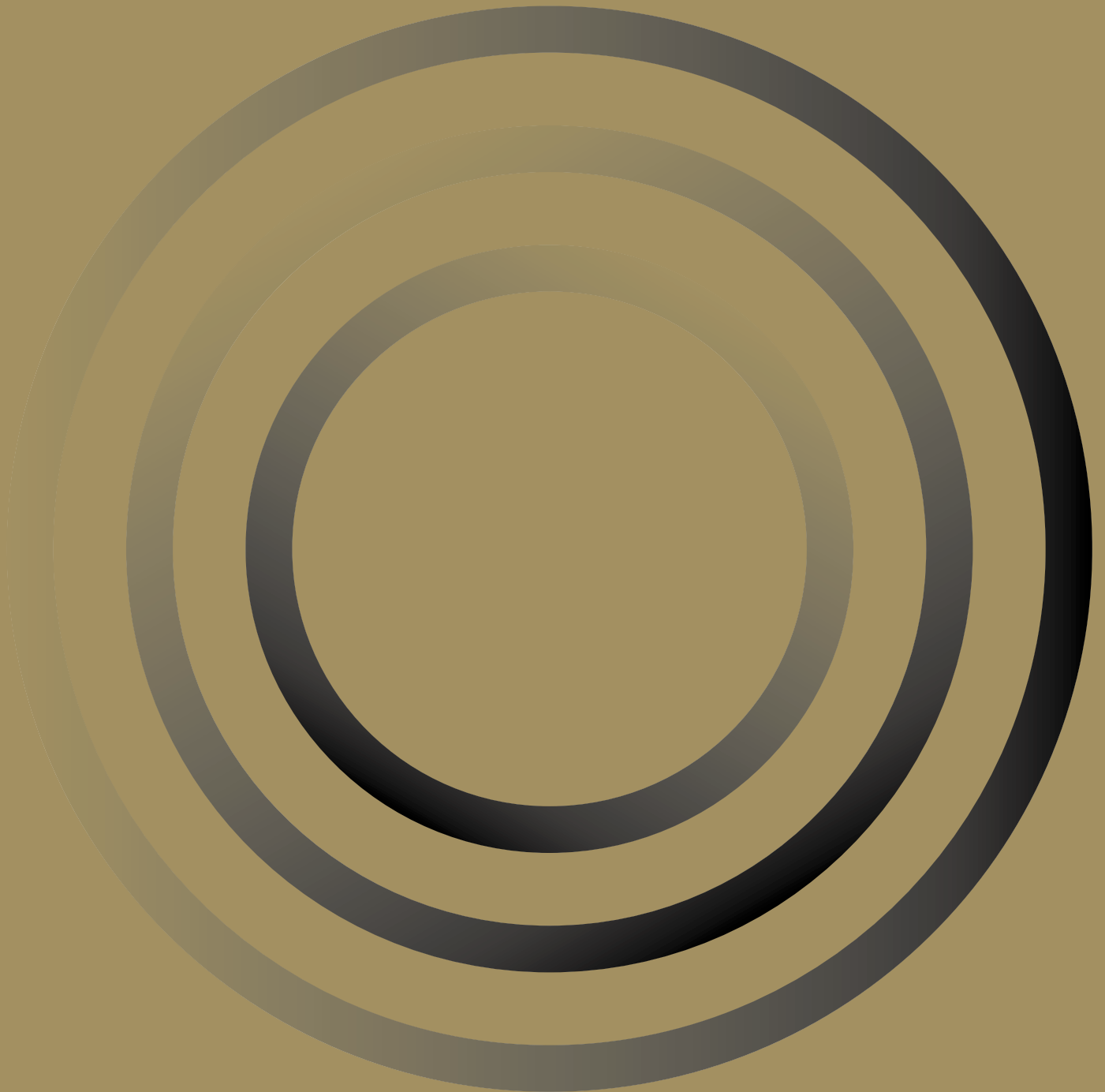WORLD
GOLD
COUNCIL

Gold as a strategic asset for UK investors:
Portfolio risk management and
capital preservation

About the World Gold Council

The World Gold Council is the market development organisation for the gold industry. Working within the investment, jewellery and technology sectors, as well as engaging in government affairs, our purpose is to provide industry leadership, whilst stimulating and sustaining demand for gold.

We develop gold-backed solutions, services and markets, based on true market insight. As a result, we create structural shifts in demand for gold across key market sectors.

We provide insights into the international gold markets, helping people to better understand the wealth preservation qualities of gold and its role in meeting the social and environmental needs of society.

Based in the UK, with operations in India, the Far East, Europe and the US, the World Gold Council is an association whose members include the world's leading and most forward thinking gold mining companies.

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Foreword

For many investors in the UK these are unprecedented times. Turmoil in Europe, a return to negative growth in the UK, a potential slowdown in some emerging markets and the spectre of higher inflation are at the forefront of investors' minds.

Periods of severe market distress typically categorised as "tail risks" – namely, unpredictable events sometimes considered unlikely which cause considerable damage to investors' capital – are occurring more frequently and becoming more prevalent. In addition, a number of recent regulatory developments in the UK are prompting a reassessment of investment strategies and asset allocation outcomes.

The Financial Services Authority's Retail Distribution Review (RDR), scheduled to come into force on 1 January 2013, should be regarded as a game changer. The UK's current commission structure for investment advice has narrowed the range of products that advisers recommend, which has been suboptimal for clients' risk preferences and diversification prospects.

Aimed at increasing the transparency, balance and fairness of investment advice given to private clients, the RDR will take time for the industry to digest. It is widely accepted, however, that robust asset allocation strategies will be instrumental to a return to stability. Thus, a positive consequence of the RDR is that financial advisers are likely to offer a broader range of assets for investors to choose from which may indeed be better suited to their individual needs. Re-focussing the advisory community and the clients it serves on the importance of asset allocation decisions, not just product selection, sits at the heart of wealth protection. Encouraging a broader approach to investing across a wider range of asset classes, based on an understanding of the long-term increase in cross correlations within global investment assets, will be a positive development.

Uncertainty and low visibility in markets experienced over the past year continue to be destructive forces. Equities have suffered from high volatility, low growth prospects and increasing correlation to other assets. During the past decade, stocks have failed to deliver the higher returns or steady dividends typically associated with the asset class and alternatives such as hedge funds or even private equity ventures have not diminished losses during tough times and failed to ensure liquidity when needed most. Risk aversion runs high.

Bonds, particularly government-issued, risk losing their reputation as reliable safe havens as their ability to honour liabilities is increasingly questioned. The thirty-year bull market in government bonds has left yields at historically and, to a large extent, artificially low levels – while financial risks are at historically high levels, as reflected by credit spreads and credit ratings.[1] With real bond yields at these low levels, UK investors, along with their international counterparts, need to reassess allocation strategies. As real yields have fallen from double figures to near or below zero in recent months, investors will undoubtedly be left to question the traditional equity-bond mix. With bond yields providing little income at current levels, investors face the prospect of assuming a higher level of risk to generate income or opting out completely.

Market observers report an emergent trend among UK investors of diverting capital from traditional investments – such as equities and bonds – towards cash. A recent survey of high-net-worth (HNW) investors conducted by the Scorpio Partnership revealed that of the discretionary managed-asset pool, 40% were not conforming to their benchmark and that during the second half of 2011, respondents had been building their cash positions at the expense of equity and fixed income allocations.[2] This dash to cash has two potentially detrimental repercussions for investors. The first is the stagnation of their capital due to lack of income from cash holdings with low and even negative real yields. The second is the concern that monetary stimulus eventually leads to unavoidable and problematic inflation. If such a trend continues – with its potentially corrosive consequences for investor holdings – then any reappraisal of investment strategies brought on in part by the RDR cannot come soon enough.

We are publishing this paper at a time when there is a real dilemma for UK investors and their advisers, which will not be a straightforward one to resolve. As we continue to navigate uncharted waters, investors must recalibrate their return expectations, assess which assets may provide core stability to their portfolio and seek better tools to manage risk. We consider gold to be an important part of the solution to these issues.

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1 See Chart 9 and Chart 10 in Appendix II.
2 *The Scorpio Partnership HNW Asset Allocator IV: Revaluating risk and return in private client portfolios,* Q4 2011.

Executive summary

A UK investor holding assets such as cash, bonds, equities, property and commodities can enhance a portfolio by adding a discrete allocation to gold as a strategic asset.

Gold's characteristics allow it to play many roles within an investor's portfolio. It serves as a portfolio diversifier, a preserver of wealth and a vehicle to manage risk more effectively, particularly against tail risks. In this paper, we show that gold provides the means for investors to reduce cross-asset correlation and, by extension, portfolio risk. Using an optimisation framework developed by Michaud et al.,[3] we analyse gold in the context of a sterling-based investor's portfolio to determine its optimal allocation and risk-hedging characteristics.

In focusing on sterling-based portfolios we aim to:

- Provide an insight into how an optimal allocation to gold can benefit UK investors during periods of economic and market stress.

- Add further support to previous findings for sterling-based investors and the existing body of similar research in other currencies.

- Discuss further uses of gold as a risk-management mechanism for sterling-based investors.

We found that for a comprehensive range of sterling-based investment strategies, from risk-averse (conservative) to risk-seeking (aggressive), gold is a significant contributor to portfolio efficiency by increasing risk-adjusted returns and reducing expected losses. Furthermore, our analysis suggests that even relatively small allocations to gold, ranging from 2.6% to 9.5%, can have a positive impact on the long-term performance of a portfolio.[4]

In addition, we found strong support for gold's risk-hedging credentials. Gold's ability to reduce losses was tested both in- and out-of-sample and during multiple periods of financial markets turmoil. During most market crises over the last 25 years, gold has consistently increased portfolio gains or reduced its losses. We found that in 78% of all the cases analysed, gold reduced the loss experienced during eight tail-risk events. For example, we found that during the 2008–2009 recession investors having a modest allocation to gold saw a reduction in losses by 227 to 676 basis points in their portfolio (£22,700 to £67,600 on every £1mn of investment) for various levels of risk tolerance. Moreover, in the out-of-sample analysis, we found that all portfolios containing gold significantly reduced losses during the worst two periods linked to the European sovereign debt crisis.[5] Consequently, the results of our analysis provide further support that an allocation to gold as a core holding is measurably beneficial to UK investors across both time and levels of risk tolerance.

The results of our analysis support the findings of previous research performed by the World Gold Council, Oxford Economics and New Frontier Advisors. The focus of this body of research has ranged from gold's allocation within currency-specific portfolios (US dollar, euro, Japanese yen), to gold's unique portfolio benefits in the presence of commodities or other alternative assets, as well as gold's role in inflation and deflationary environments.

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3 Invented by Richard Michaud and Robert Michaud. U.S. patents 6,003,018, 6,928,418, 7,412,414, 7624,060: Israel 138018. Worldwide patents pending. New Frontier Advisors LLC is worldwide licensee.

4 For a summary of results on optimal allocations to gold and portfolio impact, see Table 3 page 11 and Table 4 page 13.

5 For a summary of the effect gold had on portfolio performance during all tail-risk events analysed, see Chart 5 page 16, Chart 6 page 17 and Chart 7 page 19.

# I: Rationale behind gold as a long-term strategic asset

A robust diversifier

Increasingly globalised financial markets bring both benefits and pitfalls. Greater transparency, access and liquidity all grease the wheels of investment and savings flows while making it easier for capital to be directed toward its most productive use. However, globalised financial markets have also spurred protectionism where the forces of capitalism may at times be unwanted. More importantly, globalisation has increased the synchronisations of regional business cycles and trade flows. The impact on investors' holdings has been subtle but noticeable, particularly during periods of economic stress. The phrase "all correlations go to one" has been used often in the past few years as the global financial crisis and the recent euro area crisis have destabilised global growth. Asset classes have dutifully responded in kind and often in concert. Chart 1 shows how non-fixed income asset[6] correlations have steadily edged higher over the last 20 years, with an almost linear rise despite being broadly represented by equities, commodities and other alternatives as well as globally dispersed. The second line

on the chart shows how gold has acted to reduce this cross-correlation, with an increased impact during the last few years. The portfolio benefits accruing from investing further afield or in "alternative" assets have decreased as global finance becomes more widespread and standardised and economic cycles become more synchronised. The phenomenon is less visible in fixed income markets, a fact that does not diminish gold's ability to lower the cross correlation of bonds (Chart 11 in Appendix II).

Gold is a highly effective vehicle for diversification and risk management because of its independence from other asset classes. While many asset classes are often thought (and marketed) as diversifiers over long periods of time, few can claim that during periods of financial or economic stress. The unique dynamics and geographic mix of supply and demand for gold, whether for investment or consumption, mean that its price performance typically behaves quite differently from most other assets.

