S&P DOW JONES INDICES
McGRAW HILL FINANCIAL

TAKING A SHINE TO COPPER: THE PHYSICAL-BASED S&P GSCI® CASH COPPER INDEX

1: INTRODUCTION

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By virtue of its intrinsic properties, copper is used extensively in many manufacturing industries, from the production of power cables to consumer electronics. Statistics from the *World Bureau of Metal Statistics* (2012) reveal that global refined copper consumption reached over 19.5 million metric tonnes in 2011, with China accounting for 40% of the total. Between 2000 and 2011, Chinese demand grew by 13.5% each year, five times faster than the world average. Much of this growth was derived from the power generation sector, which now makes up 46% of total end-use demand in China, followed by household appliances and transportation.

Over the last decade, this industrial metal's cash price has risen from USD 1,800 per tonne to the current USD 8,000, attracting the attention of both institutional and retail investors. Until recently, the main vehicles for investing in the copper market have been equities and futures contracts. However, investors can now gain direct exposure to copper by choosing products that are linked to the newly-launched S&P GSCI Cash Copper index.

Responding to a growing interest in copper investments, S&P Dow Jones Indices launched the S&P GSCI Cash Copper index, which is designed to simulate the return of a physical copper holding without exposing investors to the roll return associated with trading futures contracts. In addition, this index, specifically designed for physically-backed investments, accounts for warehousing charges associated with storing the metal.

In this paper, we will discuss the following topics:

- The fundamental drivers of the copper market;
- An introduction to the S&P GSCI Cash Copper index;
- The practical applications of the index;
- How copper returns are related to economic activity;
- The inflation properties of the index;
- Whether an allocation to the S&P GSCI Cash Copper index has historically offered any diversification benefits.

2: THE COPPER MARKET

Without question, refined copper consumption in China has been robust. However, economic theory dictates that demand strength does not automatically translate into price hikes. Instead, it is the lack of an adequate supply response coupled with a rise in demand for supply-inelastic products, such as copper, that results in price inflation. It follows from this that, in many ways, supply is arguably more important than demand in explaining the recent behavior of the copper market. This assertion is borne out by statistics. Over the last decade, according to *World Bureau of Metal Statistics* (2012), primary

mine production grew by a meager 1.8% per year compared to demand, which rose by 2.4%. The copper market was in supply deficit for seven years in the last decade.

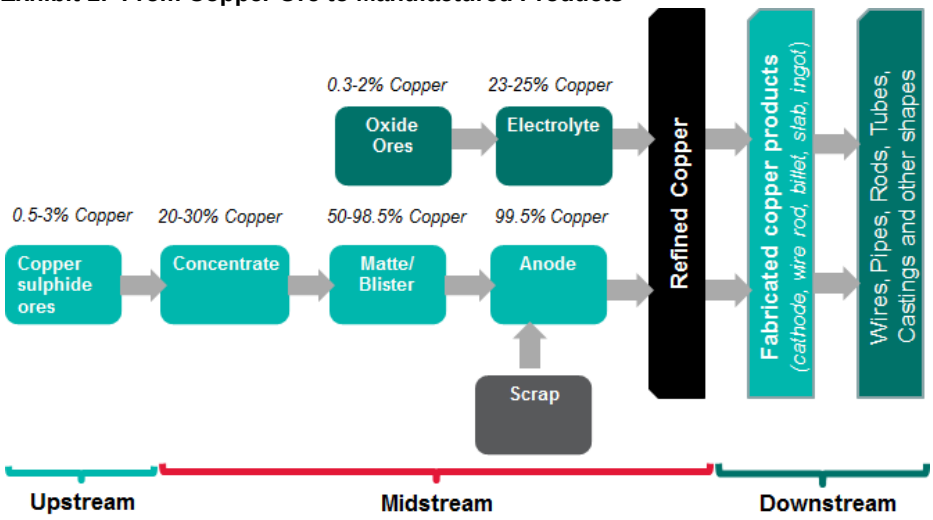
2.1: How is refined copper produced?

