Global Markets

Deutsche Bank

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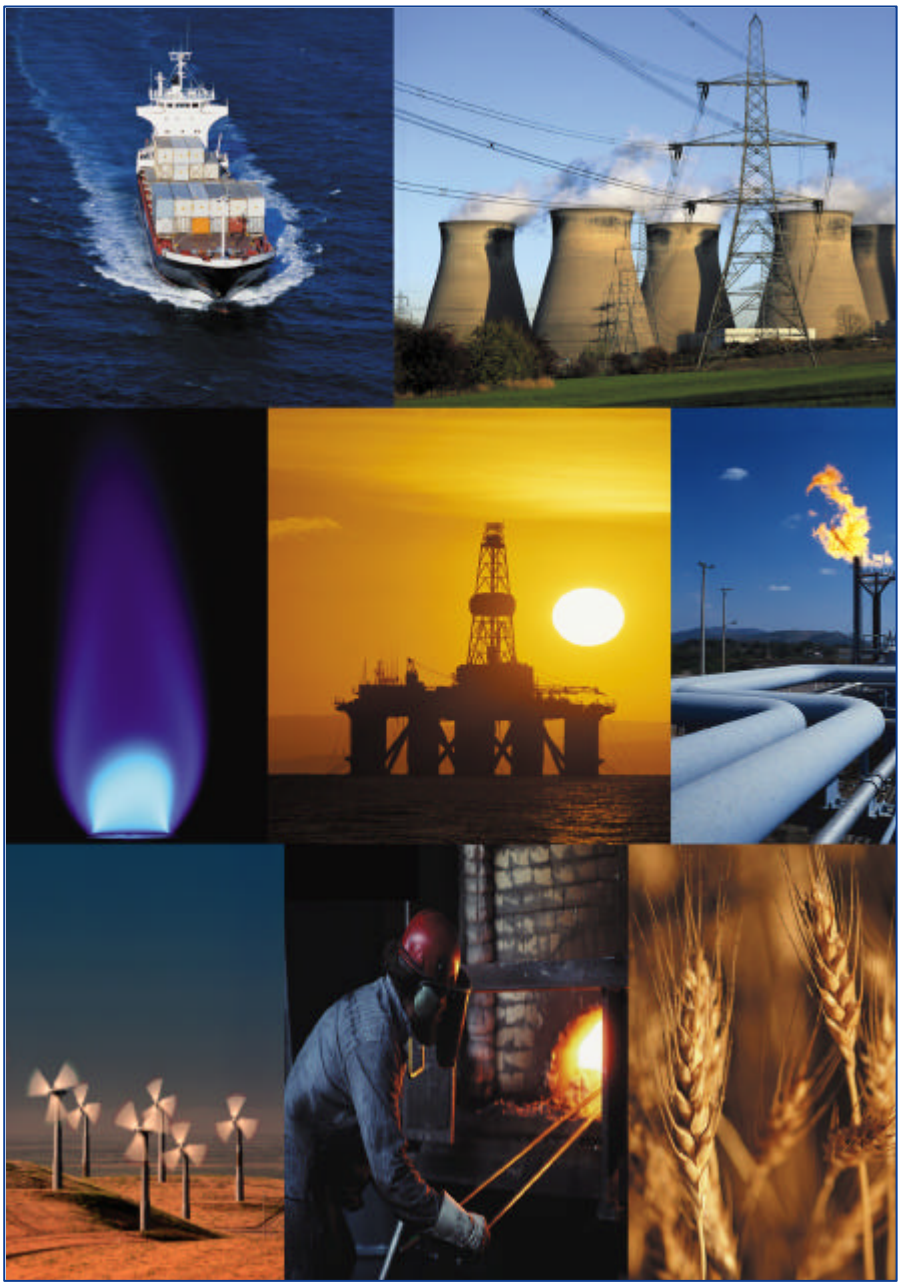
An Investor Guide To Commodities



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Introduction

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To Deutsche Bank's Clients:

Institutional investor interest in commodities has increased significantly over the past few years, a reflection of a much lower investment returns environment in this decade compared to the 1990s as well as powerful cyclical and structural forces working in favour of commodities. But, unlike fixed income and equities, investors have typically been unfamiliar with the properties of commodities such as their sources of returns and their correlation with other asset classes.

To satisfy investor interest, as well as to demystify some of the misconceptions surrounding commodities, we have brought together the leading lights of the commodity world to provide a comprehensive guide to the complex and specifically the role commodities can play in an investor's portfolio.

I hope you, our clients, find this report instructive in what is expected to be a more challenging investment environment in the years ahead. I would also like to express my thanks to all the authors for their contributions to the Deutsche Bank Investor Guide To Commodities.

Michael Lewis
Global Markets' Head of Commodities Research

Executive Summary

Institutional investor interest in commodities has increased significantly over the past few years. This, in part, reflects powerful cyclical and structural forces working in favour of commodity markets, but, also a deterioration in equity and fixed income returns and a realisation that we are living in a lower returns environment compared to the 1990s.

To satisfy growing investor demand, the Deutsche Bank Investor Guide To Commodities brings together the leading lights of the commodity world to provide a comprehensive guide to commodities as a distinct asset class. The Guide is divided into three broad sections: The first examines the growth and future prospects of commodity markets. The second section details the unique properties of commodities as an asset class, the sources of commodity returns and the potential benefits of their inclusion in a investor's portfolio. Finally we examine the routes to gain commodity exposure and the optimal allocation to commodities in an investment portfolio. From a practical perspective we then draw on the experience of Europe's 3rd largest pension fund which made a strategic allocation to commodities at the beginning of 2000.

