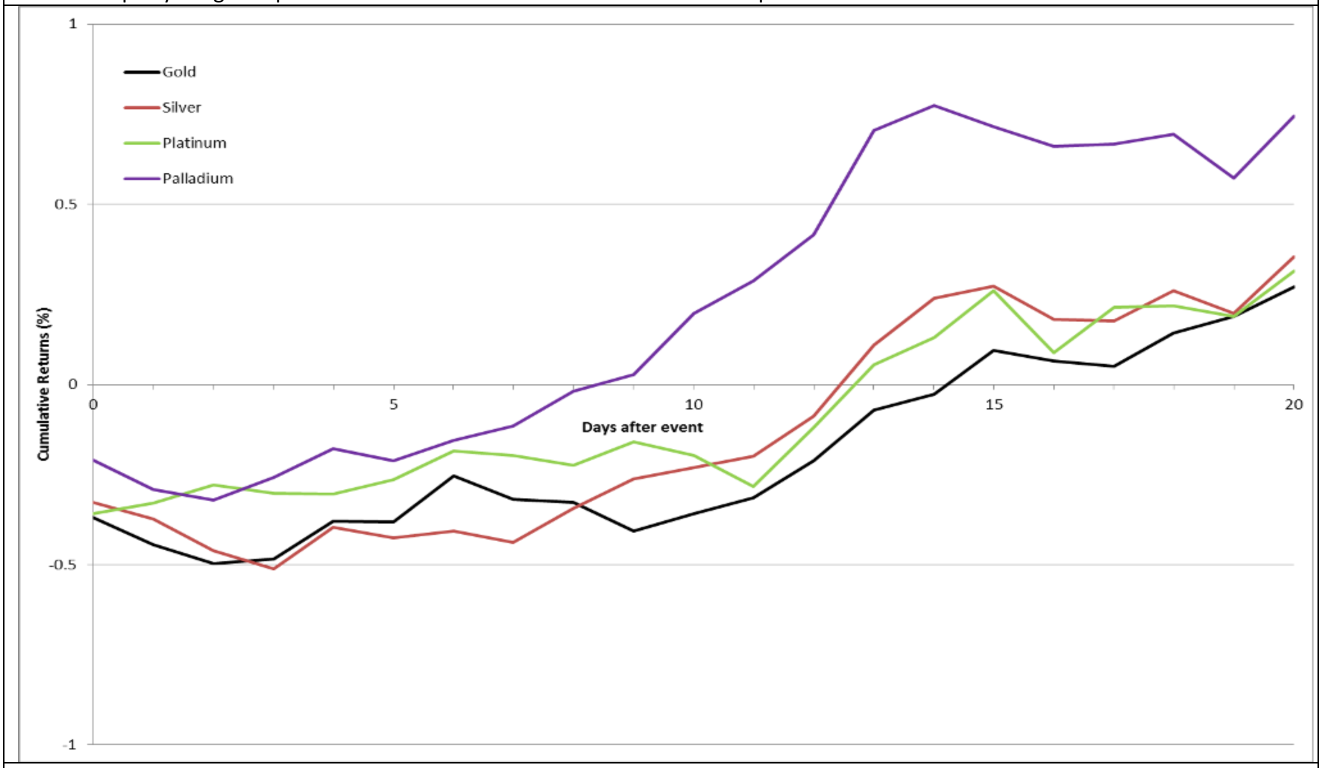


Figure 2: Post-shock performance of equally weighted portfolios consisting of the bond and dedicated precious metals

Panel A: Equally weighted portfolio of EMU benchmark bond and individual precious metals



Panel B: Equally weighted portfolio of the UK bond and individual precious metals