Chart 1: Gold reduces the average cross correlation of non-fixed income assets[1]
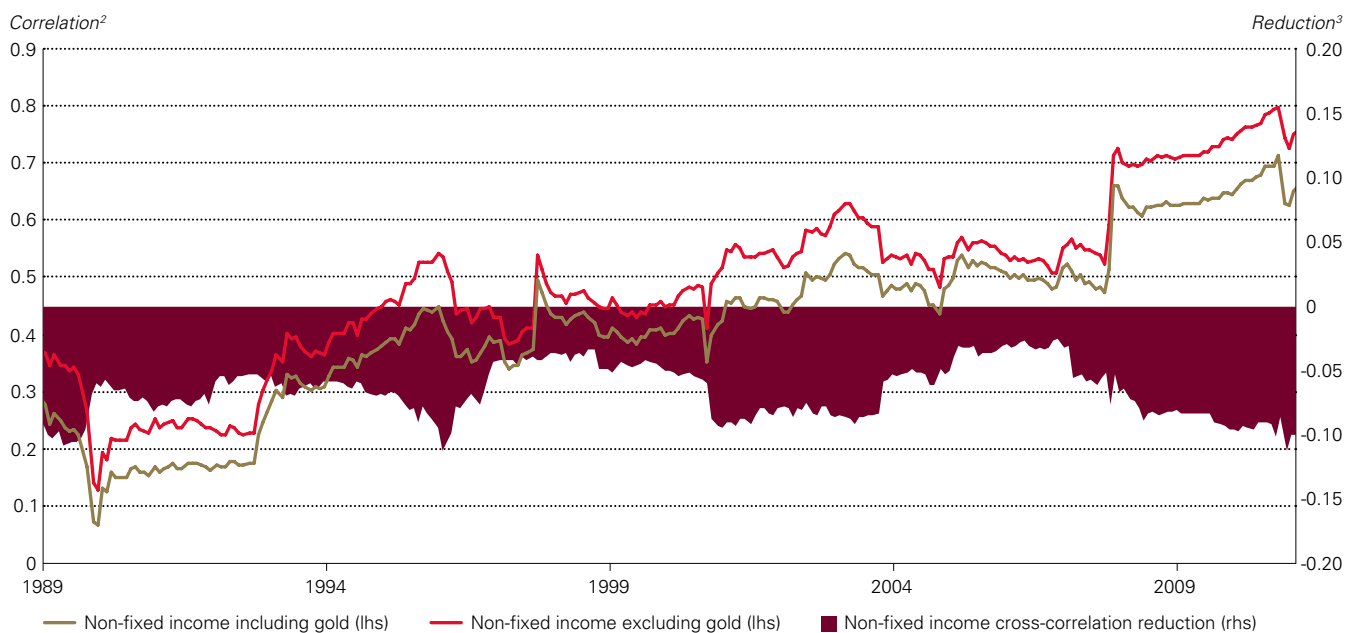
1 Non-fixed income assets include: equities, currencies, commodities, real estate, private equity and hedge funds.
2 Average cross correlations were computed as the average of pairwise correlations between non-fixed income assets including and excluding gold.
3 The reduction measure was computed as the difference between the average cross correlation with and without gold.
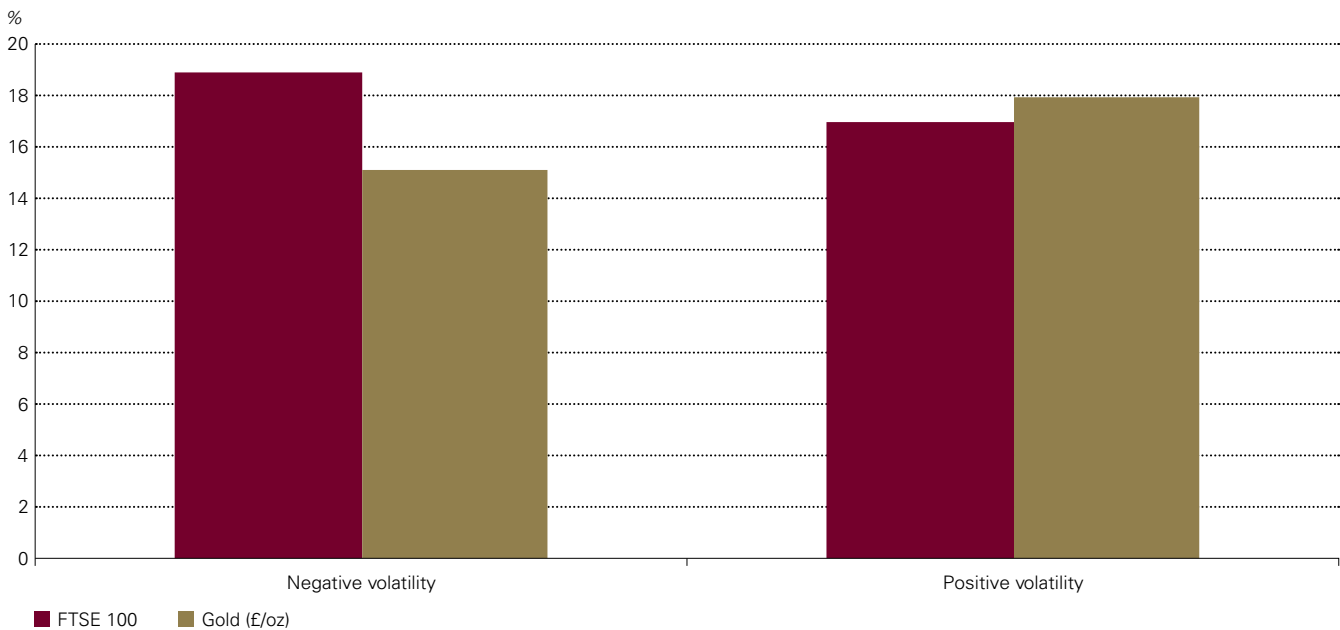
Source: Bloomberg, J.P. Morgan, World Gold Council

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6 In particular: equities, currencies, commodities, real estate, private equity and hedge funds.

Risk-hedging through asymmetry

Gold has a lower annualised volatility than many other asset classes, including developed and emerging market equity indices and real estate indices. It also has a lower volatility than a diversified basket of commodities such as the S&P Goldman Sachs Commodity Index (S&P GSCI). Moreover, gold returns are positively skewed. In other words, gold's volatility tends to be lower on the downside than it is on the upside, converse to the behaviour typically observed by equities (Chart 2).

In addition, gold is one of the few assets that not only shows low long-term correlations to most assets but often correlates negatively when investors' risk-hedging needs are greatest. Gold's average correlation to other assets is generally low. However, unlike other forms of portfolio insurance which have a strong negative correlation with traditional assets, gold tends to be negatively correlated during market distress, but shows low and positive correlations during periods of economic growth. In this sense, gold is a true diversifier.

Chart 2: Volatility skew for gold (£/oz) and FTSE 100*
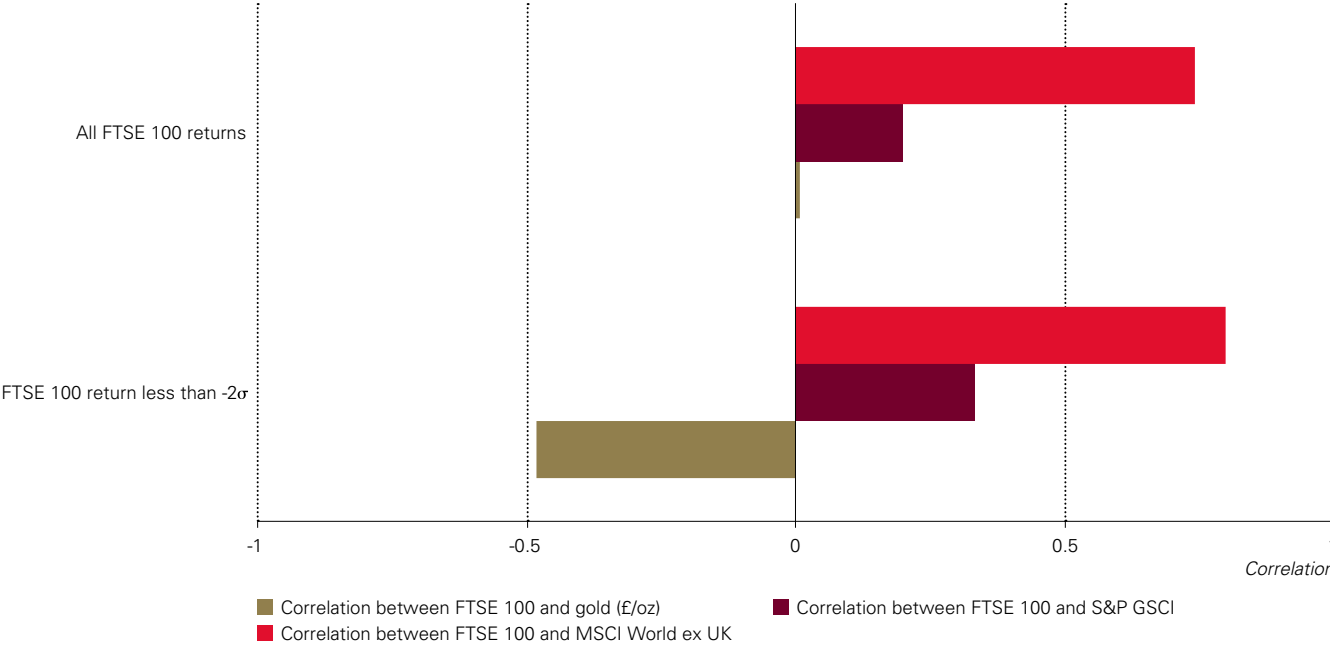

■ FTSE 100 ■ Gold (£/oz)

*Computations based on negative and positive weekly returns from January 1987 to December 2011.

Source: Bloomberg, World Gold Council

This asymmetry in correlation ensures gold can contribute to higher portfolio returns as well as lower risk. For example, using data going back to January 1987, Chart 3 shows that the long-term (unconditional) correlation between UK equities and gold is not statistically different from zero. However, the (conditional) correlation since January 1987 during periods in which UK equities dropped by more than two standard deviations is significantly negative at -0.48. In contrast, commodities and international equities experienced increased correlation with UK equities during the same period.

Consequently, during periods when higher-risk assets such as equities experience a "lower tail-risk event" (defined for the purposes of this study as periods with returns more than two standard deviations below their mean) gold performs well as a hedge. However, gold has little correlation to risk assets over the long term. This facet of gold also increases the potential gain or reduces the potential loss an investor can suffer during tail-risk events and, at the same time, does not erode the long-term returns investors expect to obtain from their portfolios. Put simply, gold preserves capital as well as protects against unforeseen risks.

Chart 3: Correlation between equities, gold and commodities over the long-run and when equities drop by more than two standard deviations*

All FTSE 100 returns

FTSE 100 return less than -2σ

-1   -0.5   0   0.5   1

Correlation

■ Correlation between FTSE 100 and gold (£/oz)　　■ Correlation between FTSE 100 and S&P GSCI
■ Correlation between FTSE 100 and MSCI World ex UK

*Computations based on weekly returns from January 1987 to December 2011.

Source: Bloomberg, World Gold Council

Liquidity and counterparty risk

Gold also helps mitigate other less frequently observed concerns such as lack of liquidity and counterparty risk. The gold market is deep and easily accessible, allowing investors to add a liquid asset to their portfolio at low cost. In addition, and often more importantly, investors can liquidate their gold positions during periods of credit stress with minimal slippage when demand for cash is high. The total amount of gold in the hands of private investors in the form of bars and coins (including gold-backed ETFs and similar physical holdings) was estimated to be approximately £1tn by December 2011. Central banks hold an additional £930bn.[7] Together with other forms of physical gold holdings such as jewellery, which in many parts of the world is seen both as an adornment and a savings vehicle, the available size of the gold market is large enough to guarantee access to a large number of market participants.

In terms of liquidity, investors have ample vehicles to choose from to gain exposure to gold: bars and coins, exchange traded funds (ETFs), gold accounts at bullion banks or derivative contracts. Many ETFs have high trading volumes and can be a cost-effective vehicle for many investors. Investors can open gold accounts, both in allocated or unallocated form. However, over-the-counter (OTC) transactions remain one of the most liquid channels to access the gold market. A recent survey by the London Bullion Market Association (LBMA) shows that turnover in gold averages US$240bn (£150bn) per day, making gold a highly liquid asset class.[8]

Physical gold has no counterparty risk, unlike most other financial assets. This may be a marginal risk at most times for the average investor, earning only a minimal premium, but often rears its head during economic crises. It has recently become particularly acute as many of the financial institutions that serve as counterparties are holders of a substantial amount of opaque derivative positions. As investors are not privy to the risks their own holdings face from the potential failure of a particular counterparty, a higher risk premium becomes inevitable. Ownership of allocated physical gold does not have any counterparty risks – imparting additional comfort for long-term investors.

7 LBMA and Thomson Reuters GFMS.

8 London Bullion Market Association, *LBMA gold turnover survey for Q1 2011,* The Alchemist, August 2011.

II: Optimal portfolio allocations to gold

Asset and period selection

This study of gold as a strategic asset incorporates data between January 1987 and December 2011 to ensure that as many representative asset classes as possible can be included without compromising the length of historical analysis. While data availability prohibits a study spanning the full 40 years that gold has been freely traded, this quarter-century period incorporates both a long bear and bull market for gold. In addition, it envelops three business cycles and several periods of market distress, reducing the potential bias of period selection. Focusing on more recent history also allows for a greater breadth of asset selection to represent the major asset classes of bonds, equities and alternatives.[9]

The study incorporates indices representing cash, both in sterling and foreign currency, and splits UK equities along market capitalisation lines to represent either end of the size spectrum with both the FTSE 100 and the FTSE UK SmallCap indices. The importance of global emerging markets investment has been reflected by the inclusion of MSCI EM index. The increasing, yet still restrained, allocation to alternatives has both commodities and Real Estate Investment Trusts (REITs) – as a proxy for property – included via the S&P GSCI and the FTSE EPRA REIT Index. While UK corporate bonds may be a more prominent feature of sterling-based investor portfolios as an alternative to UK gilts going forward, a lack of suitable indices with a long enough history led us to use a US corporate benchmark. Finally, we included an index of inflation-linked bonds, or "linkers" as they are widely referred to in the UK. Adding linkers to a portfolio should provide a further challenge to a gold allocation in its role as inflation hedge. All of the indices chosen were based in pounds sterling, and we selected total return indices wherever possible. A complete list of the corresponding indices used throughout this study can be found in Table 8 in Appendix II.