The Guide opens with an extract from Jim Rogers' book *Hot Commodities*. In it Mr. Rogers explains why a new commodity bull market is underway and why it will continue for years. He notes that every 30 years or so there have been bull markets in commodities and that these cycles have always occurred as supply-and-demand patterns have shifted. The chapter also attempts to dispel the myths about commodities. For most people, the mere mention of commodities brings to mind an elevated level of risk. Yet investing in commodities tends to be no more risky than investing in stocks and bonds and at certain times in the business cycle commodities have been a much better investment than most anything around. However, he is mindful that even in a bull market, few commodity prices go straight up; there are always consolidations along the way and not all commodity prices move higher at the same time. For example, in the last long-term bull market, which began in 1968, sugar reached its peak in 1974, but the commodity bull market continued for the rest of the decade.

In the next article *The History and Development of Commodity Exchanges* Deutsche Bank details the growth in commodity exchanges around the world which officially dates back to the 17th Century and the trading of rice futures in Osaka, Japan. However, it was 200 years later that commodity exchange trading in non-ferrous metals was established with the founding of the London Metal Exchange in 1877 in response to Britain's industrial revolution. Later still came the development of an international energy futures market which began with the listing of the sweet crude oil contract on the New York Mercantile Exchange (NYMEX) in 1983. Today, there are more than 30 physical commodity exchanges operating around the world yet more than 90% of global commodity futures trading occurs in just four countries, the US, Japan, China and the UK. While the largest commodity exchange by market turnover is NYMEX, the London Metal Exchange remains the pre-eminent centre for metals trading. However, it is in China where the most spectacular opportunities in terms of new product and market turnover growth lie in the years ahead.

In the section *Convenience Yields, Term Structures and Volatility Across Commodity Markets* Deutsche Bank explains why determining forward curves for commodity markets is more complicated than in other financial markets. Commodity term structures have to contend with changes to production costs, weather and inventory levels. The chapter introduces the concept of convenience yield, a reference to the yield that accrues to the owner of physical inventory but not to the owner of a contract for future delivery. It consequently represents the value of having the physical product immediately to hand. Intuitively the larger is the share of daily consumption of a particular commodity relative to available inventories, the greater the convenience yield. Not only does a higher convenience yield tend to imply a higher volatility, but, also the more likely the forward curve will be downward sloping, or backwardated. The share of available inventories to consumption helps to explain why gold volatility trades around 15% and why crude oil volatility typically exceeds 30%.

Having determined the underlying forces that drive commodity term structures and volatility the section *Commodity Indexes for Real Returns and Efficient Diversification* by PIMCO outlines the diversification benefits that commodities offer to an overall portfolio. Most importantly it identifies why here are inherent returns to the asset class, why these returns should be expected to have a zero or negative correlation with stocks and bonds, why these returns are positively correlated to inflation and *changes* in the rate of inflation as well as offering protection from some economic "surprises". These are valuable characteristics given the risks a large US budget deficit and a relatively accommodative central pose towards higher inflation ahead. Moreover the rising per capita demand for commodities in China, India and elsewhere in the emerging economies alongside years of underinvestment in new productive capacity provide yet further arguments in favour of commodity exposure. An exposure to a commodity index can therefore be treated as analogous to fire insurance. You invest in it in case things go bad. If things don't go bad, then the rest of your portfolio will benefit. The difference between commodity indexes and fire insurance is that even if you don't have the fire, the index has historically paid you a return. As a result, a commodity index can improve the expected performance of a portfolio is a world where we are not sure what to expect.

In *Commodities as an Asset Class: Testing for Mean Variance Spanning under Arbitrary Constraints*, Deutsche Asset Management provides evidence that commodities are an asset class in their own right and they significantly expand the investment universe for investors. The chapter also examines whether those investors using commodities for their inflation hedging properties would be better provided by Treasury Inflation Protected Securities (TIPS). While it finds that commodities status as an asset class is weakened if we also include inflation linked bonds this may well be a sample specific problem due to the limited data availability on inflation linked bonds.

Having established the diversification benefits that commodities provide, the article *Collateralized Commodity Futures: Good Portfolio Diversification and The Prospect of Equity-Like Returns* by Russell Investment Group examines the best way to gain commodity exposure and what proportion of an investor's portfolio should be allocated to commodities. It recommends collateralized commodity futures (CCF) strategies for investors looking for a liquid low cost strategy that diversifies the risks of stocks and bonds and offers the prospect of equity-like returns. It finds that of the six indexes available, the Deutsche Bank Liquid Commodity Index (DBLCI), the Dow-Jones-AIG commodity index and the Goldman Sachs Commodity Index (GSCI) satisfy most of the investment and implementation preference of institutional investors. In terms of an efficient allocation to CCF these range from a low of 15% to a high of 25%. However, in practise such an exposure is unlikely. According to a survey conducted by Russell Investment Group in August 2004, it was found that five very large pension funds had invested in CCF at an average policy allocation of 3.5% with a maximum allocation of 5%. High liquidity and low fees helped to facilitate such toe-in-the-water exposures. However, the Russell Investment Group analysis also notes that not all investors are suited to CCF exposures and highlights some cautionary notes investors should be aware of before adopting a strategic exposure to CCF.

The chapter *Commodities: An Orthogonal Asset Class* by Deutsche Bank assesses the importance of commodities in an optimal portfolio. Return-oriented investors do not pay a premium for benchmark returns on financial assets e.g., matching the performance of the stock or bond indices used to benchmark institutional portfolios (beta). Demonstrating a consistent ability to add alpha, on the other hand, is value added to these managers and their boards. Further along the investment continuum, the ability to deliver orthogonal alpha i.e., returns uncorrelated with and independent of the financial assets in the portfolio, commands an even greater premium. Risk-averse managers value investments that lower portfolio volatility and stabilize returns. This, too, is achieved with assets that provide orthogonal returns: By lowering portfolio volatility and stabilizing returns, these managers improve their portfolios' Sharpe Ratios. Commodities allow both sets of investors to meet their respective goals.