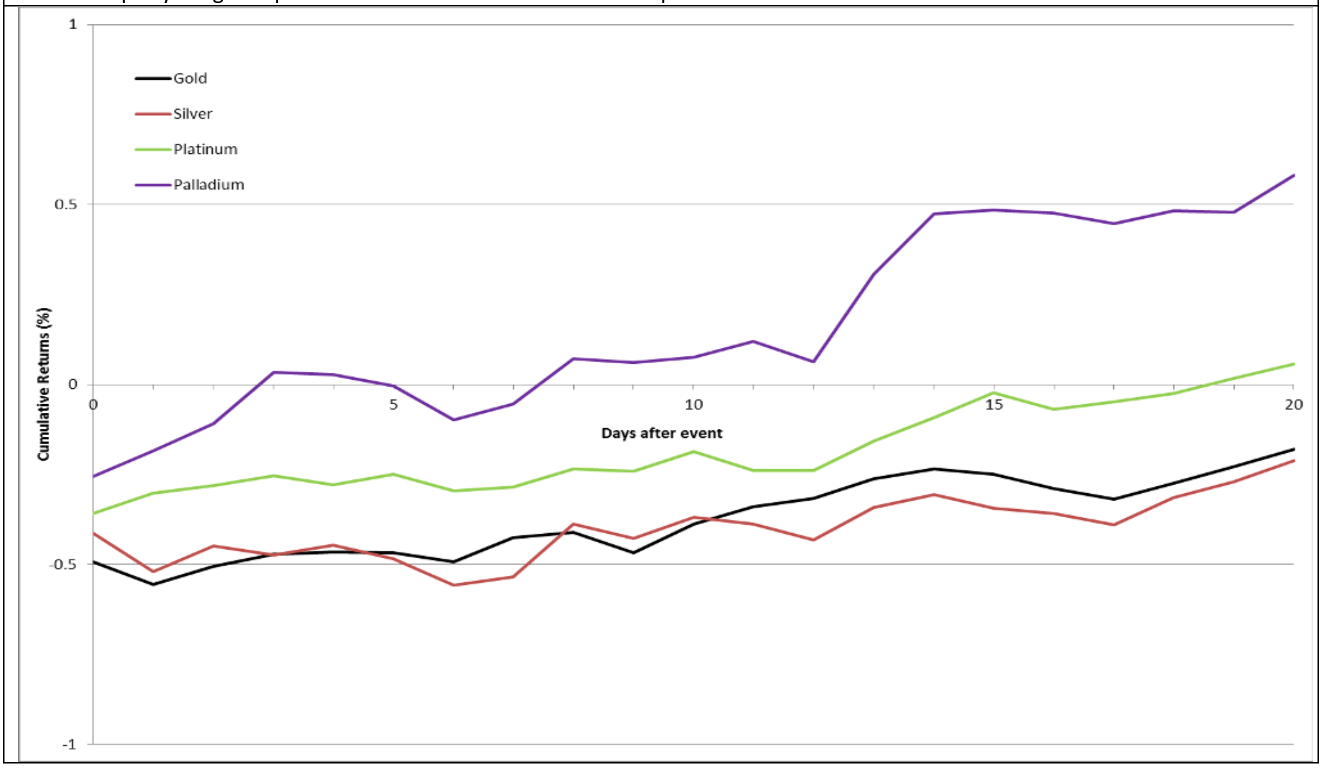


Figure 2 cont'd.

Panel C: Equally weighted portfolio of the US bond and individual precious metals