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9 The previous sterling-focused study only included domestic and international equities and bonds and ignored other assets such as commodities and property.

Return, volatility and correlation

To obtain optimal portfolios using a mean-variance optimisation approach, there are three primary inputs required: a set of expected future returns, volatilities and correlations. A natural approach is to use historical estimates based on available data. In our case, this means using performance measures between January 1987 and December 2011 as our best estimate for future returns, volatilities and correlation. Appendix I details a more in-depth discussion of the empirical performance of the selected universe of assets for this study including: returns (both nominal and real); volatility; information ratio;[10] and Value at Risk (VaR).[11] However, particularly for estimates on future returns, one can also use returns based on (theoretical) economic models or empirical returns observed during much longer periods of time to avoid any "period bias".

In line with previous research, we chose to use estimates for future returns (to derive optimal allocations) based on long-term expectations commonly found in financial and economic literature. These assumptions are summarised in Table 1 and are consistent with other studies. Some of these estimates are based on observations since the 1900s, for example – a window often used to determine long-term returns for equities, commodities, bonds or real estate. However, while average returns may still be available in the literature, the underlying data is typically not. As such, we based the volatility (and correlation) estimates on data since January 1987 as summarised in Appendix I.

While the empirical real return for gold since 1987 has been around 2% per annum (Table 7 in Appendix I), the estimate we have used is that of a zero percent real return. The rationale is three-fold. First, it is close to an average of the US dollar/gold-pegged performance last century until the 1970s and the higher real returns experienced since the end of the Bretton Woods system. Second, a conservative bias will make results more usable in planning an effective investment strategy and will highlight gold's role in a portfolio, particularly as a risk-management vehicle. Third, a zero real return is commonly accepted by investors and academics as a long-run characteristic of the gold price.[12]

Optimisation through resampled efficiency

As per previous studies in this series, Michaud Resampled Efficient Frontier™ optimisation was used to find the optimal weights for gold in a variety of constructed portfolios. Since the first UK study in 2008, the methodology has undergone a number of updates and enhancements,[13] all of which were incorporated into the analysis. The advantage of using Resampled Efficient Frontier over traditional methods of portfolio optimisation is that the results do not rely on the accuracy of the expected returns and covariance structure used during the construction of the optimal portfolios. Instead, it uses observed return distributions to obtain a large number of potential outcomes to incorporate the inherent uncertainty of future return performance. Put simply, it not only estimates an efficient frontier, it delivers a measure of confidence around each optimal weight (and tests for statistical significance).

Our analysis of gold's optimal allocation involved a number of steps to ensure the relevance and usefulness of the results. We performed two types of optimisations: 1) an unconstrained optimisation for all assets and 2) a set of constrained optimisations based on portfolios at different levels of risk representative of average UK investor allocations.[14]

An unconstrained optimisation represents a flexible way to construct an efficient frontier. It does not impose conditions on what assets investors include in their portfolios or how much to invest in each of them. This approach, however, can deliver interesting yet impractical asset allocations not applicable in practice to most investors. Many members of the investment community may also need to adhere to guidelines dictating the maximum allocation they are permitted for either the class or regional focus of each asset. Similarly, individual investors and financial advisors, in practice, tend to follow industry standards in terms of the composition of their portfolios based on their level of risk tolerance.

As such, using representative portfolios at various levels of risk tolerance gives an investor the flexibility to allocate optimally within asset classes but keeps the overall allocation to each of these large groups of assets within a desired range. By analysing various scenarios with different compositions of assets, we are partitioning an unconstrained efficient frontier at various different risk-tolerance levels to ensure representative results for all investors.

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10 The information ratio is a measure of risk-adjusted returns and it is defined as the return of the asset or portfolio divided by its corresponding volatility.

11 The Value at Risk of a portfolio measures the maximum loss an investor can expect with a certain degree of confidence during a defined period of time. More formally, the VaR of a portfolio at given confidence level $(1-\alpha)$ is the maximum expected loss such that the probability that any other loss exceeds that value is no greater than α for a defined period of time.

12 D.P. Ghosh, E.J. Levin, P. Macmillan and R.E. Wright, *Gold as inflation hedge?,* Studies in Economics and Finance, vol. 22, no. 1, 2004.

13 For more details on the enhancements used by the Michaud Resampled Efficient Frontier methodology please see *Gold as a strategic asset for European investors, December 2011.*

14 All optimisations assume "long-only" portfolios without leverage. In other words, we focus on portfolio whose asset allocation for individual components range from 0 to 1.

Table 1: Optimisation assumptions for assets in pounds sterling[1]

Asset name	Asset class	Return	Volatility	Information ratio[2]
UK cash	Cash	0.0%	1.7%	0.00
Global cash ex UK[3]	Cash	0.0%	8.1%	0.00
UK gilts 1–10 years	Fixed income	1.3%	4.8%	0.26
UK gilts 10+ years	Fixed income	1.8%	8.6%	0.20
UK linkers	Fixed income	1.5%	7.0%	0.21
US corporate bonds	Fixed income	2.5%	11.2%	0.22
Global bonds ex-UK	Fixed income	2.0%	9.6%	0.21
UK small cap	Equities	6.0%	19.3%	0.31
UK large cap	Equities	5.5%	16.1%	0.34
US large cap	Equities	6.0%	18.3%	0.33
EAFE ex UK	Equities	5.0%	17.8%	0.28
Emerging market equities	Equities	8.0%	25.8%	0.31
UK REITs	Other	2.0%	22.5%	0.09
Commodities	Other	0.0%	20.8%	0.00
Gold (£/oz)	Other	0.0%	16.1%	0.00

1 These indices and data sets were selected on the basis of their inception date and appropriateness.
2 Information ratio is equal to the return assumption divided by historical volatility.
3 Equal-weighted average of cash indices on US dollars, euro, Swiss franc and Japanese yen.

Source: Barclays Capital, Bloomberg, J.P. Morgan, World Gold Council

Representative portfolio allocations for UK investors

This paper focuses on financial advisors and intermediated wealth investors. We have calculated a fair average allocation based on a number of sources.[15] In contrast to their counterparts elsewhere in Europe, UK investors commit more capital towards equities than bonds. An allocation of approximately 50% in equities and 35% in bonds compares to about 30% and 55% respectively for European investors. The allocations of UK investors more closely resemble those of their US counterparts. In many cases, UK investors have a higher domestic equity bias than their European counterparts elsewhere, though this has been fluctuating in the last couple of years.[16] Despite often declaring the intention to invest more abroad, UK investors historically commit almost 21% of their capital to UK equities. This compares to c.12% for European investors overall. This bias towards buying companies that "they know" may also explain a lower general allocation to gold compared to the European average. The UK all-share index has a considerably higher weighting of resource and energy stocks at 39% than do either the S&P 500 (15%) or the European STOXX indices (21%).[17] Perhaps investors already believe that they have exposure to gold through their commodity index allocations, a perception we have shown through our research to be incorrect. In fact, a 10% allocation to the S&P GSCI leaves an investor with an effective 0.3% allocation to gold.[18]

We have chosen five portfolio allocations representative of a wide range of investors to perform our analysis. These portfolios shown in Table 2 include allocations typically considered conservative (low risk), moderate conservative (medium-low risk), moderate (medium risk), moderate aggressive (medium-high risk) and aggressive (high risk). In general, most other portfolio allocations will fall around the selected portfolios, and the results can be extrapolated with a degree of confidence. This is true not only for individual investors, but also for institutional portfolios.[19]

Table 2: Constraints applied to different asset classes for various portfolio strategies[1]

Asset class category	Portfolio strategy				
	Conservative	Moderate conservative	Moderate	Moderate aggressive	Aggressive
Cash[2]	<25%	<15%	<10%	<5%	<3%
Fixed income[3]	55%	45%–50%	35%–40%	20%–25%	10%–15%
Equities[4]	15%–20%	30%–35%	45%–50%	60%–65%	70%–75%
Other assets[5]	n.a.	n.a.	n.a.	n.a.	n.a.
Total	100%	100%	100%	100%	100%

1 '<' implies a maximum constraint, '>' implies a minimum constraint, '-' implies a minimum and maximum constraint.
2 Cash includes pounds sterling and foreign currency.
3 Fixed income includes UK gilts 1–10 years, UK gilts 10+ years, UK linkers, US corporates, and global bonds ex UK.
4 Equities includes UK small cap, UK large cap, US large cap, EAFE ex UK, and emerging market equities.
5 Other assets include UK REITs, commodities and gold (£/oz). These assets were not explicitly constrained but implicitly bounded as a result of the constraints to other assets.
'n.a.' = not applicable.

Source: Barclays Capital, Bloomberg, J.P. Morgan, World Gold Council

15 Invesco, *European Institutional Asset Management Survey,* 2011; IFSL, *International Private Wealth Management,* 2009; Mercer, *Asset Allocation Survey,* May 2011; The City UK, *Fund Management,* 2011.

16 Mercer, *Asset Allocation Survey,* May 2011; MSCI Barra, *A Fresh Look at the Strategic Equity Allocation of European Institutional Investors,* 2010.

17 Basic materials and energy sector shares of FTSE 350, STOXX Europe and S&P 500 respectively as of March 2012.

18 World Gold Council, *Gold: a commodity like no other,* April 2011.

19 According to average allocations based on various industry reports including IMA annual survey, Tower Watson, Mercer and Association of British Insurers indicates that a typical pension fund portfolio holds up to 2% in cash, 35%–45% in fixed income, 45%–55% in equities and 0%–10% in other assets. Similarly, a typical insurance company holds up to 7% in cash, 45%–55% in fixed income, 30%–40% in equities and 0%–10% in other assets.

Summary of the allocation results

The analysis shows that optimal long-term allocations to gold for investors at various levels of risk tolerance ranged from 2.5% to 11.1% obtaining the highest risk-adjusted returns between 2.6% and 9.5% – all significant at the 10% level (Table 3; for a graphical representation, see Chart 13 in Appendix II).[20] For example, for an investor with a conservative asset mix (more cash and fixed income assets), optimal allocations to gold ranged from 2.5% to 5.4%, while a 2.6% allocation helped achieve the highest information ratio. For an investor with an aggressive asset mix (primarily equities and alternative assets), the optimal range for gold was from 4.2% to 11.1%, with the highest information ratio obtained by including a 9.5% allocation.

For the unconstrained portfolio, the optimal range to gold was lower, from 0.6% to 6.6%, achieving the maximum information ratio with a 4.5% allocation. In this case, the results were mostly significant at the 25% level (and 10% for the lower end of the volatility range). While the unconstrained case can be of academic interest, the asset composition as shown in Chart 14 in Appendix II presents portfolios containing mostly cash or atypically large allocations to emerging market equities and relatively low allocations to UK equities. These portfolios are not only uncommon in practice but can even be unappealing to some investors.

Table 3: Summary results of optimal gold allocations for various portfolio strategies[1]

Portfolio strategy[2]	Range for optimal gold allocations	Optimal allocation to gold producing the highest information ratio	% of portfolios with statistically significant allocations to gold
Conservative	2.5% – 5.4%	2.6%	94.1%
Moderate conservative	3.9% – 4.5%	4.1%	82.4%
Moderate	3.8% – 4.7%	4.4%	82.4%
Moderate aggressive	4.4% – 9.1%	7.7%	94.1%
Aggressive	4.2% – 11.1%	9.5%	98.0%
Unconstrained	0.6% – 6.6%	4.5%	80.4%

1 All ranges and optimal allocations are statistically significant at the 10% level except for the "unconstrained" case which is significant at the 25% level.
2 For portfolio composition corresponding to the portfolio strategy please see Table 10 in Appendix II.

Source: World Gold Council

20 Optimal allocations alone do not tell us anything about their statistical significance. For that, we need to turn to the distribution of allocations. Herein lies the advantage of the Resampled Efficient Frontier methodology. By constructing a distribution of possible optimal allocations for each level of risk, we are able to determine whether an allocation to gold is significantly different from zero. In this case, we show that an allocation to gold is statistically different from zero at the 10% and sometimes 5% level, supporting the evidence provided in previous research conducted by the World Gold Council.

Gold improves portfolio efficiency and reduces risk

Table 4 reveals a more detailed picture of the performance and composition of the different portfolio strategies with and without gold at comparable levels of volatility. We found that, in general, portfolios with gold produce equal or higher risk-adjusted returns than those without. Moreover, portfolios with gold consistently produce an equivalent or better efficient frontier than those without.

For example, the moderate-risk strategy depicted in Chart 4 (and Table 10 in Appendix II) shows what the optimal allocations are based on a strategy that strives to invest 45%–50% in equities, 35%–40% in fixed income and at most 10% in cash. The results for such a strategy yield 9.8% in cash, 39.4% in fixed income, 45% in equities, 1.5% in alternatives excluding gold, and a statistically significant 4.4% in gold (at a 10% confidence level). This strategy is consistent with average UK professional portfolio allocations, and the individual gold allocation is consistent with our previous findings. By adding gold, fixed income allocations are reduced slightly. Equity allocations are maintained, but the mix changes – with an increase in UK small caps and emerging markets and a decrease in UK large caps and EAFE ex UK. The most significant change is the reduction in commodity holdings which fall from 5% to 1%. These shifts in portfolio allocation tell us that while gold does not completely replace an allocation to particular assets; gold's statistically significant allocation highlights its portfolio-improving characteristics.