In *Commodity Allocation From A Private Client Perspective* Deutsche Bank highlights that private investors have often gained exposure to commodities via investing in equities operating in one way or another in the commodity sector. The problem with this procedure is, that the companies, although operating in the commodity sector, are still linked to influences and developments of the overall equity market. Moreover, company specific policies and procedures can lead to significant deviations, time lags, etc. with respect to the price developments in the respective commodity sectors. In order to get exposure, which is directly linked to price developments in commodities, one could choose direct investments in commodity futures traded on commodity exchanges such as e.g. in Chicago or London. For private investors, however, investing in commodities via commodity futures is, in general, costly and difficult to handle. To avoid such difficulties, indirect investment vehicles seem to be a better way to implement such strategies. The financial services industry has reacted to these needs and has created a variety of new commodity investment vehicles, which are more suitable for the investment needs of private clients. Such indirect vehicles are, as a rule, wrapped into structures such as funds, exchange traded funds, warrants or certificates, which are either directly linked to the price of specific commodities or to an index of several commodities.

Having identified commodities as a distinct asset class and that the benefits of their inclusion in a portfolio by enhancing Sharpe ratios, *Commodities As a Strategic Investment For PGGM* by PGGM Pension Fund outlines the experience of the 3^{d} largest pension fund in Europe following its decision to make a strategic allocation to commodities at the beginning of 2000. Today a quarter of PGGM's portfolio is invested in alternative assets with the exposure to commodities at 4% of total assets. Although this 4% is lower than the 20-25% optimal allocation that some studies have indicated, it has still enabled a substantial reduction in the required contributions of its participants. While a 4% allocation might seem small, one should be conscious of the risk it represents. For example, more than 50% of the total year to date return of the PGGM portfolio as of the first quarter of 2005 was attributable to its sub-5% allocation to commodities. Since its initial allocation to commodities in 2000, the experience of PGGM has been one of a passive long only investment which has served not only to increase the expected return of the strategic mix but also to reduce its overall volatility.

Conclusion

The role of commodities as an asset class in its own right is expected to gain increasing prominence in the years ahead. We hope this Investor Guide To Commodities provides a useful theoretical and practical explanation of commodities and the role they can play in an investor's portfolio. To cite one of the references in this Guide, one can consider commodities as analogous to a fine martini, in which a commodity index is the vermouth and its addition to an investor's portfolio makes the whole thing smoother and a little goes a long way.

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Hot Commodities

Jim Rogers

Founder of the Rogers International Commodity Index Fund
Author of *Investment Biker, Adventure Capitalist* & *Hot Commodities*

If stocks, bonds, and commodities were part of the same family, commodities would be the sibling who never measured up, the black sheep – the brother-in-law, perhaps, who got wiped out in soybeans. Commodities have never gotten the respect they deserve, and it's been something of a mystery to me why.

More than three decades ago, as a young investor searching for value wherever I could find it, I realized that by studying just a commodity or two one began to see the world anew. Suddenly, you were no longer eating breakfast but thinking about whether the weather in Brazil would keep coffee and sugar prices up or down, how Kellogg's shares would respond to higher corn prices, and whether demand for bacon (cut from pork bellies) would go down during the summer months. (Consumers prefer lighter fare for breakfast). Those headlines in the newspaper about oil prices or agricultural subsidies were no longer just news; you now knew why OPEC prefers higher oil prices than Washington and why sugar farmers in the U.S. and Europe have a different opinion about price supports than do their counterparts in Brazil and elsewhere in the Third World.

But knowing about the commodities markets does much more than make you interesting at breakfast; it can make you a better investor – not just in commodities futures but in stocks, bonds, currencies, real estate, and emerging markets. Once you understand, for example, why the prices of copper, lead, and other metals have been rising, it is only a baby step toward the further understanding of why the economies in countries such as Canada, Australia, Chile, and Peru, all rich in metal resources, are doing well; why shares in companies with investments in metal-producing countries are worth checking out; why some real-estate prices are likely to rise; and how you might even be able to make some money investing in hotel or supermarket chains in countries where consumers suddenly have more money than usual.

Of course, I've made a much bolder claim in this book[1]: that a new commodity bull market is under way and will continue for years. I have been convinced of this since August 1, 1998, when I started my fund, and have been making my case for commodities ever since. I have written about commodities and given scores of speeches around the world filled with experienced investors and financial journalists. I have met bankers and institutions. I have even been asked to confer with some mining companies to explain why I think they're going to do so well. But, as kind and hospitable as my audiences have been, some seemed no more eager to invest in commodities when I finished talking.

It was as if myths about commodities had overtaken the realities. For most people, when you mention the word commodities, another word immediately comes to mind: risky. Worse still, when investors who are curious about commodities raise the subject with their financial advisers, consultants, or brokers at the big firms, the "experts" are likely to flinch in horror – as if Frankenstein himself had just stepped into the room. And then they launch into sermons about the dangers of such "risky" investments or that colleague who specialized in commodities but "is no longer with the company".

It's weird. From my own experience, I knew that investing in commodities was no more risky than investing in stocks or bonds – and at certain times in the business cycle commodities were a much better investment than most anything around. Some investors made money investing in commodities when it was virtually impossible to make money in the stock market. Some made money investing in commodities when the economy was booming and when the economy was going in reverse. And when I pointed out to people that

their technology stocks had been much more volatile than any commodity over time, they nodded politely and kept looking for the next new thing in equities.