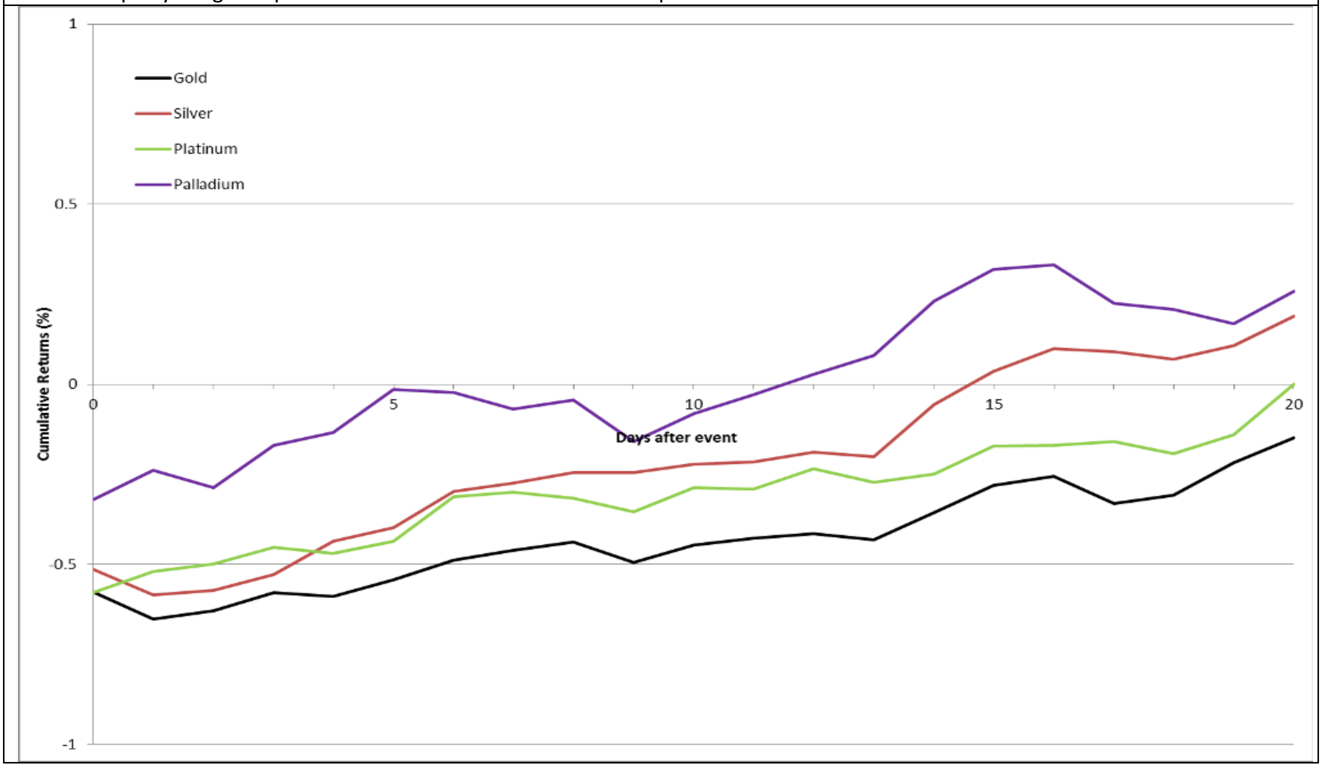
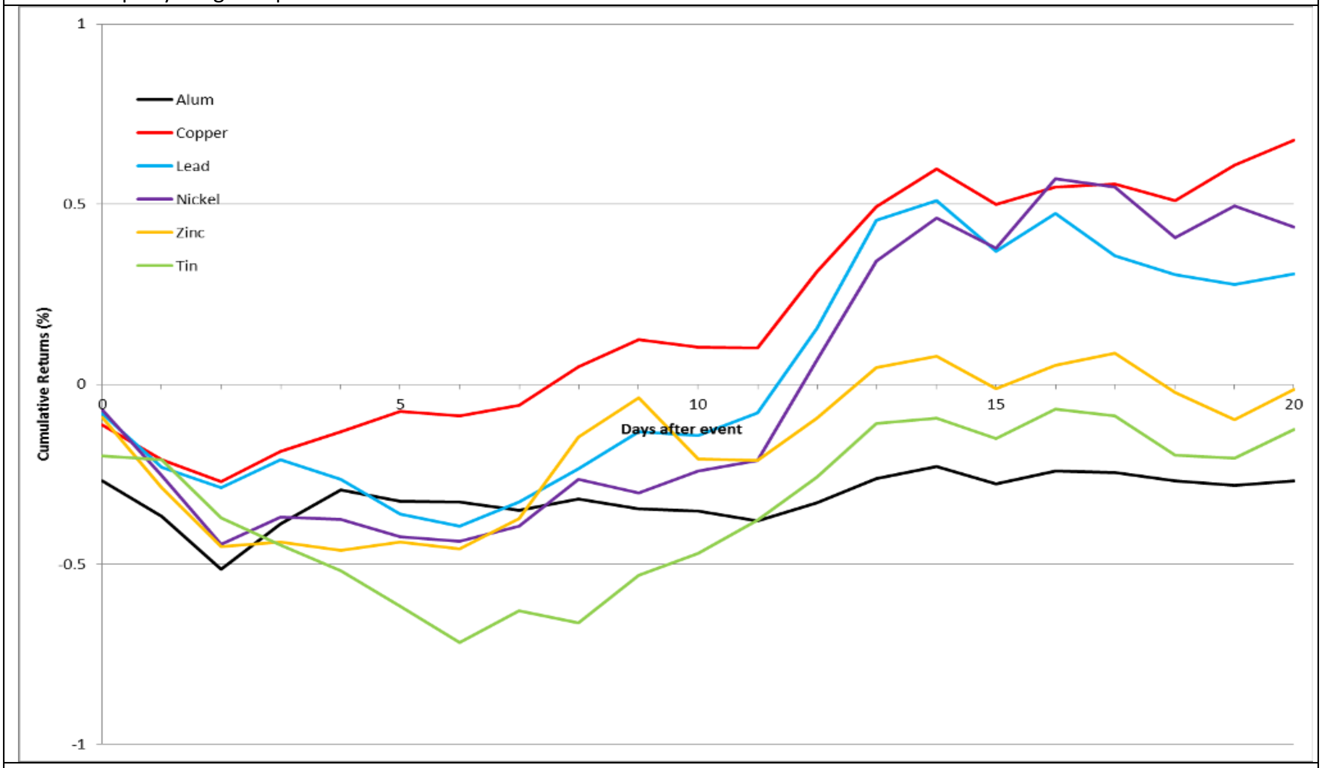