To isolate the effect of gold, we chose portfolios without gold at the same level of return for all strategies (Table 4). We consistently found that portfolio risk, as denoted by expected annualised volatility, is generally reduced between 10 and 30 basis points while keeping the return of the portfolio constant. In other words, adding gold increases the return per unit of risk for the portfolio. The VaR on the different strategies typically falls between 5 and 23 basis points. This translates into a reduction in the maximum monthly loss between £500 and £2,300 on every £1mn of investment. A detailed table with corresponding weights for each index/asset can be found in Table 10 in Appendix II.

Put simply, adding the optimally proposed allocation to gold makes the portfolio more efficient. In each case, this efficiency is highlighted through the reduction of overall volatility at a given level of return. This result is even more robust, considering that a zero real return assumption for gold was used amidst positive returns for other assets. Only one case, the conservative strategy, sees the VaR increased by one basis point when gold is added. The marginal increase can be attributed to the historically dominant allocation to bonds.

Table 4: Summary statistics and optimal asset allocation for each scenario[1]

Scenario	Conservative		Moderate conservative		Moderate		Moderate aggressive		Aggressive	
	with gold	without gold	with gold	without gold	with gold	without gold	with gold	without gold	with gold	without gold
Gold (£/oz)	2.6%	-	4.1%	-	4.4%	-	7.7%	-	9.5%	-
Expected annual return (%)[2]	1.7%	1.7%	2.3%	2.3%	3.1%	3.1%	3.8%	3.8%	4.2%	4.2%
Expected annualised volatility (%)[3]	4.5%	4.5%	5.9%	5.9%	7.8%	7.9%	10.2%	10.5%	11.8%	12.1%
Information ratio[4]	0.38	0.38	0.40	0.39	0.39	0.39	0.37	0.36	0.36	0.35
Monthly 2.5% VaR[5]	292	291	383	388	510	516	668	686	767	790

1 Each portfolio was optimised with a different set of constraints. See Table 2 for further details on portfolio constraints.
2 Computed as a weighted average of asset return assumptions in Table 1 and asset weights in Table 10 (Appendix II).
3 Portfolio standard deviation corresponding to the volatility assumptions in Table 1 and optimal weights in Table 10 (Appendix II).
4 Computed as the ratio of expected annual return and expected annualised volatility.
5 Maximum expected loss on a given month at a given confidence level $(1-\alpha)$ expressed in basis points of principal. This assumes that portfolio returns are normally distributed and 97.5% confidence corresponds to approximately 2.26 standard deviations. A lower number indicates a smaller expected loss.

Source: Barclays Capital, Bloomberg, J.P. Morgan, World Gold Council

Chart 4: Optimisation results for various case scenarios

Weight (%)
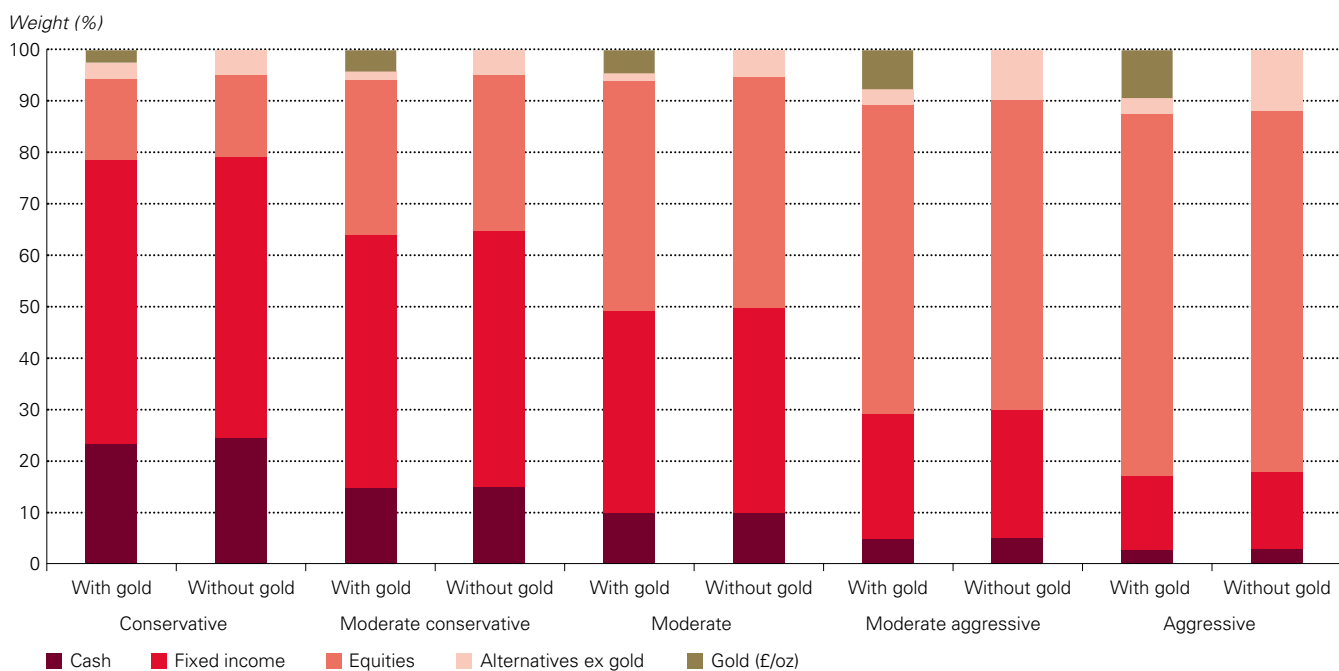
Source: Barclays Capital, Bloomberg, J.P. Morgan, World Gold Council

III: Gold as a risk management vehicle in practice

So far we have discussed the impact gold is expected to have on portfolios at various levels of risk tolerance, based on returns, volatilities and correlations investors expect to obtain in the future. There is robust evidence for adding gold as a foundation to a portfolio: over the long run, risk-adjusted returns tend to increase, losses diminish and capital is preserved. Interestingly, it is not only in theory that gold benefits investor portfolios by preserving capital and managing risk more effectively.

Over the period from January 1987 to December 2011, investors across the board would have obtained better risk-adjusted returns and/or reduced the maximum losses on a given month during the period (Table 5). Using the aggressive strategy as an example, adding gold to a portfolio would have resulted in a slightly lower average return over the period. However, portfolio volatility would have fallen by 40 basis points to 11.6%, driving the information ratio up from 0.69 to 0.7. At the same time, the maximum monthly loss expressed in basis points would have been reduced by 27 basis points to 1,652 basis points (16.5%). This translates to a reduction of £2,700 on every £1mn of investment. This improvement in portfolio efficiency is echoed across most strategies, typically exhibiting an increase in the full period information ratio and reduction in the maximum monthly loss.

In addition, by looking at periods of financial stress, we can also show that portfolios including gold tend to perform better (by either posting gains or reducing losses) than those without gold. Our analysis concentrates on periods – starting in January 1987 – when financial markets experienced an unexpected and negative shock that affected more than one asset class. We focused on eight periods typically considered to be tail-risk events:

- The market crash around October 1987, also known as "Black Monday", looking at the performance between September and November of that year;

- The Long-term Capital Management (LTCM) crisis, between July and October 1998;

- The bursting of the Dot-com bubble, in the period between March 2000 and Feburary 2001;

- The 9/11 terrorist attacks in September 2001;

- 2002 market downturn, as stocks fell sharply between May and July 2002;

- The financial crisis of 2008–2009, also known as the "Great Recession", between May 2008 and March 2009;

- The first phase of the European sovereign debt crisis between April 2010 and July 2010; and

- The second phase of the European sovereign debt crisis between February 2011 and October 2011.

Table 5: Portfolio performance from January 1987 to December 2011

In-sample case results	Conservative		Moderate conservative		Moderate		Moderate aggressive		Aggressive	
	with gold	without gold	with gold	without gold	with gold	without gold	with gold	without gold	with gold	without gold
Gold allocation	2.6%	-	4.1%	-	4.4%	-	7.7%	-	9.5%	-
Cumulative return (%)	591%	596%	611%	619%	616%	628%	633%	633%	617%	636%
Annualised return (%)[1]	8.0%	8.0%	8.1%	8.2%	8.2%	8.2%	8.3%	8.3%	8.2%	8.3%
Annualised volatility (%)[2]	4.1%	4.1%	5.6%	5.7%	7.6%	7.7%	10.1%	10.4%	11.6%	12.0%
Information ratio[3]	1.95	1.96	1.46	1.44	1.07	1.07	0.82	0.80	0.70	0.69
Maximum monthly loss (bps)[4]	242	254	506	502	904	904	1,359	1,366	1,652	1,678

1 Compounded annual growth rate of the case portfolio, using the optimised weights in Table 10 (Appendix II).
2 Annualised historical volatility of the portfolio, using monthly data and the optimised weights in Table 10 (Appendix II).
3 Historical return divided by historical volatility, also known as risk-adjusted return.
4 Maximum expected loss on a given month expressed in basis points of principal. A lower number indicates a smaller expected loss.
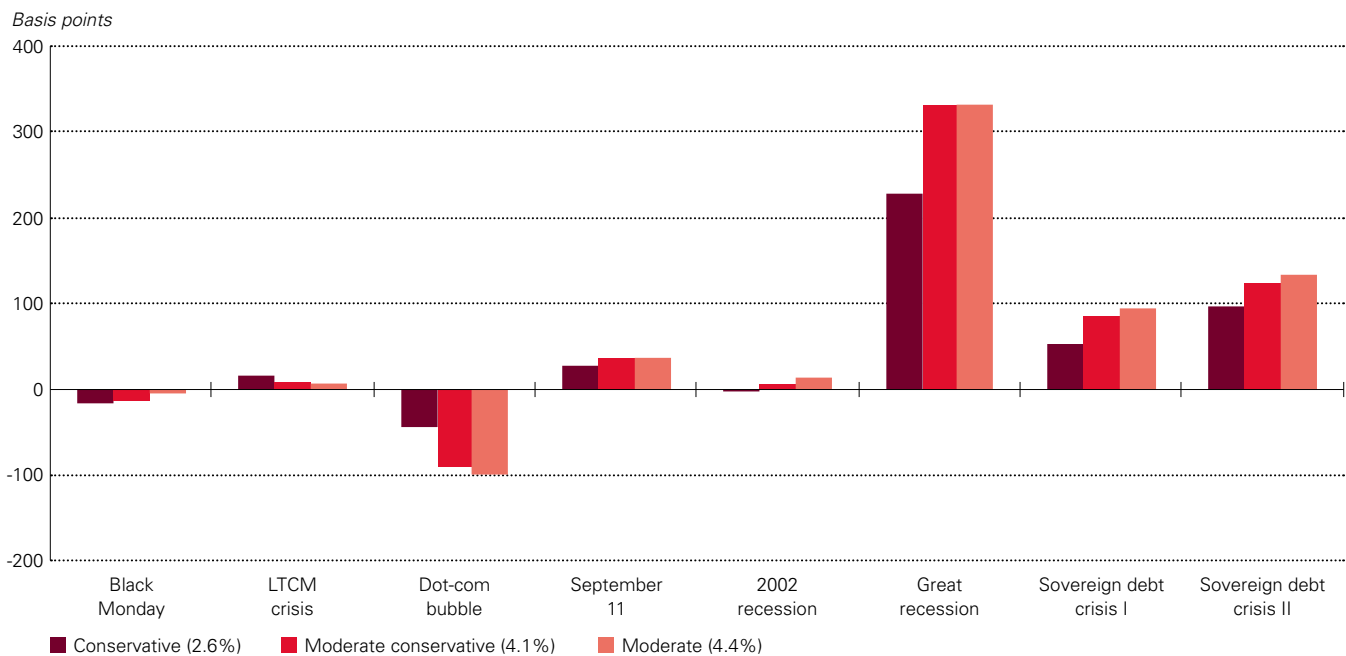
Source: Barclays Capital, Bloomberg, J.P. Morgan, World Gold Council

Chart 5 and Chart 6 summarise the outperformance (loss reduction or, in some cases, additional gain) experienced by investors at various levels of risk tolerance. While portfolios that included gold did not always fare better, they considerably outperformed those lacking gold during the recent recessionary periods. Of the 32 events, eight for each level or risk tolerance, 25 reduced losses or increased gains. This equates to a success rate of 78%. For example, during the Great Recession, a conservative investor with a 2.6% allocation to gold would have reduced their loss from £38,400 to £15,700 on every £1mn of investment, while a moderate aggressive investor with a 7.7% allocation to gold would have saved £58,600 (from £289,300 to £230,700) for every £1mn invested in the portfolio on a similar investment. In percentage terms, these savings are equivalent

to 59% and 20% respectively. In total, investors choosing a modest allocation to gold outperformed investors without gold by an average of £9,700 on every £1mn of investment during tail-risk events.

The one event where gold failed to provide portfolio protection at any risk level was the Dot-com bubble of 2000. The period between 1999 and 2001 was challenging for the gold market. We believe this to be the result of two predominant factors. First, the event was sector-specific (technology) and did not entail a market-wide meltdown. Second, structural issues, emanating from forward hedging and official sector activity, prevented gold from properly performing as a risk hedge.[21] If we exclude the Dot-com bubble, the success rate would climb to

Chart 5: Outperformance of portfolios containing gold (conservative, moderate conservative, and moderate) during crises*

Basis points

■ Conservative (2.6%)   ■ Moderate conservative (4.1%)   ■ Moderate (4.4%)

*Outperformance measured in basis points of principal. The composition of these portfolios is available in Table 10 (Appendix II).
The dates for each tail-risk event are listed in Table 11 (Appendix II).