One of the main reasons I wanted to write this book was to open the mind of investors to commodities. I was eager to point out that every 30 years or so there have been bull markets in commodities; that these cycles have always occurred as supply-and-demand patterns have shifted. I wanted people to know that it took no measure of genius on my part to figure out when supplies and demand were about to go so out of whack that commodity prices would benefit. How hard could it be to make the case that during bull markets in stocks and bear markets in commodities, such as the most recent ones in the 1980s and 1990s, few investments are made in productive capacity for natural resources? And further, if no one is investing in commodities or looking for more resources, no matter how much of a glut there is, how difficult is it to understand that those supplies are bound to dwindle and higher prices are likely to follow? The next step is as clear and logical as anything in economics can be: that if, in the face of dwindling supplies, demand increases or even just stays flat or declines slightly in any fundamental way, something marvellous happens, and it is called a bull market.

But even with the formidable forces of supply and demand on my side, I couldn't prove beyond anyone's doubt that without commodities no portfolio could be called truly diversified. I could make arguments, cite examples from my own experience, point to historical and current trends. Still, I hadn't done the heavy lifting, the professorial analysis and detail, to prove academically, with charts and graphs, how commodities performed vis-à-vis stocks and bonds. I was an investor, not a professor. But then I got lucky. As I was deep into the writing of this book, two professors who had actually done the research and analysis of how commodities investment performed relative to stocks and bonds reported their results.

And that is why I am of the opinion that the 2004 study from the Yale School of Management's Center for International Finance, "Facts and Fantasies About Commodity Futures," is a truly revolutionary document[2]. Professors Gary Gorton, of the University of Pennsylvania's Wharton School and the National Bureau of Economic Research, and Professor K. Geert Rouwenhorst, of the Yale School of Management, have finally done the research that confirms that:

- Since 1959, commodities futures have produced better annual returns than stocks and outperformed bonds even more. Commodities have also had less risk than stocks and bonds as well as better returns.
- During the 1970s, commodities futures outperformed stocks; during the 1980s the exact opposite was true – evidence of the "negative correlation" between stocks and commodities that many of us had noticed. Bull markets in commodities are accompanied by bear markets in stocks, and vice versa.
- The returns on commodities futures in the study were "positively correlated" with inflation. Higher commodity prices were the leading wave of high prices in general (i.e., inflation), and that's why commodity returns do better in inflationary times, while stocks and bonds perform poorly.
- The volatility of the returns of commodities futures they examined for a 43-year period was "slightly below" the volatility of the S&P500 for the same period.
- While investing in commodities companies is one rational way to play a commodity bull market, it is not necessarily the best way. The returns of commodities futures examined in the study were "triple" the returns for stocks in companies that produced the same commodities.

Therefore commodities are not just a good way to diversify a portfolio of stocks and bonds; they often offer better returns. And, contrary to the most persistent fantasy of all about commodities, investing in them can be less risky than investing in stocks.

This is dramatic news. I call it "revolutionary," because it will change in a major way how financial advisers, fund trustees, and brokers treat commodities. To dismiss investing in commodities out of hand will now be liable to criticism and reproach – backed up by a reputable academic study. In the late 1970s, there was an academic study that examined one of the more controversial financial instruments ever devised, the junk bond, which bestowed

credibility on investing in junk bonds and turned them into an acceptable asset class. I recall another academic report in the late 1960s, after stocks had been suspect for decades, giving a boost to buying shares in companies again. It helped reinvigorate the stock market. This Yale report will do the same for commodities.

Frankenstein is dead.

But please keep this in mind: Even in a bull market, few commodities go straight up; there are always consolidations along the way. And not all commodities move higher at the same time. Just because it's a bull market doesn't mean you can throw a dart at a list of things traded on the futures exchanges around the world and hit a winner. You might, for example, hit copper, and copper may already have peaked. In the last long-term bull market, which began in 1968, sugar reached its peak in 1974, but the commodity bull market continued for the rest of the decade. A bull market by itself, no matter how impressive, cannot keep every commodity on an upward spiral.

Every commodity, as we have seen, is guided by its own supply-and-demand dynamic. Not all commodities in a bull market will reach their peak at the same time – any more than all stocks do during their own bull market. Some company shares will soar in one year and others might make their highs a year or two or three later. That is also true of commodity bull markets.

During the question-and-answer periods after my speeches, someone usually pipes up to say, "So I invest in commodities, and it is a bull market. When do I know it's over?"

You will know the end of the bull market when you see it; and especially once you have educated yourself in the world of commodities and get some more years of experience under your belt. You will notice increases in production and decreases in demand. Even then, the markets often rise for a while. Remember that oil production exceeded demand in 1978, but the price of oil skyrocketed for more than two years because few noticed or cared. Politicians, analysts and learned professors were solemnly predicting $100 oil as late as 1980. Bull markets always end in hysteria.

When the shoeshine guy gives Bernard Baruch a stock tip, that's high-stage hysteria, and time to get out of the market. We saw it again in the dot-com crash. In the first stage of a bull market, hardly anyone even notices it is under way. By the end, formerly rational people are dropping out of medical school to become day-traders. Wild hysteria has taken over – and I am shorting by then. I usually lose money for a while, too, as I never believe how hysterical people can get at the end of a long bull market. Remember all the giggling and drooling over dot-coms on CNBC in 1999 and 2000. Of course, no one ever admits that they never saw it coming. If I had told you in 1982-83 that a bull market in stocks was under way, you would have laughed at me. Everyone knew back then stocks were dead – except that over the next seven years the S&P500 almost tripled. Had I advised then to put all your money in stocks, you would have hooted me out of the room: Surely, no rational being would believe that stocks could continue to rise after already tripling in a few years. But between 1990 and 2000, the S&P500 continued upward, almost quintupling – while the Nasdaq composite rose tenfold.