Refined copper is produced by recycling old scrap metal or mining copper-bearing ores, with over 85% derived from the latter source. In their natural state, copper deposits are bound up with other deleterious material and usually contain a sparse quantity of useful metal. The extraction method used depends on the type of ore found (see Exhibit 1).

Copper sulphide ores are typically extracted via pyrometallurgical processes that involve first crushing and concentrating the minerals to produce a metal concentrate. This concentrate is then smelted and further refined at very high temperatures to produce "pure" copper. On the other hand, lower-grade oxide ores are usually recovered via hydrometallurgical processes in which sulphuric acid is used to percolate through and dissolve the ore to form a copper-rich leachate solution. The metal is then extracted from the solution and further purified through techniques, such as solvent extraction and electrowinning.

Overall, 70% of refined copper is produced from concentrates with 18% derived from solvent extraction-electrowinning technology and the remainder from secondary scrap (International Copper Study Group, 2010). The biggest producers of copper concentrates are Chile and Peru.

Exhibit 1: From Copper Ore to Manufactured Products



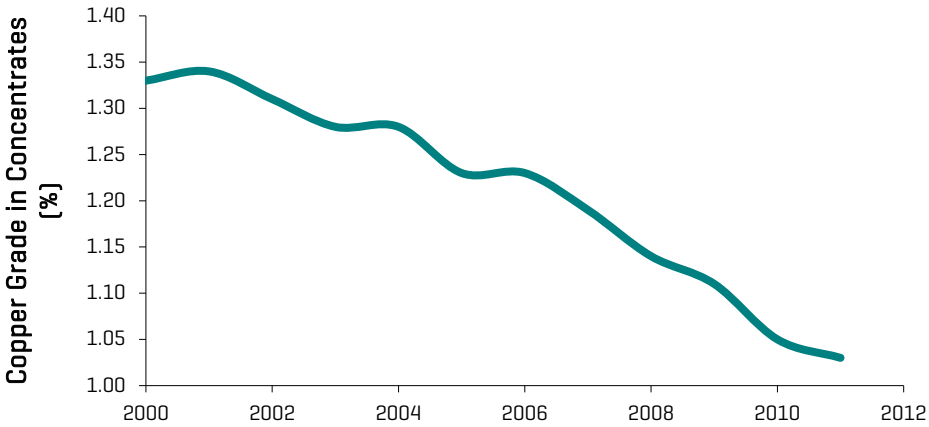
Source: The International Copper Study Group (2010). Diagram created by S&P Dow Jones Indices based on information from the International Copper Study Group and is provided for illustrative purposes only,

2.2: Copper supply challenges

Some of the issues facing the copper market can be attributed to underinvestment in the 1990s. Measures are now being taken to tackle the supply tightness including new mining projects, such as the Esperanza mine in Chile, which is expected to produce 650,000-700,000 tonnes a year. However, significant challenges remain, including:

- **Supply shortage of concentrates:** Approximately 80% of all mined copper is converted into concentrates with the remainder recovered through solvent extraction and electrowinning. Since 2000, supply growth in concentrate has only been 1.4% per year, owing to declining ore grades (see Exhibit 2), equipment failures and shortages, and labor disputes. For example, the strikes at the Grasberg mine in Indonesia alone led to a 13% decline in mine output last year.

Exhibit 2: Purity in Copper Ores



Source: Brook Hunt. Chart created by S&P Dow Jones Indices based on information from Brook Hunt and is provided for illustrative purposes only. Data as of June 2012.

- **Escalating capital and operating expenditure**: With the exception of 2009, which saw a reprieve after the credit crunch, operating costs have skyrocketed over the last decade. Direct cash costs have risen by 24% in the last year alone, owing to higher fuel bills and a shortage of skilled labor (Metals Cost Service, Brook Hunt, 2012). In spite of an average wage increase of over 211% in the last five years (Pearlman and Rowley, 2011), many job vacancies remain unfilled and staff turnover is high as companies poach talent from competitors.

  Moreover, capital expenditure has also jumped substantially due to scarcity of key production inputs, such as tires for specialist mining vehicles, leading to a tripling of prices (Behrmann, 2011) and lengthy production lead times. In some instances, this has resulted in the slow ramp-up, or even deferral, of new projects.