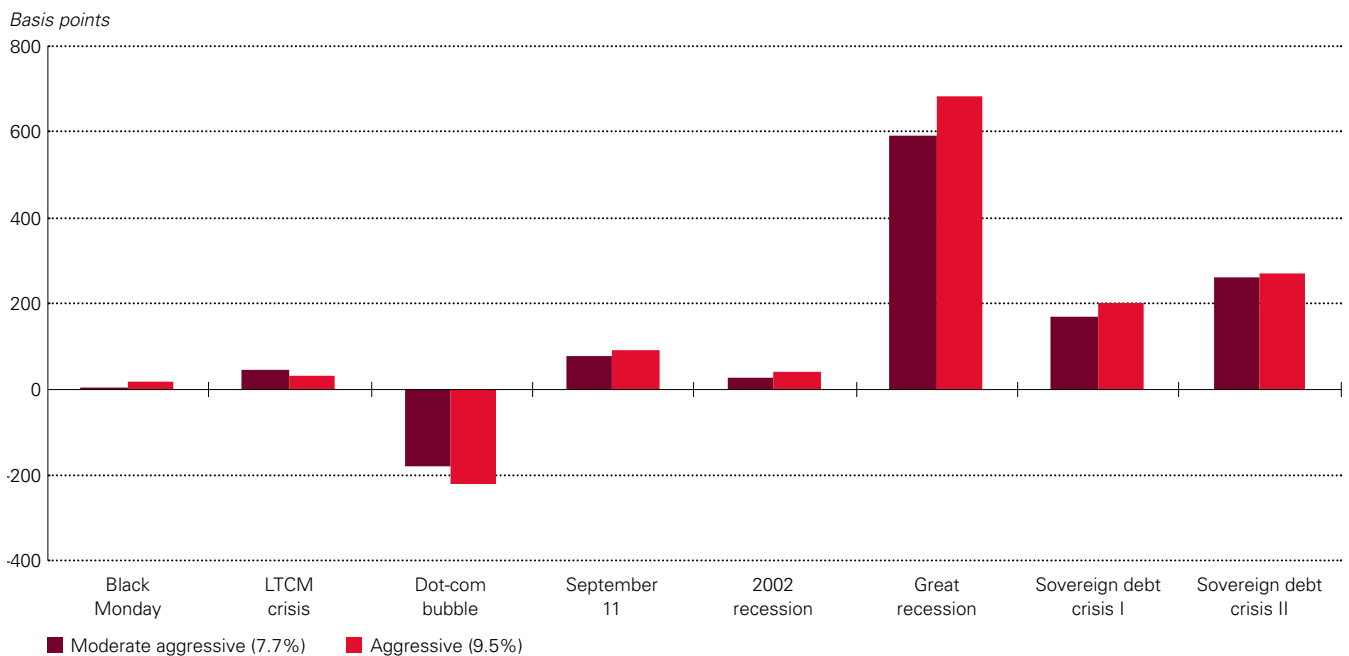Source: Barclays Capital, Bloomberg, J.P. Morgan, World Gold Council

21 We believe that the Central Bank Gold Agreements (CBGA) and a recognition that wholesale forward hedging is damaging to the gold market have largely eradicated the structural issues present towards the end of the 1990s.

91% with only 'Black Monday' and the 2002 recession showing marginally poorer performance for portfolios with gold. In addition, these periods of underperformance would be restricted to the more conservative portfolio strategies. An optimal allocation to gold would have benefited moderately aggressive and aggressive portfolios in almost every discrete occasion. The magnitude of protection is detailed in Table 11 in Appendix II. Measured in basis points, gold has added an additional 352 basis points (3.52%) to portfolio gains (or equivalently reduced losses) for conservative portfolios during crises since 1987. These figures rise as risk levels are increased: moderate portfolio (5%), moderate aggressive portfolio (10%) and aggressive portfolio (11.2%).

The benefits from holding gold substantially increased during the last three crises. This is due in part to the growing importance of emerging markets for gold demand and a rediscovery of gold's hedging potential by developed markets, which have both provided a buffer during extreme price moves.

Thus, gold has not only helped manage risk for expected or theoretical losses, but on multiple occasions has helped reduce the observed loss on an investment while keeping a similar or better average return profile and overall lower volatility.

Chart 6: Outperformance of portfolios containing gold (moderate aggressive and aggressive) during crises*

Basis points

**Outperformance measured in basis points of principal. The composition of these portfolios is available in Table 10 (Appendix II). The dates for each tail-risk event are listed in Table 11 (Appendix II).

Source: Barclays Capital, Bloomberg, J.P. Morgan, World Gold Council

Out-of-sample considerations

A caveat to the analysis presented in the previous section is that the optimal portfolios were constructed "in sample". In other words, we computed returns, volatilities, correlations and – consequently – optimal allocations based on the complete data range. In practice, investors make allocations prior to an event's occurrence. This does not invalidate the analysis, but it does raise the question of whether selecting a portfolio allocation using only information available during a specific period of time will still deliver similar results (i.e. if adding gold to the portfolio mix allows investors to manage risk more effectively) for events that happen outside of the estimation period.

The answer is that it does. Gold can be shown to reduce losses even for out-of-sample analysis. We estimated average correlations and volatilities using weekly returns between January 1987 and December 2008, excluding the most recent period during which the European sovereign debt crisis unfolded. Subsequently, we found optimal portfolios using the same methodology as before: with and without gold. We selected the portfolio with the maximum information ratio for each of the different portfolio strategies. We focused on two different periods: 1) the first phase of the European sovereign debt crisis, between April 2010 and July 2010; and 2) the second phase of the European sovereign debt crisis, between February and October 2011.

In all cases adding gold to the portfolio mix helped either reduce losses or increase gains during those market events (Chart 7). For example, during the early phase of the sovereign debt crisis, including a 2.6% allocation to gold in a conservative portfolio reduced losses by £5,000 on every £1mn of investment; a 7.9% gold allocation in an aggressive portfolio reduced losses by almost £18,000 on a similar investment. During the latter phase of the crisis, the improvement was similar going from £8,300 for conservative investors to £26,300 for aggressive ones for every £1mn in their portfolio. A more detailed summary of these results can be found in Table 12 in Appendix II.

This provides further support for our position that in real-world scenarios, investors can benefit from including a long-term strategic allocation to gold in their portfolios.

Chart 7: Outperformance of a portfolio containing gold during the European sovereign debt crisis using out-of-sample results*

Basis points

Case (gold %)

■ Sovereign debt crisis I   ■ Sovereign debt crisis II
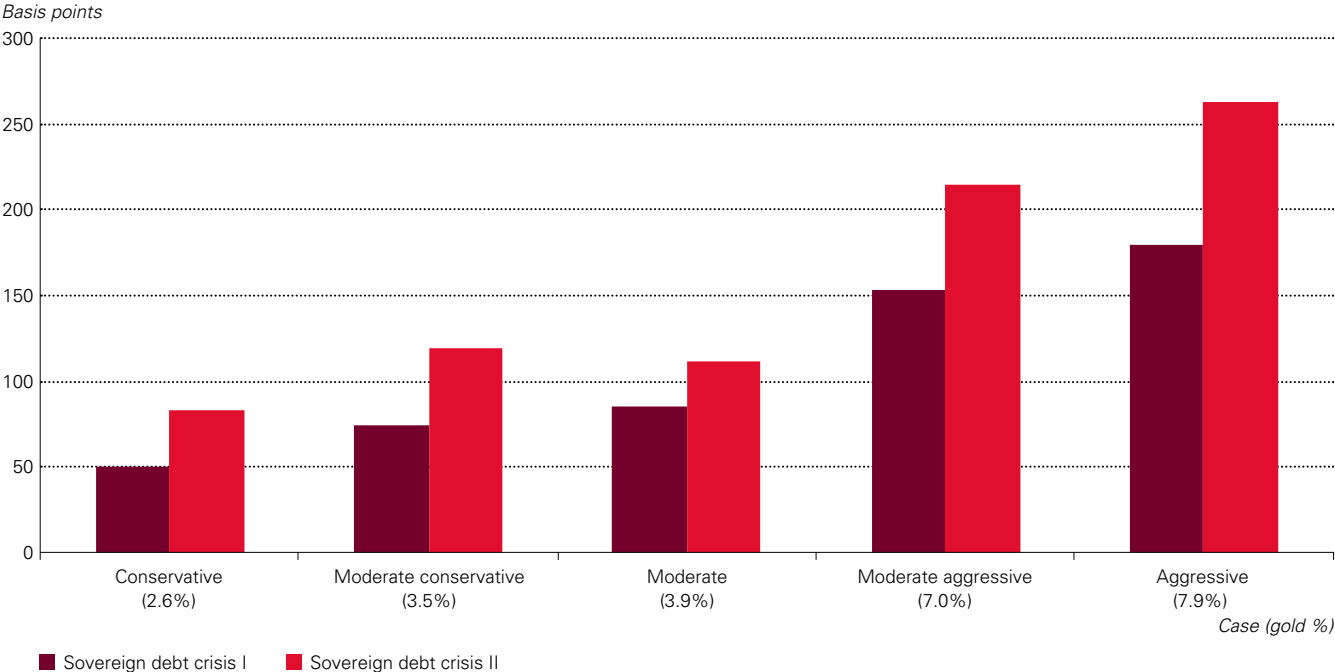
*Outperformance measured in basis points of principal.

Source: Barclays Capital, Bloomberg, J.P. Morgan, World Gold Council

Conclusion

The recent global financial crisis and the ongoing euro area crisis have caused considerable damage to investor portfolios. They have also exposed some of the fallacies of traditional investment practices and undermined standard approaches designed for normal market conditions. In addition, the increased frequency of tail-risk events, higher cross correlation of global risk assets and the lower potential benefits of government bonds have prompted investors to revisit their asset holdings. Many investors therefore have increased their capital towards cash deposits which, in turn, have the potential to erode future wealth. However, the introduction of the RDR by the FSA means investors will not only be given a broader set of options, but will also need to reconsider their allocation strategies. Collectively, these factors have already promoted the rediscovery of gold as a foundation asset and as a vehicle for managing portfolio risk.

For the average UK investor, our analysis suggests that even small allocations to gold, ranging from 2.6% to 9.5%, can have a positive impact on the structure of a portfolio. On average, such allocations can reduce the maximum expected losses in a portfolio while increasing risk-adjusted returns, when considered against equivalent portfolios without an allocation to gold

(Table 6). For the five portfolio strategies analysed using data over 25 years, adding gold delivered better risk-adjusted returns and/or reduced the maximum expected (and observed) losses. Additionally, we found that portfolios including gold outperformed those lacking it in multiple tail-risk events, particularly during the recent crises. For example, investors with gold would have saved as much £67,600 on every £1mn of investment during the 2008-2009 recession, and an average of £9,700 (per £1mn) on all financial crises over the past 25 years.

Gold benefits sterling-based investors for multiple reasons. It effectively helps manage risk in a portfolio, as it increases risk-adjusted returns and reduces the expected losses incurred during extreme market events. In the long term, gold's diversification credentials increase portfolio efficiency, both in good and bad economic times. Likewise, a reduction of potential losses over the long term requires fewer, often expensive, contingency measures to deal with the potential for extreme losses. There are both short-term and long-term advantages to using gold as a foundation asset in a portfolio, particularly its unique way of helping investors manage portfolio risk and preserve wealth.

Table 6: Summary of the impact gold has on sterling-based portfolios[1]

		In-sample[2]				
		Conservative	Moderate conservative	Moderate	Moderate aggressive	Aggressive
Gold allocation		2.6%	4.1%	4.4%	7.7%	9.5%
Information ratio	01/1987 – 12/2011	−	+	+	+	+
Maximum monthly loss	01/1987 – 12/2011	+	−	−	+	+
Black Monday	09/1987 – 11/1987	−	−	−	+	+
LTCM crisis	07/1998 – 10/1998	+	+	+	+	+
Dot-com bubble	03/2000 – 02/2001	−	−	−	−	−
September 11	09/2001 – 09/2001	+	+	+	+	+
2002 recession	05/2002 – 07/2002	−	+	+	+	+
Great recession	05/2008 – 03/2009	+	+	+	+	+
Sovereign debt crisis I	04/2010 – 07/2010	+	+	+	+	+
Sovereign debt crisis II	02/2011 – 10/2011	+	+	+	+	+
		Out-of-sample[3]				
Gold allocation		2.6%	3.5%	3.9%	7.0%	7.9%
Information ratio	01/2009 – 12/2011	+	+	+	+	+
Maximum monthly loss	01/2009 – 12/2011	+	+	+	+	+
Sovereign debt crisis I	04/2010 – 07/2010	+	+	+	+	+
Sovereign debt crisis II	02/2011 – 10/2011	+	+	+	+	+

1 These include: 1) higher (+) or lower (−) information ratios or maximum losses over the period under consideration; and 2) gains (+) or losses (−) during various financial downturns generally considered tail risks.
2 Estimation and outperformance analysis using data between January 1987 and December 2011.
3 Estimation using data between January 1987 and December 2008. Outperformance analysis conducted using data between January 2009 and December 2011.
Source: World Gold Council

Appendix I: Empirical returns, volatility and correlation

Gold's true benefits become evident when investors consider all their holdings at the same time – when assets are not seen in isolation, but in a portfolio context. However, even from an individual asset perspective, gold shows desirable qualities. Table 7 details the empirical performance of the selected universe of assets for this study. For each asset, we have calculated returns, both nominal and real; volatility; the information ratio; and Value at Risk (VaR). Table 9 in Appendix II summarises the matrix of correlations between selected assets. These metrics cover the period from January 1987 to December 2011.