The commodities version will come in it its own form of madness. Instead of CEOs and VCs in suspenders, you will see rich, smiling farmers and oil rigs on the covers of Fortune and Business Week. CNBC's "money honeys" will be broadcasting from the pork-belly pits in Chicago, and the ladies down at the supermarket will be talking about how they just made a killing in soybeans. Small cars will be the norm, homes will be heated five degrees below today's preferred room temperature, and there might be a wind farm on the outside of town as far as the eye can see. When you see all that, then it's time to get your money out of commodities. The bull market will be over.

Those days, in my opinion, are a decade away, at least. It is now up to you. Consider this book the beginning of your expertise as a commodities investor. Do your homework and keep learning. Luck always follows the prepared mind.

Endnotes

[1] This chapter is an extract from Jim Rogers' latest book *Hot Commodities* published by Random House in 2004.

[2] Gorton, Gary, and Geert Rouwenhorst (2005) "Facts and Fantasies about Commodity Futures."

Jim Rogers

Mr. Rogers was formerly in the Army and worked for Dominick & Dominick. In 1970, he co-founded the Quantum Hedge Fund. He has been a Professor of Finance at the Columbia University Graduate School of Business and has contributed to print and electronic media world wide for several decades. From 1990 to 1992, Jim Rogers set a Guinness World Record while taking a motorcycle trip of over 100,000 miles around the word, crossing six continents. He set another one from 1999 to 2001 taking an overland trip of 116 countries and 152,000 miles to chronicle the world during the turn of the Millennium. The author can be reached on www.jimrogers.com.

The History & Development of Commodity Exchanges

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The origins of commodity exchanges are typically traced back to the 17th century and the trading of rice futures in Osaka, Japan. However, well before then trading in commodity futures was being reported in ancient Greece and China. The first commodity exchange to be established in the United States was the Chicago Board of Trade in 1848 in response to the growth in agricultural production in the economy. Today, the largest US exchange by volume is the Chicago Mercantile Exchange, which was founded in 1898 as the Chicago Butter and Egg Board. However, in terms of commodity futures alone, the New York Mercantile Exchange (NYMEX) is the world's largest.

During the same period the development of commodity exchanges was being given an additional push by Britain's industrial revolution. Almost overnight the UK became an insatiable consumer of industrial metals. To ensure a more organised market structure the London Metal Exchange (LME) was established in 1877. However, the development of an international energy futures market only began in the 1980s following the listing of the gas oil futures contract on the International Petroleum Exchange (IPE) in 1981, the sweet crude oil contract on the New York Mercantile Exchange in 1983 and the Brent crude futures in 1988. Table 1 details the major commodity exchanges according to sector type and location.

Exhibit 1: The main commodity exchanges by type of contract listed

Commodity	Exchange	Abbreviation
Energy	New York Mercantile Exchange	NYMEX
	International Petroleum Exchange	IPE
	Tokyo Commodity Exchange	TOCOM
	Central Japan Commodity Exchange	CJCE
Metals	New York Mercantile Exchange	COMEX
	London Metal Exchange	LME
	Shanghai Futures Exchange	SFE
	Philadelphia Board of Trade	PHLX
	Tokyo Commodity Exchange	TOCOM
Electricity	New York Mercantile Exchange	NYMEX
	Nordic Power Exchange	NORDPOOL
	European Energy Exchange	EEX
	UK Power Exchange	UKPX
	Amsterdam Power Exchange	APX
	Paris Power Exchange	POWERNEXT
Fibres	Chicago Mercantile Exchange	CME
	New York Cotton Exchange	NYCE
Grains & Oilseeds	Chicago Board of Trade	CBT
	Dalian Commodity Exchange	DCE
	Kansas City Board of Trade	KCBT
	Minneapolis Grain Exchange	MGE
	Tokyo Grain Exchange	TGE
Livestock	Chicago Mercantile Exchange	CME
Softs	Coffee, Sugar and Cocoa Exchange	CSCE
	New York Board of Trade	NYBOT
	Tokyo Grain Exchange	TGE
	EURONEXT, UK	EURONEXT
	National Commodity & Derivatives Exchange Ltd., India	NCDEX

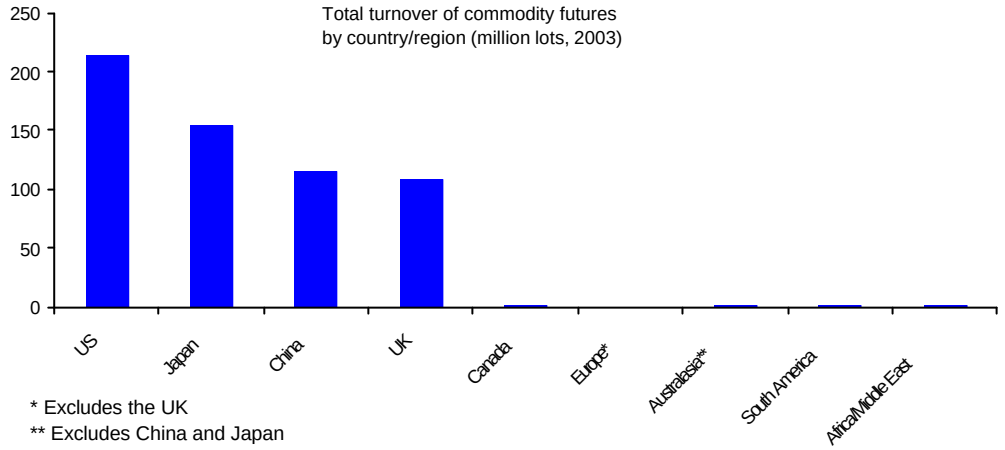
Source: CRB Yearbook 2004

In the current decade, the major growth in commodity futures trading is expected to occur in Asia and specifically China. In the early part of the 1990s, the number of commodity exchanges in China totalled more than 40. However, in 1994 the Chinese Securities Regulatory Committee embarked on a programme of consolidation which resulted in three commodity exchanges emerging in the country:

1) The Shanghai Futures Exchange (SFE)
2) The Zhengzhou Commodity Exchange (ZCE)
3) The Dalian Commodity Exchange (DCE)

Following this rationalisation, there are more than thirty commodity exchanges operational around the world. The proliferation of commodity exchanges has occurred as more and more countries have deregulated their economies and removed price supports. However, in terms of market turnover there remains a high degree of market concentration with the lion's share of commodity trading occurring in just four countries: the US, Japan, China and the UK, Exhibit 1.

Exhibit 1: Commodity futures' turnover by country/region

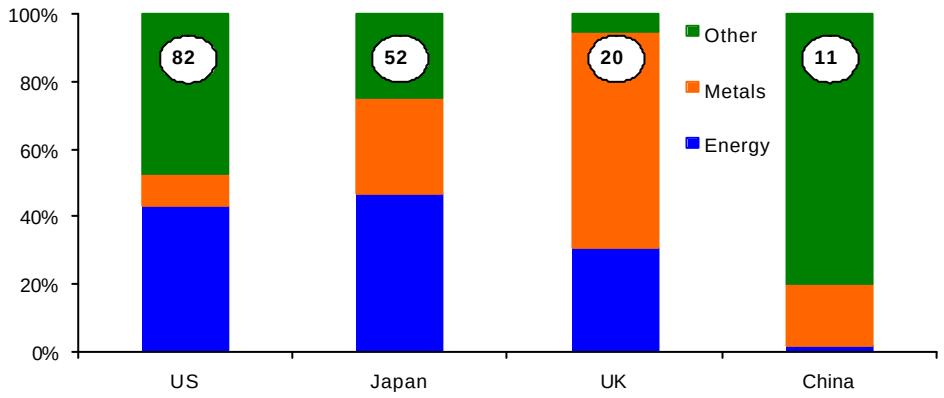


Source: DB Global Markets Research, CRB Yearbook 2004

Market concentration

The number and composition of futures contracts traded in these four centres are detailed in Exhibit 2. Not surprisingly, the US and Japan dominate not only in terms of turnover, but, also in the number of commodity futures contracts listed on their exchanges at 82 and 52 respectively. China's three exchanges currently offer eleven futures contracts including aluminium, corn, copper, cotton, wheat, rubber, soybeans and fuel oil.

Exhibit 2: Number of tradeable futures contracts and the share of market turnover by commodity sector by country



Source: DB Global Markets Research, CRB Yearbook 2004

In terms of the composition of futures contracts listed, typically in the early stages of a country's development commodity futures have tended to be in agricultural products. For example, in China 80% of commodity futures' volumes traded in 2004 were in agricultural contracts. As a result, the Dalian Commodity Exchange is the country's largest exchange by turnover. It is expected that as the country industrialises and deregulates its financial markets, metals and energy contracts will become more prevalent. Indeed there are plans to launch new listed futures' products for crude oil, gas oil, natural gas, steel, coal, rice and soy oil. The breakdown of turnover in 2004 by commodity exchange and individual contracts in China is outlined in Table 2.

Table 2: Contracts listed and market turnover on China's three commodity exchanges

Exchange	Commodity	Turnover in 2004 (in lots)	Growth (% yoy)
Dalian Commodity Exchange	Soybean Meal	49,501,916	65.5
	Soybean No. 1	114,681,606	-4.4
	Soybean No. 2	228,694	--
	Corn	11,656,090	--
	Total	**176,068,306**	**17.5**
Shanghai Futures Exchange	Copper	42,496,740	90.3
	Aluminium	13,658,998	216.8
	Rubber	19,361,298	-63.8
	Fuel Oil	5,637,710	--
	Total	**81,154,746**	**1.2**
Zhengzhou Commodity Exchange	Strong Gluten Wheat	19,311,918	-36.6
	Hard Winter Wheat	23,174,538	20.0
	Cotton	5,988,092	--
	Total	**48,474,578**	**-2.6**

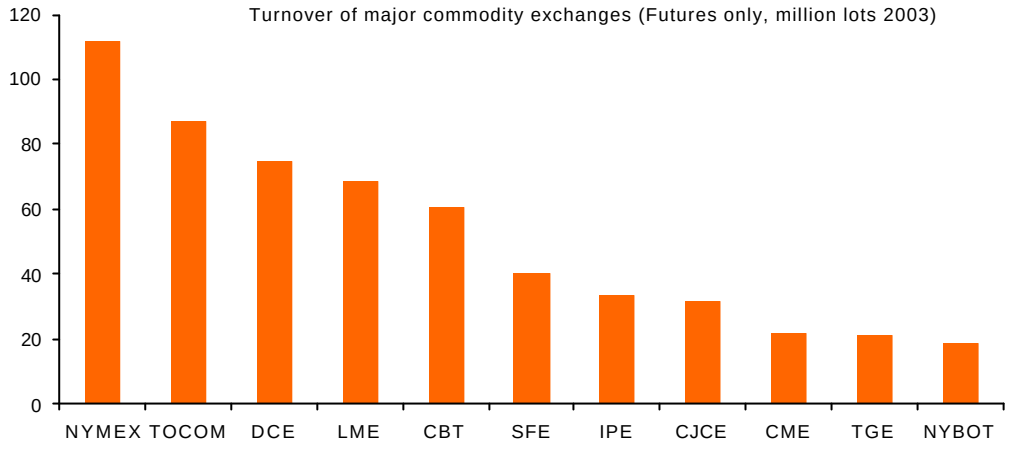
Source: China Futures Association

In the US, the introduction of an energy futures market only occurred in the 1980s following the launch of the sweet crude oil futures contract on the New York Mercantile Exchange (NYMEX) in 1983. Today energy and agricultural futures trading constitute the lion's share of turnover on US commodity exchanges, with metals accounting for less than 10% of total turnover with the bulk of this represented by the COMEX gold future.