- **Heightened government intervention:** In recent years, governments have sought to introduce new fiscal policies, hoping to capture a larger share of the revenues generated from natural resources, as in the cases of Zambia and Australia. A wave of resource nationalism could potentially raise the marginal costs of production.

Structural supply issues in the copper industry have generally supported prices but there are also factors that may undermine this support. In particular, faced with current high prices, some manufacturers are beginning to replace copper with aluminium in some products, such as electric cables and wires, automobiles and air conditioners. This substitution may lead to a permanent destruction of some copper demand.

Furthermore, the uncertainty currently pervading the global economy may lead to a further decline in the overall consumption, both in terms of end-use demand and investment demand, driven by physically-backed ETFs and index trackers.

3: THE S&P GSCI CASH COPPER INDEX

The S&P GSCI Cash Copper index allows investors to track the daily return of a physically-backed copper investment, after the deduction of storage costs. It is computed daily by valuing the holding of physical (cash) copper, after including the average daily warehousing rent. In order to ensure the wide applicability of the index, country-specific costs, such as physical premia, insurance and free-on-truck rates are excluded.

3.1: Do physical copper prices bear any relation to the London Metal Exchange (LME) cash copper price?

Official prices published by the LME are recognized internationally as a benchmark for physical metal contracts because they correspond closely to the prices used for valuing metals in the physical market. Under an LME metal contract, the buyer or seller is bound to take or make delivery of the metal concerned

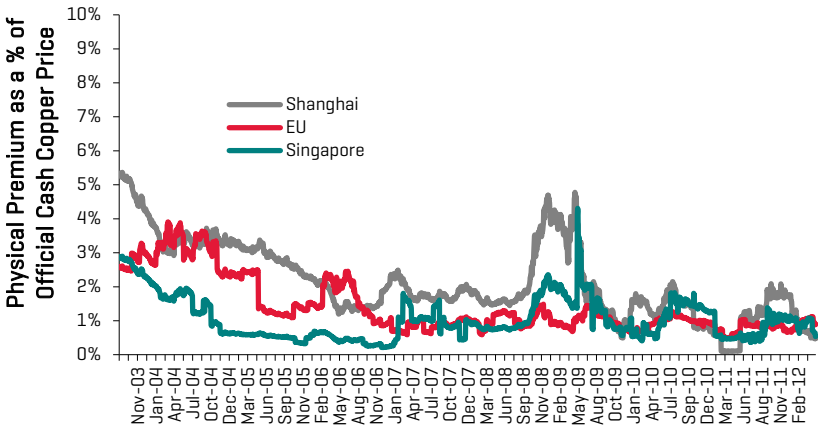
after the prompt date has passed. To facilitate the physical delivery process, the LME has approved a network of geographically well-dispersed warehouses so as to meet the needs of an international clientele.

Physical delivery of contracts at the LME is made by way of warrants, which are bearer documents that grant the holder (buyer) the right to take possession of a specific metal in a randomly-assigned LME warehouse. The result is that a buyer might be allocated warrants in a location it does not desire or even a shape of metal it does not use. Should such an eventuality arise, the buyer could - via a specialist broker - exchange its warrants by either paying a premium or receiving a payment, depending on the local supply and demand situation. The exchange of LME warrants is not carried out in an open market and, as such, is not an activity governed by the exchange.

Thus, the LME cash price should be considered a "flat" global price inasmuch as metals purchased in the physical market are usually priced on the basis of the LME price, albeit with physical premia included. The physical premia reflect the quality, location and brand of the metal, and represent a small fraction of the total value (see Exhibit 3) as most of the value is captured in the LME cash price.

Because of its inextricable link to physical copper, the S&P GSCI Cash Copper index is a representative measure of a physical copper holding, even though physical premia are not taken into account in the calculation of the index.