Returns

The first two columns summarise returns over the selected period. The last 25 years have seen a real (deflated by UK RPI)[22] outperformance by emerging market equities at an annualised growth rate of 13.3% as would be expected given both the attraction of superior economic growth and diversification potential these markets have offered. Surprisingly, while the other equity aggregates have not performed badly, their performance is in line with or even slightly worse than that of fixed income. As we have mentioned, fixed income, particularly government bonds has experienced a bull-market over the

past quarter century. Yields are at historic lows in most developed markets with negative implications for investors. Strategic allocations based on past returns are likely to be overly complementary towards bonds as risks going forward are skewed to the downside. Gold returns, in sterling terms and consistent with previous research, have exceeded zero in real terms over the long run at 1.8%, slightly behind that of a diversified commodities index. The poorest performers have been European equities and UK REITs, a fact that should not be taken lightly.

Volatility

The standard deviation measure shows gold to be less volatile than all the non-fixed income indices in the table. While it may not be a surprise, this point is even more relevant if one remembers that gold is a single asset. Its variability is not diluted by the interaction of individual securities within an index. All other indices in the table, fixed-income or otherwise, are already baskets comprising several (in some cases hundreds of) individual securities. Each of these constituents will have some reductive influence on the volatility of the index itself. All this helps put gold's price stability into context.

Table 7: Performance summary of selected assets from January 1987 to December 2011[1]

Asset name	CAGR[2] (%) Real	CAGR[2] (%) Nominal	Annualised volatility[3] (%)	Information ratio[4]	Monthly VaR[5] (bps) 97.5%	Monthly VaR[5] (bps) 99%
UK cash	2.9%	6.6%	1.1%	6.29	n.a.	n.a.
Global cash	1.5%	5.1%	7.9%	0.65	358	395
UK gilts 1–10 years	4.6%	8.3%	4.4%	1.89	171	214
UK gilts 10+ years	5.9%	9.7%	8.3%	1.17	354	433
UK linkers	4.7%	8.4%	6.8%	1.24	262	393
US corporates	3.7%	7.4%	11.0%	0.68	510	555
Global bonds ex UK	3.4%	7.1%	9.3%	0.76	363	470
UK small cap	3.1%	6.8%	19.2%	0.35	1,194	1,458
UK large cap	5.2%	9.0%	16.1%	0.56	916	1,056
US large cap	5.4%	9.1%	18.2%	0.50	912	1,235
EAFE ex UK	-0.7%	2.9%	17.8%	0.16	1,202	1,279
Emerging market equities	9.5%	13.4%	25.1%	0.53	1,256	1,699
UK REITs	-0.5%	2.7%	21.9%	0.12	1,340	1,538
Commodities	3.3%	7.0%	21.1%	0.33	1,071	1,218
Gold (£/oz)	1.8%	5.4%	16.0%	0.34	807	944

1 Performance based on total return indices except for gold and EAFE ex UK in which spot price is used.
   MSCI EM index starts on December 1987 and FTSE EPRA UK REIT starts on December 1989.
2 Compounded annual growth rate.
3 Annualised standard deviation based on monthly returns.
4 Ratio of nominal return and volatility (a higher number indicates a better return per unit of risk).
5 Maximum expected loss on a given month at a predefined confidence level $(1-\alpha)$ expressed in basis points of principal.
   A lower number indicates a smaller expected loss.
'n.a.' = not applicable.

Source: Barclays Capital, Bloomberg, J.P. Morgan, World Gold Council

22 Since December 2003, the Consumer Prices Index has served as the Bank of England's target inflation measure for monetary policy purposes.
    The RPI is a long-standing comparative series which predates the CPI and is the de-facto standard historical measure of inflation in the UK.

Information ratio

Combining returns and volatility in a ratio provides a measure of return per unit of risk, or risk-adjusted returns. The third column details this ratio, also known as the "information ratio".[23] The number has no distinct value in itself but is a widely used way to compare different investments and one of the factors considered during the decision-making process. In short, a higher information ratio means that an investment delivers, on average, higher returns for each unit of volatility incurred.

Table 7 shows that gold's information ratio is low relative to other assets. Only UK REITs, developed market equities excluding the US and UK, and commodities have returned less per unit of risk. In isolation, this suggests that gold has not been the best individual investment over the selected time period, which adds more credibility to any marginal contribution that gold provides towards portfolio efficiency.

Value at Risk

What the low information ratio fails to capture is the fact that despite a 16% long-term volatility in the gold price, that volatility is higher on the upside than the downside. As previously shown, gold's returns are positively skewed, in contrast to those of equities or commodities. This facet is visible in the VaR figures, representative of the capital at risk should a tail event occur, which for gold is notably lower than all non-fixed income asset classes. For example, in any given month, for every £1mn allocation to UK small cap companies an investor can expect to lose no more than £145,800 with 99% confidence. In contrast, a similar investment into gold would result in a 35% reduction in the maximum potential loss, to £94,400.

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23 The Sharpe and Sortino ratios are alternative measures of the risk-return trade-off, but essentially convey the same information.

Correlation

Correlation forms the final piece of the puzzle. The unique make-up of gold's supply and demand base is the reason it has such a low and at times negative correlation with other asset classes. Both demand and supply are geographically diverse with no single country or region dominating, reducing concentration risk. Further, each source of demand is driven by a unique set of factors, often independent of business cycles and explaining why gold dances to a different tune. Chart 8 details how gold correlates to the universe of assets chosen

for this study (Table 9 in Appendix II). None of the assets correlate highly with gold;[24] in fact, gold's average correlation with the other assets is 0.16. Only global cash and foreign issued bonds have relatively higher correlations to gold in part due to its negative correlation to the US dollar. In general, risk assets typically held by investors such as equities and corporate bonds have average correlations double that of gold and ranging from 0.3 to 0.4. To an investor, the higher the correlations are, the lower the diversification benefits.

**Chart 8: Gold's correlation to selected assets***
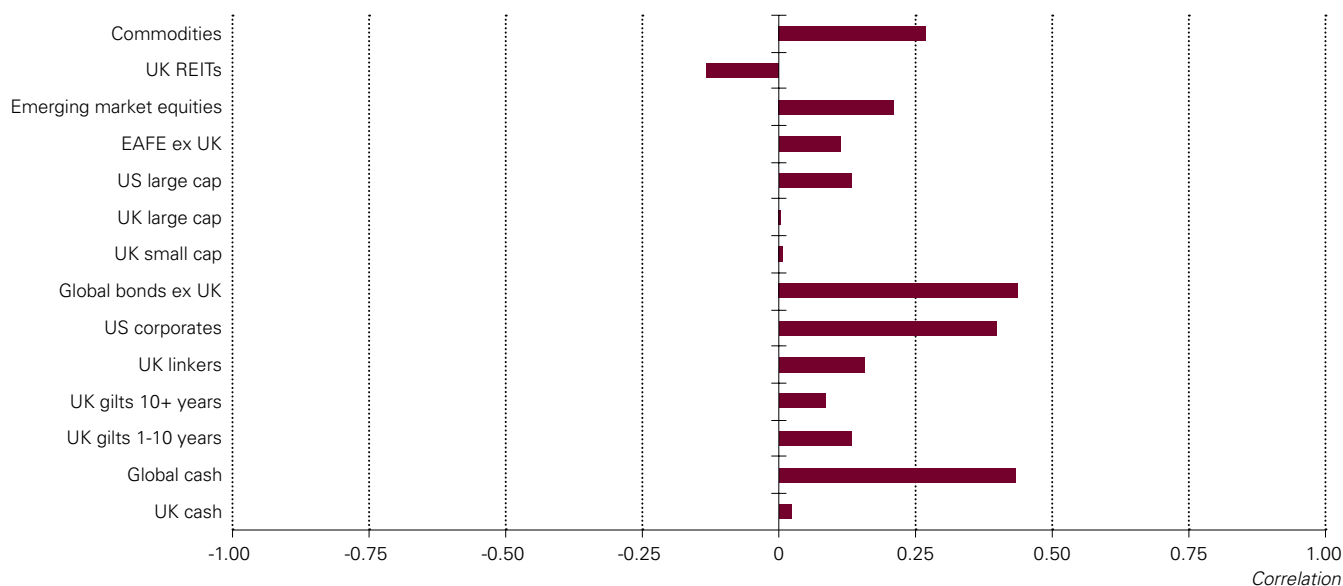
*Based on monthly returns between January 1987 and December 2011.

Source: Barclays Capital, Bloomberg, J.P. Morgan, World Gold Council

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24 There is no definitive rule for what constitutes a high correlation, but among financial instruments correlation higher than 0.6 is often considered to represent an indication of a strong linear relationship.
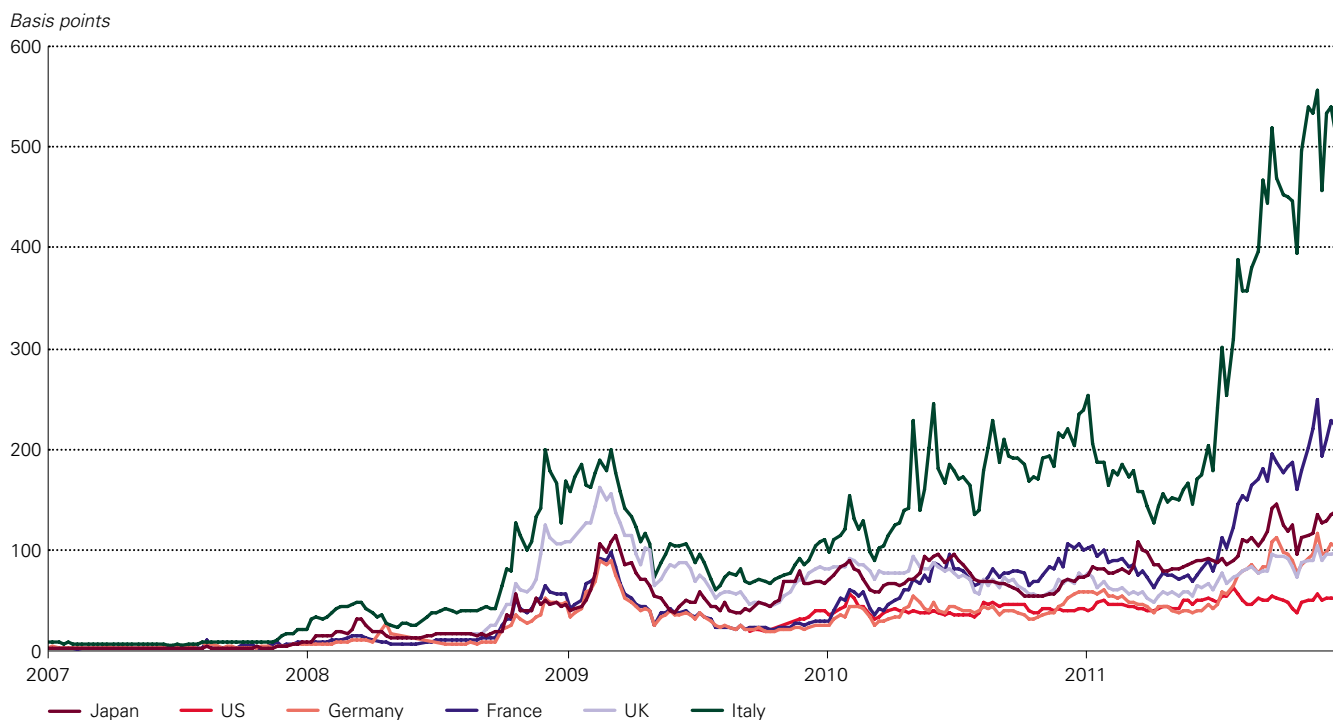
Appendix II: Charts and tables

Chart 9: G7 5-year government bond yields

Yield (%)

Japan — US — Germany — France — Canada — UK — Italy
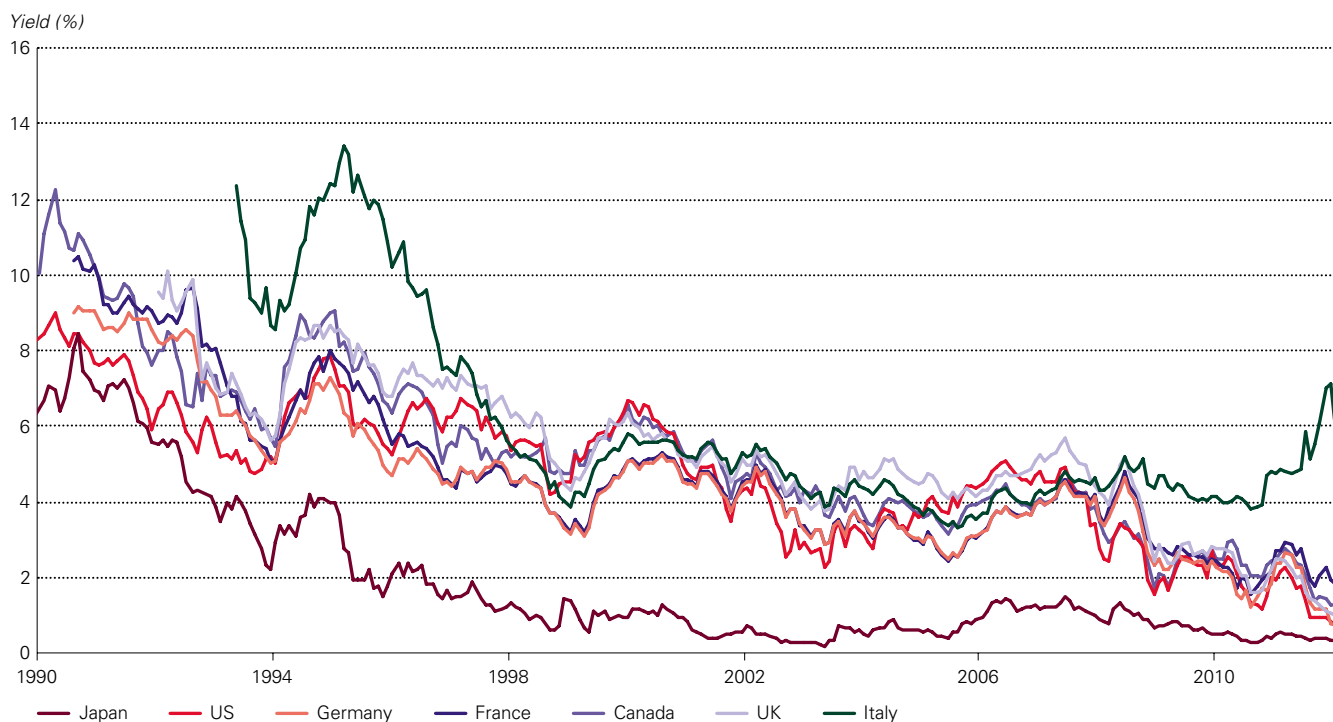
Source: Bloomberg, World Gold Council