Figure 3: Post-shock performance of equally weighted portfolios consisting of the bond and dedicated industrial metals

Panel A: Equally weighted portfolio of the EMU benchmark bond and individual industrial metals



Panel B: Equally weighted portfolio of the UK bond and individual industrial metals

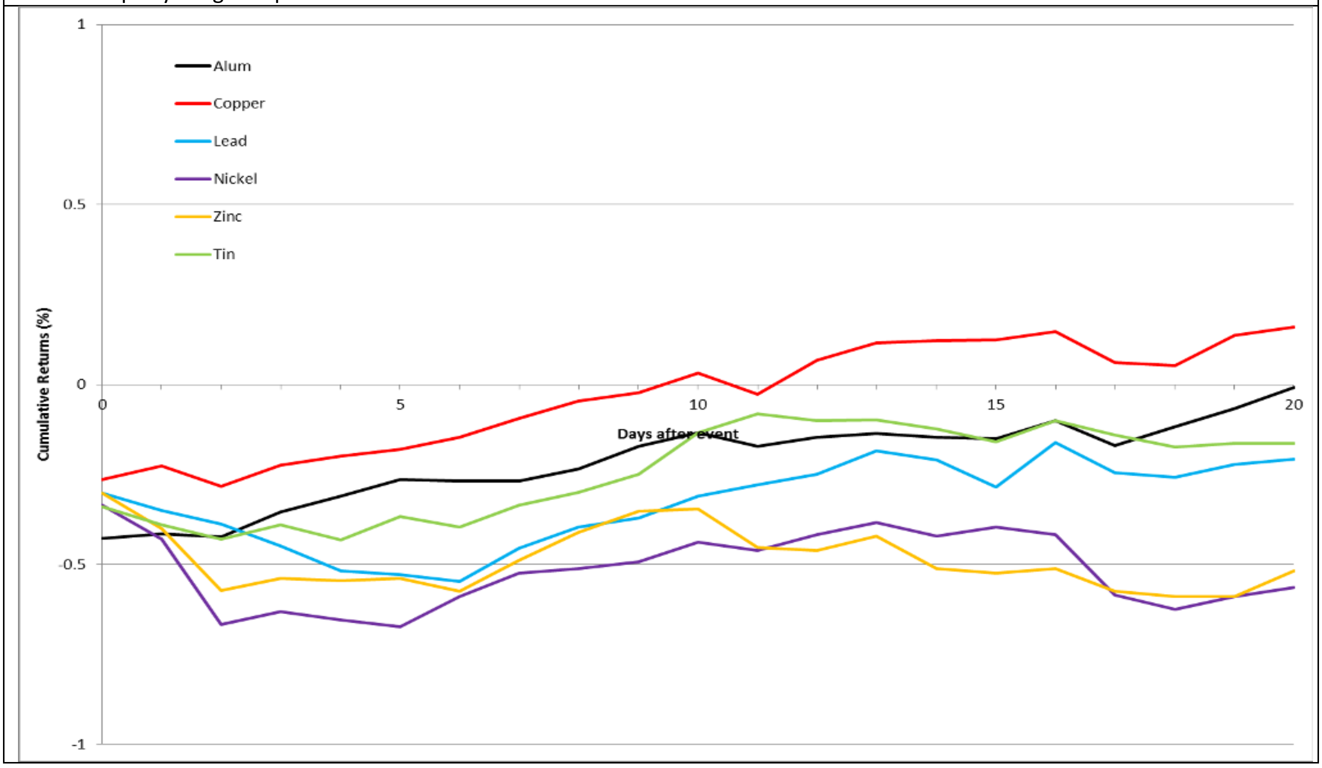


Figure 3 cont'd.

Panel C: Equally weighted portfolio of the US bond and individual industrial metals