Exhibit 3: Physical Premium as a Proportion of Official Cash Copper Price



Source: Bloomberg. Data from August 2003 to April 2012. Chart created by S&P Dow Jones Indices based on information from Bloomberg and is provided for illustrative purposes only

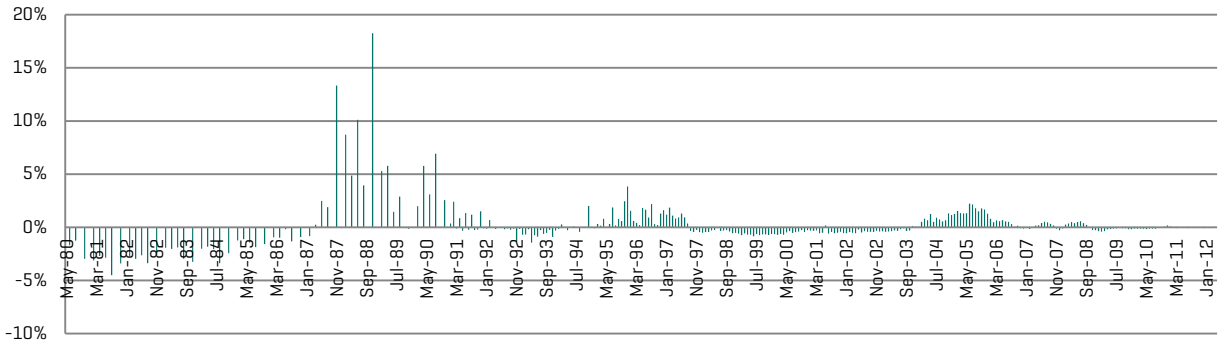
4: THE PRACTICAL APPLICATIONS OF THE S&P GSCI CASH COPPER INDEX

4.1: Potential uses of the index

The S&P GSCI Cash Copper index gives investors access to the price of copper. Unlike an equity-based investment, the S&P GSCI Cash Copper index excludes exposure to unrelated factors such as producers' company-specific factors. If investors believe that producers have expertise in understanding the copper market, there may be an advantage in leveraging that skill. However, equity-based investments may only offer variable exposure to this metal.

In addition, because the S&P GSCI Cash Copper index is constructed on the basis of the LME cash copper price, it provides exposure to the cash (or "spot") copper market. This deviates from futures-based indices where an investment in "spot" is not achievable and the return comprises three components – the spot, the roll and the collateral return. As shown in Exhibit 4, the roll return can vary vastly. A positive roll yield can enhance the overall return whereas a negative roll yield can reduce it. Whether the roll return is positive or negative depends on the supply and demand dynamics of the commodity. A negative roll return is usually associated with an excess in inventories while a positive roll return typically coincides with a shortage. Conditions tend to change according to the expected inventory levels.

Exhibit 4: Monthly Roll Returns of S&P GSCI Copper Futures



Source: S&P Dow Jones Indices, Bloomberg. Calculations based on monthly returns of S&P GSCI Copper Excess Return and S&P GSCI Copper Spot Return. Charts are provided for illustrative purposes. It is not possible to invest directly in an index. This graph may reflect hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

4.2: Practical applications of the index

The S&P GSCI Cash Copper index has a wide range of applications, including:

- **Measuring a physical investment in Copper**: Products, such as Exchange Traded Funds (ETF) tied to the index could be particularly useful for those wishing to hold copper in their portfolios as part of an investment strategy. This is because the metal underlying the investment is fully redeemable, subject to the restrictions imposed by the issuer of the product.

- **Structured products**: The S&P GSCI Cash Copper index can be the basis as an underlying asset within structured investment products because of its relationship to the LME cash copper price. The LME cash copper price is already a well-established underlying in this field. The index may also be seen as a representative indicator of the value of a physical holding since the index accounts for the costs of storage.

- **Active trading strategies**: Potential products based on this index can be used as the basis for active trading strategies either on copper itself or as part of an options strategy. However, whether the index can be used to implement trading strategies depends on the rules and regulations of different countries.