Chart 10: G7 country credit default spreads (5-year)*

Basis points

Japan — US — Germany — France — UK — Italy

*Canada was excluded from the chart because data for the CDS Contract on Canadian sovereign debt is unavailable.
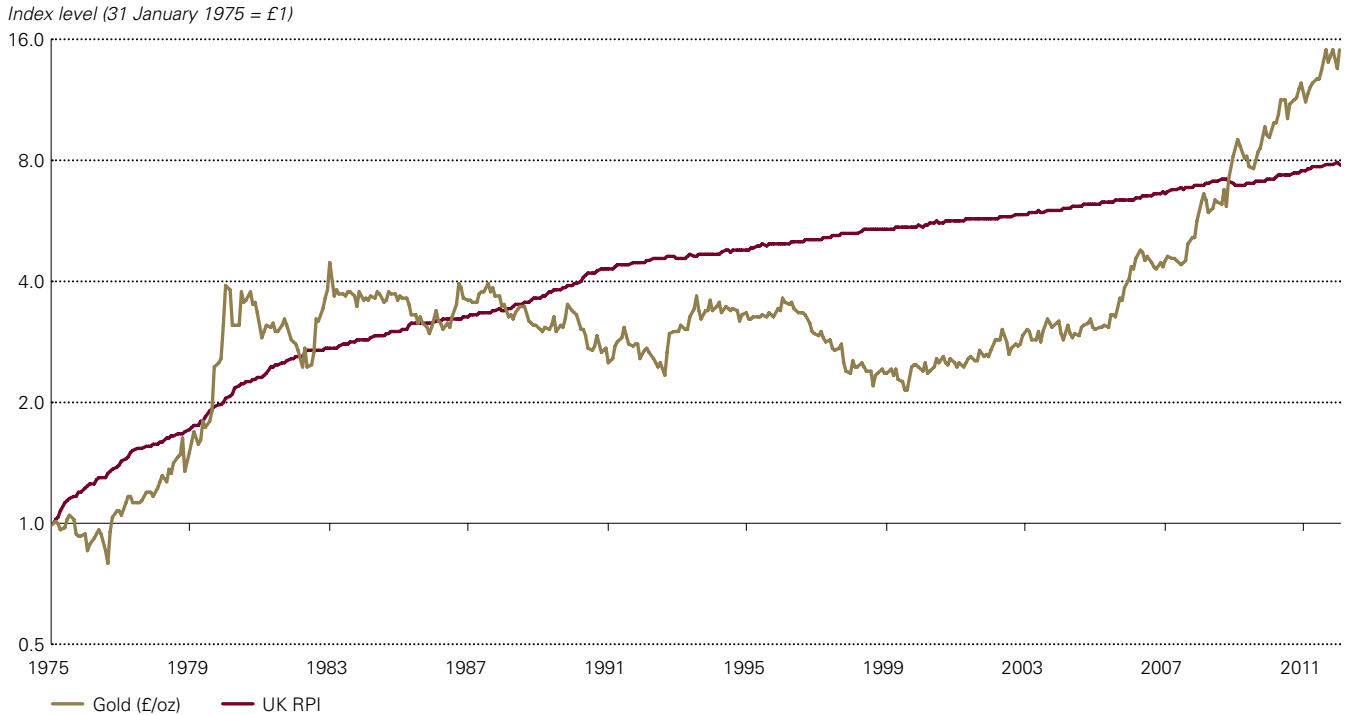
Source: Bloomberg, World Gold Council

Chart 11: Gold reduces the average cross-correlation of fixed income assets[1]

Correlation[2]   *Reduction[3]*

— Fixed income including gold (lhs)   — Fixed income excluding gold (lhs)   ■ Fixed income cross-correlation reduction (rhs)
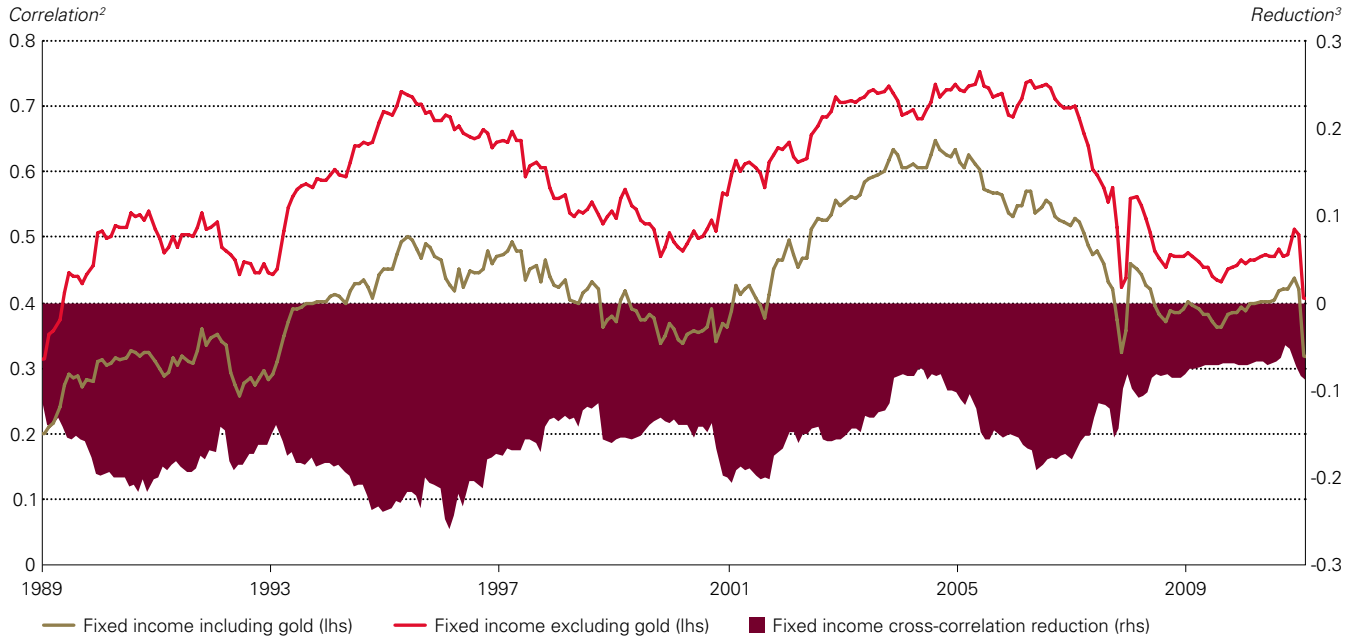
1 Fixed income assets include: UK gilts, UK corporates, US corporates, UK linkers, global bonds ex UK, and UK cash.
2 Average cross correlations were computed as the average of pairwise correlations between fixed income assets including and excluding gold.
3 The reduction measure was computed as the difference between the asset correlation with and without gold.

Source: Bloomberg, J.P. Morgan, World Gold Council

Chart 12: Performance of UK RPI versus gold (£/oz) since 1975

Index level (31 January 1975 = £1)

— Gold (£/oz)   — UK RPI

Source: Barclays Capital, Bloomberg, J.P. Morgan, World Gold Council

Table 8: Name keys for assets used throughout this report[1]

Short name	Index name[2]	Asset class	Date range[3]
UK cash	JP Morgan UK Cash	Cash	
Global cash[4]	JP Morgan Global Cash ex UK	Cash	
UK gilts 1–10 years	JPM GBI UK (1–10)	Fixed income	
UK gilts 10+ years	JPM GBI UK (10+)	Fixed income	
UK linkers	BarCap UK Government Inflation-Linked	Fixed income	
US corporates	BarCap US Corporate	Fixed income	
Global bonds ex UK	JPM GBI Global ex UK	Fixed income	
UK small cap	FTSE Small Cap UK	Equities	
UK large cap	FTSE 100	Equities	
US large cap	MSCI US	Equities	
EAFE ex UK	MSCI EAFE ex UK	Equities	
Emerging market equities	MSCI EM	Equities	December 1987 – December 2011
UK REITs	FTSE EPRA UK REIT	Other	December 1989 – December 2011
Commodities	S&P GSCI Index	Other	
Gold (£/oz)	London PM Fix	Other	

1 These indices and data sets were selected on the basis of their inception date and appropriateness.
2 Total return indices except for MSCI EAFE ex UK and London PM fix for gold.
3 All price/level data series span from December 1986 to December 2011 unless otherwise noted.
4 Equal-weighted average of a combination of US dollar, euro, Swiss franc and Japanese yen cash indices.

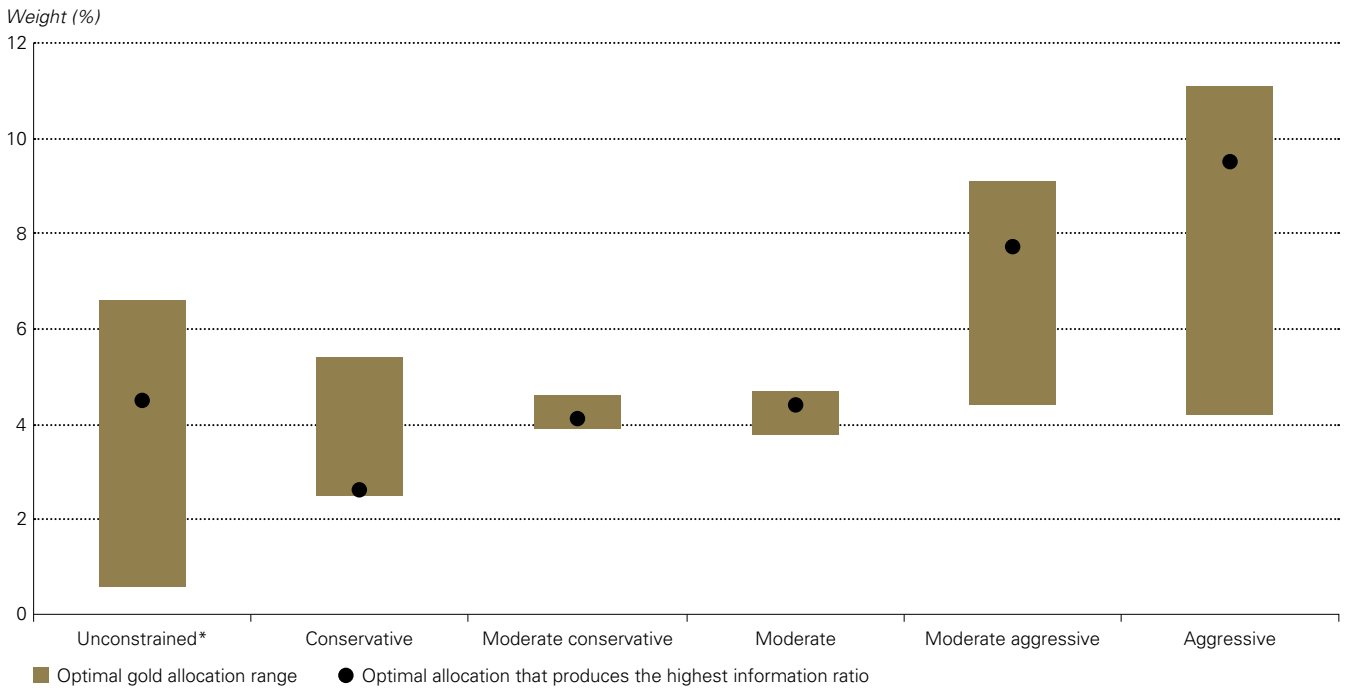Source: Barclays Capital, Bloomberg, J.P. Morgan, World Gold Council

Table 9: Correlation matrix of assets used for optimisation*

	UK cash	Global cash	UK gilts 1–10 years	UK gilts 10+ years	UK linkers	US corporates	Global bonds ex UK	UK small cap	UK large cap	US large cap	EAFE ex UK	Emerging market equities	UK REITs	Commodities	Gold (£/oz)
UK cash	1.00														
Global cash	0.24	1.00													
UK gilts 1–10 years	0.45	0.29	1.00												
UK gilts 10+ years	0.27	0.19	0.86	1.00											
UK linkers	0.21	0.25	0.62	0.66	1.00										
US corporates	0.24	0.67	0.35	0.31	0.31	1.00									
Global bonds ex UK	0.25	0.90	0.45	0.38	0.34	0.85	1.00								
UK small cap	0.07	0.01	0.04	0.05	0.21	0.19	0.04	1.00							
UK large cap	0.11	0.10	0.16	0.15	0.26	0.24	0.13	0.78	1.00						
US large cap	0.14	0.33	0.08	0.08	0.19	0.57	0.42	0.62	0.76	1.00					
EAFE ex UK	0.06	0.27	0.09	0.10	0.25	0.28	0.25	0.70	0.73	0.70	1.00				
Emerging market equities	0.08	0.19	0.06	0.05	0.16	0.35	0.21	0.64	0.63	0.70	0.71	1.00			
UK REITs	-0.06	-0.26	0.12	0.16	0.19	-0.01	-0.18	0.61	0.53	0.32	0.38	0.30	1.00		
Commodities	-0.06	0.16	-0.09	-0.10	0.07	0.23	0.15	0.23	0.17	0.24	0.19	0.29	0.05	1.00	
Gold (£/oz)	0.03	0.43	0.12	0.08	0.15	0.39	0.42	0.01	0.00	0.13	0.11	0.21	-0.13	0.27	1.00

*Correlations computed using available monthly return data from January 1987 to December 2011.