In the UK, commodity futures trading is highly skewed to the metals sector, a reflection of the London Metal Exchange's dominance in trading non-ferrous metals. The next phase of the LME's development will be the launch of futures contracts for polypropylene (PP) and linear low density polyethylene (LL) on 27 May 2005.

In terms of the individual commodity exchanges, Exhibit 3 highlights the world's top 11 commodity exchanges by volume. All of the top 11 exchanges are located in the US, Japan, China or the UK.

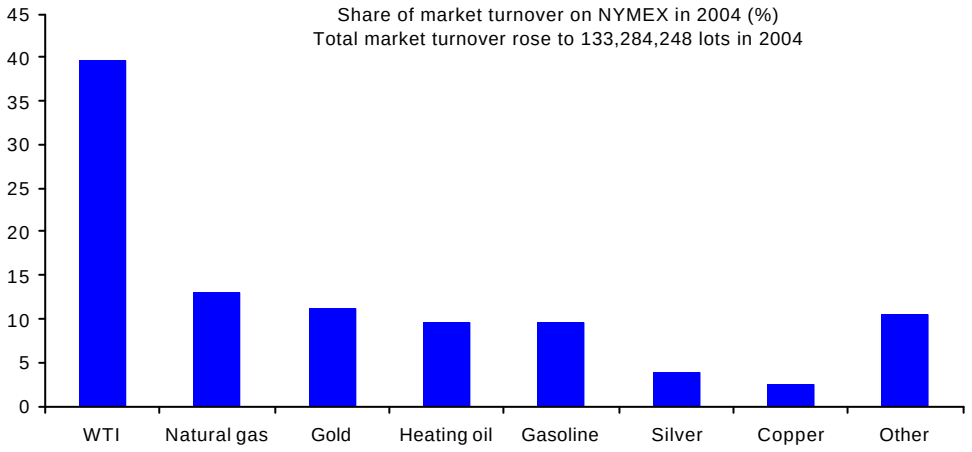
Exhibit 3: Turnover of the world's top 11 commodity exchanges



Source: CRB Yearbook 2004

In 2004, many of these commodity exchanges reported traded volumes at or close to record highs and although these individual exchanges offer a wide variety of futures contracts, market activity tends to be concentrated in just one or two contracts. To highlight this, we examined market turnover in commodity futures contracts in the top four exchanges, NYMEX, the Tokyo Commodity Exchange (TOCOM), the DCE and the LME. On NYMEX, annual volumes hit 163.2 million contracts last year, up 17% compared to 2003. However, market activity remained heavily concentrated in just one commodity, the West Texas Intermediate light, sweet crude oil futures contract, which represented 39.7% of total turnover on the exchange, or 52.9 million lots in 2004, Exhibit 4.

Exhibit 4: Turnover on the New York Mercantile Exchange by contract

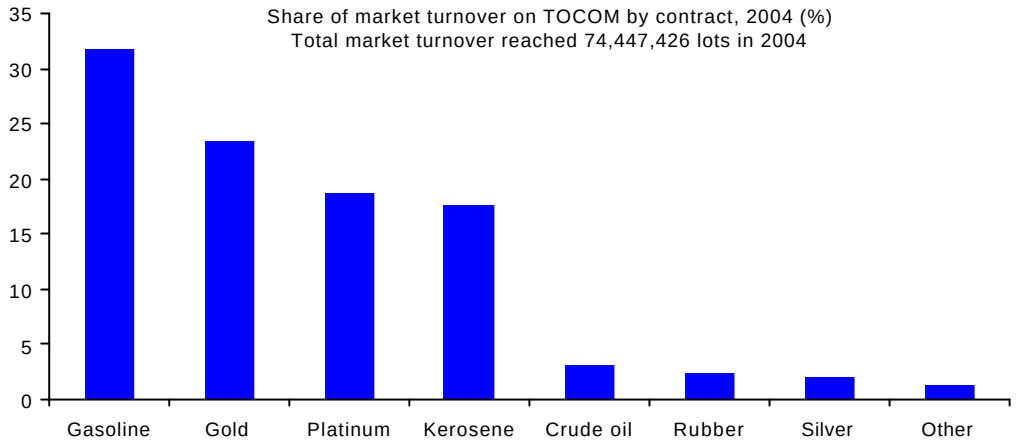


Source: NYMEX

On TOCOM, the degree of market concentration is skewed towards four contracts, gasoline, gold, platinum and kerosene which together constitute 91.3% of total turnover on the exchange, Exhibit 5. Despite the launch of the Middle East Crude Oil contract on the Singapore Exchange (SGX) in 2002 this has failed to gather much traction and Japan remains the most important centre for energy futures trading in Asia. However, the launch of the fuel oil contract on the Shanghai Futures Exchange (SFE) in August 2004 is possibly the first sign of where the main threat to Japan's dominance in the region exists. However, of the four con-

tracts listed on the SFE trading in the copper futures contract dominates activity commanding a 52% share of market turnover, with fuel oil representing just 7% of market activity in its first year of trading, Table 2. On the DCE, the soybean No. 1 future accounts for 65% of total trading volumes on the exchange.