5: RELATIONSHIP BETWEEN COPPER AND ECONOMIC ACTIVITY

Economic activity drives the demand for metals because they are required as inputs to manufacturing processes. As the supply of most metals is fairly inelastic in the short term, prices tend to rise in the face of increasing demand, contributing to overall inflation. This increase in overall inflation then induces a given country's central bank to raise interest rates in order to prevent the economy from overheating. When this happens, economic expansion reaches its peak before growth slows and investments decline due to higher financing costs. With a lag of several months, the higher interest rate reduces the demand for metals, resulting in a drop in prices. From this perspective, it appears there is a strong link between economic activity and industrial metals (see Exhibit 5).

Exhibit 5: Correlation between Industrial Metals and Economic Growth since the 1980s

Industrial Metal	Correlation with World GDP growth
Copper	39%
Aluminium	35%
Nickel	31%
Lead	36%

Source: Bloomberg, Thomson Datastream, S&P Dow Jones Indices. Data from June 1986 for copper, March 1987 for lead and nickel and September 1987 for aluminium to April 2012.

Unsurprisingly, the analysis in Exhibit 5 shows that there is a positive relationship between economic growth and industrial metal returns. It is also worth noting that copper seems to be the most strongly

linked to world economy performance. Having established that copper is related to GDP, it would be interesting to examine how copper returns change in different business cycles, using a framework similar to the one proposed by Adams, Füss and Kaiser (2008). As indicated previously, there is often a lag before the economy registers the effects of a rise in interest rates. For this reason, quarterly world industrial production is preferred to world GDP for the second part of the analysis, which examines how copper returns varied historically in different business cycles.

The quarterly changes in industrial production are split into four different sub-periods: strong expansion, weak expansion, strong recession and weak recession. For the purpose of this analysis, strong growth is defined as a period in which growth is positive and increasing for two quarters whereas weak growth corresponds to a period in which growth is positive but decreasing. A strong recession occurs when growth becomes increasingly negative for at least two quarters and a weak recession is signified by two consecutive quarters of negative but improving growth.

Between 1987 and 2012, there were 81 quarters of growth and 19 quarters of recession. The average copper returns during those periods are shown in Exhibit 6.

Exhibit 6: Copper Return in Different Business Cycles

Business Cycle	Quarters	Average Copper Return/Year
Strong Expansion	38	23%
Weak Expansion	43	11%
Weak Recession	14	7%
Strong Recession	5	-30%

Source: Bloomberg, Thomson Datastream, S&P Dow Jones Indices, Data from March 1987 to April 2012. Calculations are based on LME cash copper prices.

The results above show that copper returns appear highest in the strong expansion phase and lowest in the strong recession phase. However, what is most remarkable is that returns seem to hold up quite well during periods of weak recession.

6: INFLATION PROPERTIES OF THE S&P CASH COPPER INDEX

An important property of commodity investments is their ability to hedge inflation (Greer, 1978). This relationship is predicated on the argument that, unlike bonds and equities, commodities form part of the basket of goods from which the overall Consumer Price Index (CPI) is calculated. Hence, an increase in commodity prices should directly affect inflation. In fact, research has demonstrated that there is a positive relationship between commodities and inflation. Some authors have gone even further to propose a link between inflation and roll yield (from the trading of futures) by suggesting that commodities with the highest historical roll return have the highest correlation with inflation (Erb and Harvey, 2006).

Given that the S&P GSCI Cash Copper index is designed for physical investments and therefore does not rely on the rolling of futures, it would be interesting to examine whether the positive relationship with inflation still holds.

To ascertain whether any relationship exists, the S&P GSCI Cash Copper returns have been regressed against the two components of inflation (both expected and unexpected) from 1994:

$$R_t = \beta_0 + \beta_1 \varepsilon(\pi_t^{\,e}) + \beta_2 \varepsilon(\pi_t^{\,u}) + e_t$$

R_t is the yearly return of the S&P GSCI Cash Copper (expressed as a %). β_0 is a constant. $\beta_1 \varepsilon(\pi_1^{\,e})$ is expected inflation, whereas $\beta_2 \varepsilon(\pi_1^{\,u})$ is unexpected inflation and e_t is an error term. The coefficients β_1 and β_2 measure the correlation to expected and unexpected inflation respectively.