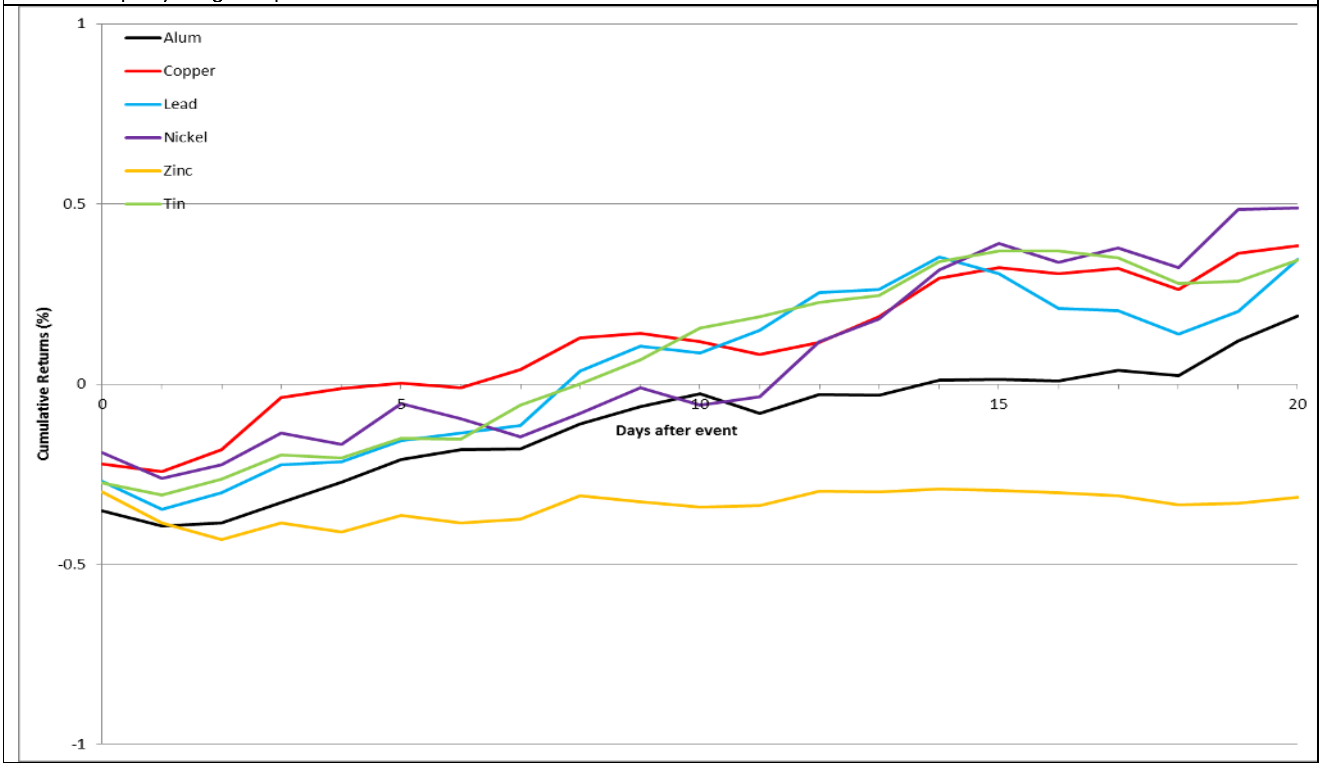