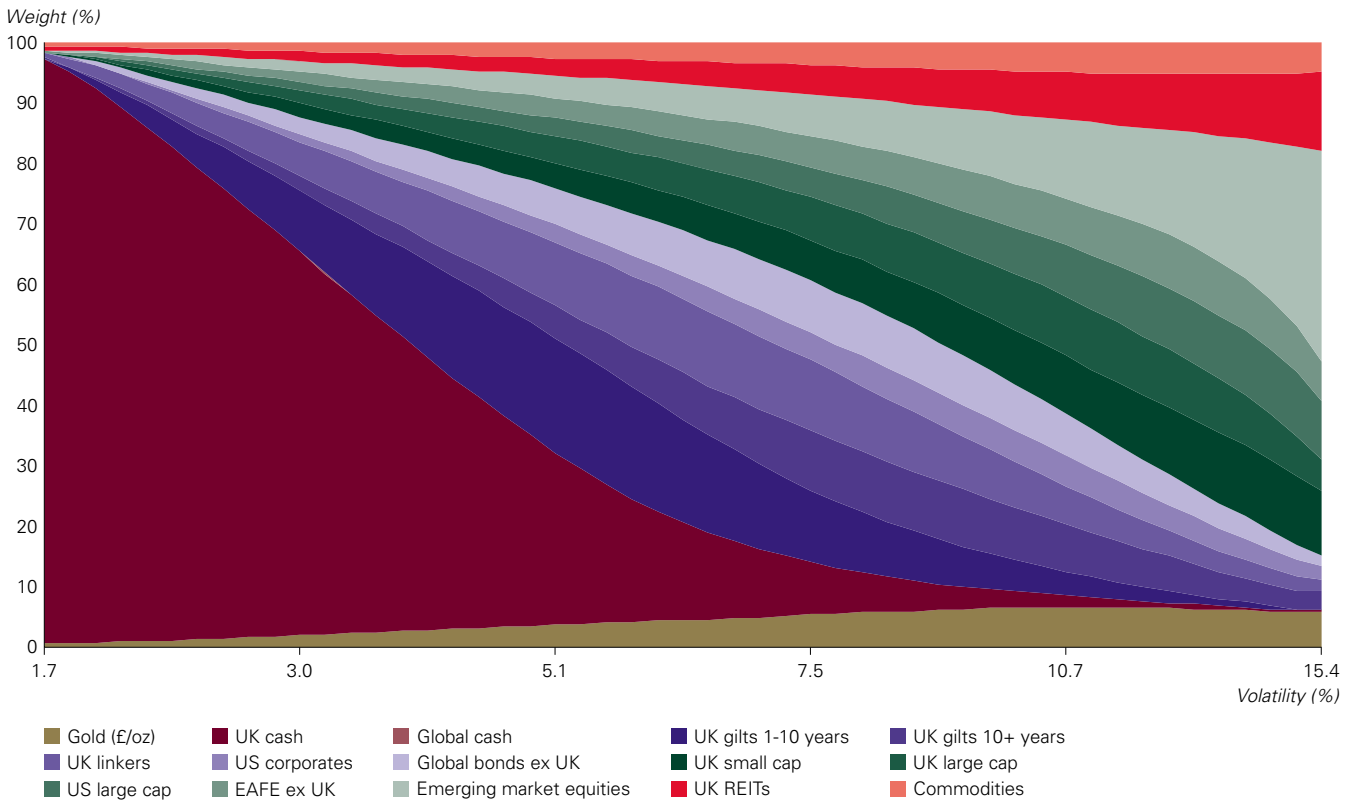Source: Barclays Capital, Bloomberg, J.P. Morgan, World Gold Council

Chart 13: Range for optimal gold allocations at the 10% significance level*

Weight (%)

Legend:
- Optimal gold allocation range
- ● Optimal allocation that produces the highest information ratio

*The optimal allocation range shown for the unconstrained portfolio is at the 25% significance level.

Source: World Gold Council

Chart 14: Asset allocation map of the unconstrained portfolio

Weight (%)

Volatility (%)

Legend:
- Gold (£/oz)
- UK cash
- Global cash
- UK gilts 1-10 years
- UK gilts 10+ years
- UK linkers
- US corporates
- Global bonds ex UK
- UK small cap
- UK large cap
- US large cap
- EAFE ex UK
- Emerging market equities
- UK REITs
- Commodities

Source: Barclays Capital, Bloomberg, J.P. Morgan, World Gold Council

Table 10: Summary statistics and optimal asset allocation for each scenario[1]

Scenario	Unconstrained with gold	Unconstrained without gold	Conservative with gold	Conservative without gold	Moderate conservative with gold	Moderate conservative without gold	Moderate with gold	Moderate without gold	Moderate aggressive with gold	Moderate aggressive without gold	Aggressive with gold	Aggressive without gold
Expected annual return (%)[2]	2.3%	2.3%	1.7%	1.7%	2.3%	2.3%	3.1%	3.1%	3.8%	3.8%	4.2%	4.2%
Expected annualised volatility (%)[3]	6.3%	6.0%	4.5%	4.5%	5.9%	5.9%	7.8%	7.9%	10.2%	10.5%	11.8%	12.1%
Information ratio[4]	0.37	0.38	0.38	0.38	0.40	0.39	0.39	0.39	0.37	0.36	0.36	0.35
Theoretical monthly 2.5% VaR[5]	410	394	292	291	383	388	510	516	668	686	767	790
Portfolio weights[6]												
UK cash	16%	22%	24%	24%	15%	15%	10%	10%	5%	5%	2%	3%
Global cash	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
UK gilts 1–10 years	17%	17%	41%	43%	45%	46%	34%	36%	15%	17%	8%	8%
UK gilts 10+ years	8%	8%	2%	2%	1%	1%	2%	2%	5%	4%	3%	4%
UK linkers	12%	11%	6%	6%	2%	2%	2%	1%	2%	1%	2%	1%
US corporates	4%	5%	2%	1%	0%	0%	0%	0%	0%	0%	0%	0%
Global bonds ex UK	8%	8%	3%	3%	1%	1%	1%	1%	2%	2%	1%	1%
UK small cap	6%	5%	4%	4%	5%	5%	7%	6%	9%	8%	10%	8%
UK large cap	6%	5%	4%	4%	12%	13%	19%	20%	25%	26%	30%	32%
US large cap	4%	4%	3%	3%	6%	6%	8%	9%	11%	11%	13%	13%
EAFE ex UK	4%	3%	3%	4%	6%	7%	10%	10%	12%	14%	14%	15%
Emerging market equities	5%	6%	2%	2%	1%	1%	1%	1%	3%	2%	4%	3%
UK REITs	4%	3%	1%	1%	0%	0%	0%	0%	1%	2%	1%	2%
Commodities	3%	4%	2%	4%	2%	5%	1%	5%	2%	8%	2%	10%
Gold (£/oz)	5%	-	3%	-	4%	-	4%	-	8%	-	10%	-
Cash	16%	22%	24%	24%	15%	15%	10%	10%	5%	5%	3%	3%
Fixed income	48%	48%	55%	55%	49%	50%	39%	40%	25%	25%	15%	15%
Equities	24%	23%	16%	16%	30%	30%	45%	45%	60%	60%	70%	71%
Alternatives ex Gold	7%	7%	3%	5%	2%	5%	2%	5%	3%	10%	3%	12%
Gold (£/oz)	4.5%	-	2.6%	-	4.1%	-	4.4%	-	7.7%	-	9.5%	-
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

1 Each portfolio was optimised with a different set of constraints. See Table 2 for further details on portfolio constraints.
2 Computed as a weighted average of asset return assumptions in Table 1 and asset weights in this table.
3 Portfolio standard deviation based on the volatility assumptions in Table 1 and the weights provided in this table.
4 Information ratio is computed as the ratio of expected annual return and expected annualised volatility.
5 Maximum expected loss in a given month at a given confidence level (1−α) expressed in basis points of principal.
   This assumes that portfolio returns are normally distributed and 97.5% confidence corresponds to approximately 2.26 standard deviations.
   A lower number indicates a smaller expected loss.
6 Portfolio weights for the gold portfolios were based on allocations that achieved the maximum information ratio available.
   The portfolio weights for the no-gold portfolios were selected to match the return of the gold portfolio.

Source: Barclays Capital, Bloomberg, J.P. Morgan, World Gold Council

Table 11: Observed gain (loss) on selected portfolios with and without including gold during various tail-risk events in basis points[1]

		Conservative			Moderate		
		Portfolio gain (loss)			Portfolio gain (loss)		
		with gold	without gold	Difference	with gold	without gold	Difference
Black Monday	09/1987 – 11/1987	(141)	(124)	(17)	(1,201)	(1,195)	(6)
LTCM crisis	07/1998 – 10/1998	1	(14)	15	(790)	(796)	6
Dot-com bubble	03/2000 – 02/2001	517	561	(44)	(49)	51	(99)
September 11	09/2001 – 09/2001	(270)	(296)	26	(777)	(813)	36
2002 recession	05/2002 – 07/2002	(311)	(308)	(3)	(1,155)	(1,166)	12
Great recession	05/2008 – 03/2009	(157)	(384)	227	(1,505)	(1,837)	331
Sovereign debt crisis I	04/2010 – 07/2010	(21)	(73)	52	(517)	(610)	93
Sovereign debt crisis II	02/2011 – 10/2011	337	241	96	(311)	(444)	132
Gold allocation		2.6%	-	-	4.4%	-	-
Return (%) Jan 1987 to Dec 2011[2]		8.0%	8.0%	-	8.2%	8.2%	-
		Moderate aggressive			Aggressive		
		Portfolio gain (loss)			Portfolio gain (loss)		
		with gold	without gold	Difference	with gold	without gold	Difference
Black Monday	09/1987 – 11/1987	(1,796)	(1,801)	5	(2,168)	(2,186)	18
LTCM crisis	07/1998 – 10/1998	(1,237)	(1,285)	48	(1,537)	(1,569)	32
Dot-com bubble	03/2000 – 02/2001	(327)	(151)	(176)	(520)	(303)	(217)
September 11	09/2001 – 09/2001	(1,063)	(1,144)	81	(1,237)	(1,328)	91
2002 recession	05/2002 – 07/2002	(1,618)	(1,645)	27	(1,905)	(1,947)	42
Great recession	05/2008 – 03/2009	(2,307)	(2,893)	586	(2,764)	(3,441)	676
Sovereign debt crisis I	04/2010 – 07/2010	(768)	(936)	168	(945)	(1,148)	203
Sovereign debt crisis II	02/2011 – 10/2011	(611)	(871)	260	(866)	(1,137)	271
Gold allocation		7.7%	-	-	9.5%	-	-
Return (%) Jan 1987 to Dec 2011[2]		8.3%	8.3%	-	8.2%	8.3%	-

1 The gains and losses represent portfolio fluctuations during tail-risk events. Portfolio composition for the different cases can be found in Table 10.
  The moderate conservative case had the following outperformance (bps) in the chronological order of tail-risk events: -15, 8, -90, 36, 5, 331, 84, 124.
2 Historical compounded annual growth rate of the portfolio.

Source: Barclays Capital, Bloomberg, J.P. Morgan, World Gold Council

Table 12: Observed gain (loss) of a portfolio with and without including gold during various tail-risk events using out-of sample data in basis points[1]

		Conservative			Moderate		
		Portfolio gain (loss)			Portfolio gain (loss)		
		with gold	without gold	Difference	with gold	without gold	Difference
Sovereign debt crisis I	04/2010 – 07/2010	(25)	(75)	50	(528)	(613)	85
Sovereign debt crisis II	02/2011 – 10/2011	334	251	83	(335)	(447)	112
Gold allocation		2.6%	-	-	3.9%	-	-
Return (%) Jan 1987 to Dec 2011[2]		8.0%	8.0%	-	8.1%	8.2%	-

		Moderate aggressive			Aggressive		
		Portfolio gain (loss)			Portfolio gain (loss)		
		with gold	without gold	Difference	with gold	without gold	Difference
Sovereign debt crisis I	04/2010 – 07/2010	(793)	(946)	153	(968)	(1,148)	180
Sovereign debt crisis II	02/2011 – 10/2011	(662)	(877)	215	(922)	(1,184)	263
Gold allocation		7.0%	-	-	7.9%	-	-
Return (%) Jan 1987 to Dec 2011[2]		8.2%	8.2%	-	8.2%	8.1%	-

1 The gains and losses represent portfolio fluctuations during tail-risk events. The moderate conservative case had the following outperformance (bps); Sovereign debt crisis I: 74, Sovereign debt crisis II: 119.
2 Historical compounded annual growth rate of the portfolio.

Source: Barclays Capital, Bloomberg, J.P. Morgan, World Gold Council

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