The year-over-year change in the U.S. CPI is used as a measure of expected inflation and the year-over-year change in that inflation is used as a proxy for unexpected inflation. This is based on the random walk hypothesis, which states that the best prediction of this year's inflation is the inflation of last year (Kat and Oomen, 2007).

The results of the analysis are presented as follows.

$$R_t = -25.94 + 24.45\varepsilon(\pi_t^{\ e}) + 38.59\varepsilon(\pi_t^{\ u}) + e_t$$

Exhibit 7: ANOVA Results for the Regression Analysis over a Three-Year Horizon

	Expected Inflation	Unexpected Inflation	Intercept
Value	24.45	38.59	-25.94
Statistical Significance	**	**	**

** Denotes statistical significance at 5% level

Source: S&P Dow Jones Indices. Data as of June 1994. The index was launched in April 2012. It is not possible to invest directly in an index. Charts are provided for illustrative purposes. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested index performance.

The regression model indicates that both expected and unexpected inflation are positively correlated to copper returns, though the correlation to unexpected inflation is more significant. Limited importance should be attached to the negative intercept term in the regression equation as the analysis does not purport to have identified all the pertinent factors. Rather, it serves to evaluate the importance of inflation and unexpected inflation in determining copper returns. Furthermore, the explanatory power of the model increases significantly with a longer time horizon.

A similar analysis was also conducted on gold and neither expected nor unexpected inflation was found to be statistically significant in explaining gold returns. This result is compatible with findings that the return from holding gold is very sensitive to the choice of start date and investors purchasing gold in the early 1980s would have experienced losses relative to inflation (Cai et al, 2008).

Although the analysis here is based on the U.S., the same study can be extended to other countries, albeit with slightly different results. This is because the proportion of allocation to commodities in an investor's portfolio may vary from country to country due to different consumption patterns and levels of economic development.

Overall, copper returns appear to perform better in inflationary periods than those of gold, especially when unexpected inflation is high. This is significant, especially given that copper makes up a very small portion of the CPI.

7: DIVERSIFICATION PROPERTIES OF THE S&P GSCI CASH COPPER INDEX

Much research has been dedicated to the benefits of exposure to commodities in a traditional investment portfolio and this section examines whether a small allocation in the S&P GSCI Cash Copper historically produced a similar positive effect. The intent of this exercise is to investigate whether copper shares similar properties to other commodities, rather than to advocate replacing a well-diversified commodities index with a single commodity to achieve diversification benefits.

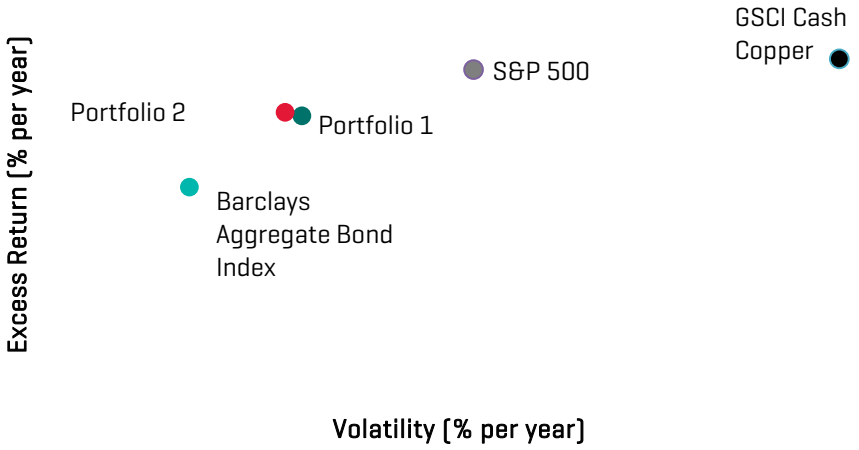
In this analysis, a comparison of the return characteristics of two portfolios is made. The first portfolio contains a maximum of 60% equities and 40% bonds. The second portfolio contains a similar allocation but also allocates a maximum of 5% to the S&P GSCI Cash Copper index. The results are presented below in Exhibit 8.