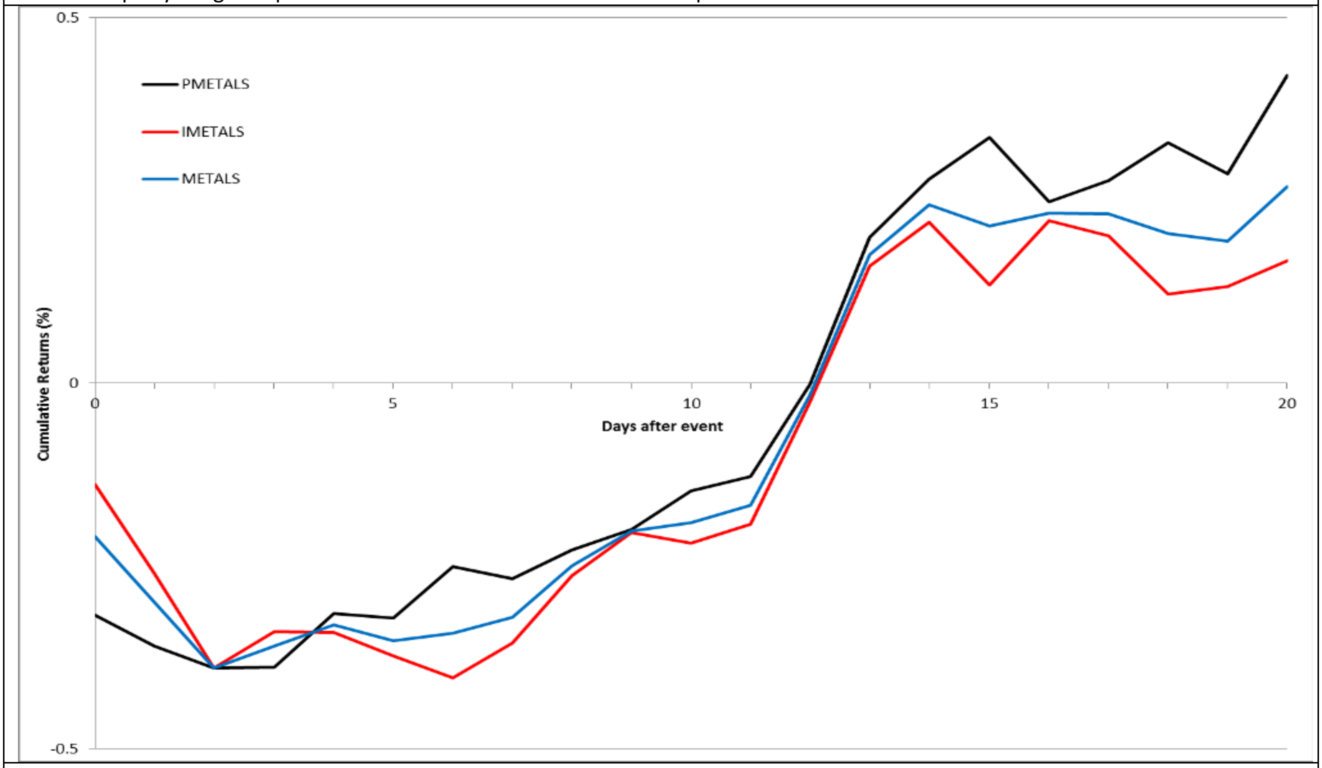


Figure 4: Post-shock performance of equally weighted portfolios consisting of the bond and portfolio of metals

Panel A: Equally weighted portfolio of the EMU benchmark bond and portfolio of metals



Panel B: Equally weighted portfolio of the UK bond and portfolio of metals

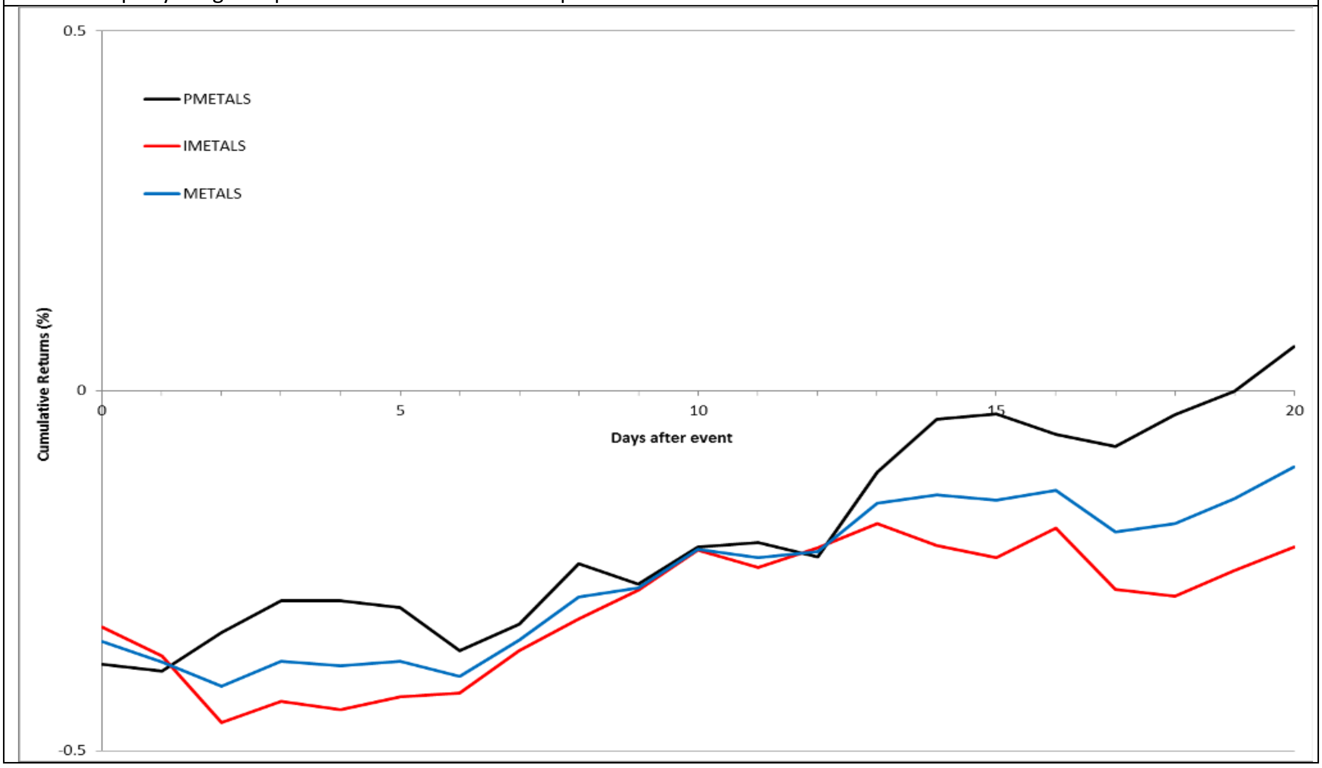


Figure 4 cont'd.

Panel C: Equally weighted portfolio of the US bond and portfolio of metals