Exhibit 8: Risk-Reward Comparison for Portfolio 1 and Portfolio 2

Portfolio 1		Portfolio 2	
Stocks	60%	**Stocks**	55%
Bonds	40%	**Bonds**	40%
		S&P GSCI Cash Copper	5%*

**Note: A 5% allocation of GSCI Cash Copper is chosen in order to avoid having an overly concentrated position in a single commodity. As investors generally allocate 7%-13% of their portfolio in commodity investments, a 5% weight is therefore deemed reasonable.*

Exhibit 9: Historical Diversification Effect of Allocating S&P GSCI Cash Copper to a Traditional Portfolio



Source: S&P Dow Jones Indices, Barclays. Data from May 1994 to April 2012. It is not possible to invest directly in an index. Charts are provided for illustrative purposes. This graph may reflect hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested index performance.

The analysis shows that both Portfolio 1 and Portfolio 2 yield a similar excess return of roughly 8% per annum and the inclusion of 5% GSCI Cash Copper index in the portfolio reduces the risk of the portfolio slightly by 0.5% per annum.

It seems, at least for the time frame in question, that there was some positive diversification benefit of including an allocation to copper. However, the benefit was reduced because the correlation of copper with bonds (0.155) and equities (0.159) was positive, albeit very low.

8: CONCLUSION

The following conclusions can be drawn from the analyses outlined in this paper:

- Structural issues in the industry, such as declining ore grades, increasing occurrences of strikes and shortages of production inputs, have meant that mine production growth has been unable to keep up with demand over the last decade. However, that bullishness is tempered by some demand concerns.
- The S&P GSCI Cash Copper index is a daily return index designed for tracking physically-backed copper investments while taking into account associated storage costs.
- Potential products linked to the S&P GSCI Cash Copper index can be used as part of both passive and active investment strategies.
- Copper seems more closely linked to economic activity than other industrial metals and seems to perform well in expansionary and weak recessionary environments.
- Copper tends to perform well when unexpected inflation is high.
- A small allocation of copper may provide some diversification benefits.

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PERFORMANCE DISCLOSURE

The inception date of the S&P GSCI Cash Copper Index was April 26, 2012, at the market close.

All information presented prior to the index inception date is back-tested. Back-tested performance is not actual performance, but is hypothetical. The back-test calculations are based on the same methodology that was in effect when the index was officially launched. Complete index methodology details are available at www.spindices.com.

Past performance of the Index is not an indication of future results. Prospective application of the methodology used to construct this index may not result in performance commensurate with the back-test returns shown. The back-test period does not necessarily correspond to the entire available history of the index. Please refer to the methodology paper for the index, available at www.spdji.com or www.spindices.com for more details about the index, including the manner in which it is rebalanced, the timing of such rebalancing, criteria for additions and deletions, as well as all index calculations. It is not possible to invest directly in an Index.

Another limitation of back-tested hypothetical information is that generally the back-tested calculation is prepared with the benefit of hindsight. Back-tested data reflect the application of the index methodology and selection of index constituents in hindsight. No hypothetical record can completely account for the impact of financial risk in actual trading. For example, there are numerous factors related to the equities (or fixed income, or commodities) markets in general which cannot be, and have not been accounted for in the preparation of the index information set forth, all of which can affect actual performance.

The index returns shown do not represent the results of actual trading of investor assets. S&P/Dow Jones Indices LLC maintains the indices and calculates the index levels and performance shown or discussed, but does not manage actual assets. Index returns do not reflect payment of any sales charges or fees an investor would pay to purchase the securities they represent. The imposition of these fees and charges would cause actual and back-tested performance to be lower than the performance shown. In a simple example, if an index returned 10% on a US $100,000 investment for a 12-month period (or US$ 10,000) and an actual asset-based fee of 1.5% were imposed at the end of the period on the investment plus accrued interest (or US$ 1,650), the net return would be 8.35% (or US$ 8,350) for the year. Over 3 years, an annual 1.5% fee taken at year end with an assumed 10% return per year would result in a cumulative gross return of 33.10%, a total fee of US$ 5,375, and a cumulative net return of 27.2% (or US$ 27,200).

DISCLAIMER