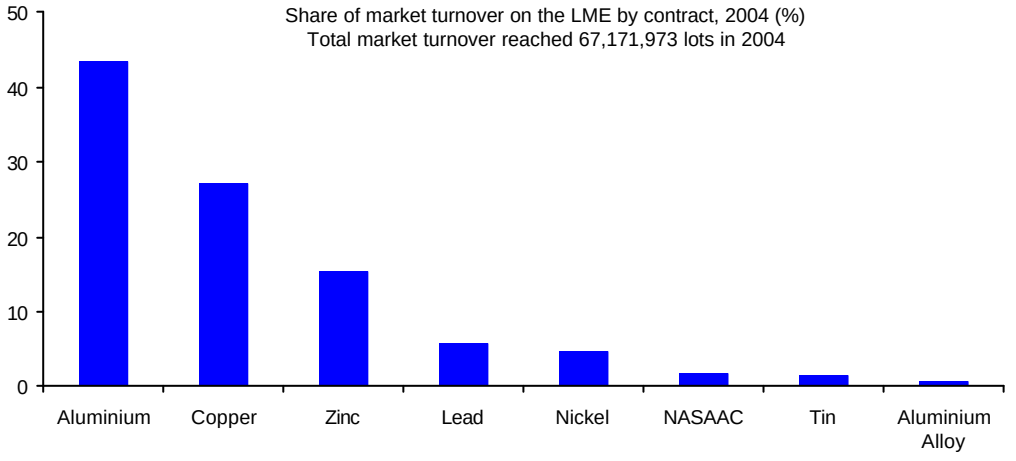
Exhibit 5: Turnover on the Tokyo Commodity Exchange by contract



Source: TOCOM

A similar concentration of futures turnover occurs on the LME with the primary HG aluminium and copper Grade A futures contracts together accounting for just over 70% of turnover on the exchange, Exhibit 6. In terms of the two energy contracts listed on the International Petroleum Exchange (IPE), turnover on the Brent crude oil futures contract represented 72% of total market turnover in 2004 with the gas oil futures contract constituting the remainder of the exchange's activity.

Exhibit 6: Turnover on the London Metal Exchange by contract



Source: LME

Commodities in comparison

Despite the growth in financial futures trading over the past two decades, commodities remain an important part of overall futures trading. Table 3 details the top 15 futures contracts traded in the United States during 2003. We find that commodities occupy seven of the top 15 products traded with crude oil, corn and natural gas the most widely traded commodity futures contracts.

Table 3: Top 15 contracts traded in the United States in 2003

Rank	Contract	Volume	Share (%)
1	Eurodollars (3-month)	208,771,164	33.38%
2	E-Mini S&P 500 Index	161,176,639	25.77%
3	T-Notes (10-year)	146,745,281	23.46%
4	T-Notes (5-year)	73,746,445	11.79%
5	E-Mini NASDAQ 100	67,888,938	10.86%
6	T-Bonds (30-year)	63,521,507	10.16%
7	**NYMEX Crude Oil**	**45,436,931**	**7.27%**
8	S&P500 Index	20,175,462	3.23%
9	**CBT Corn**	**19,118,715**	**3.06%**
10	**NYMEX Natural Gas**	**19,037,118**	**3.04%**
11	**CBT Soybeans**	**17,545,714**	**2.81%**
12	**COMEX Gold (100 oz)**	**12,235,689**	**1.96%**
13	**NYMEX Heating Oil #2**	**11,581,670**	**1.85%**
14	CME Euro FX	11,193,922	1.79%
15	**NYMEX Unleaded Regular Gas**	**11,172,050**	**1.79%**
Total		1,042,968,664	100%

Source: CRB Yearbook 2004

New developments during this decade

The main developments to emerge relating to commodity exchanges this decade are:

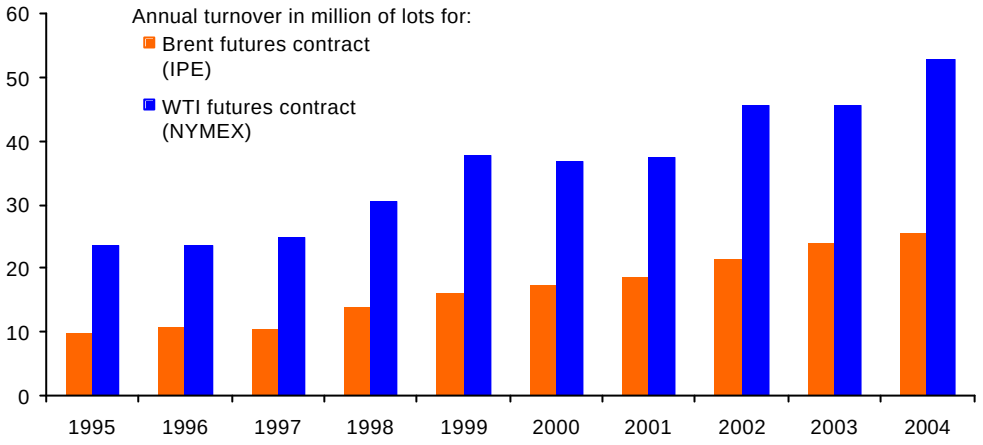
- The listing of new commodity futures' products.
- The increasing cooperation and competition between exchanges.
- The move from open outcry to electronic trading platforms.

Despite the launch of the LME's polypropylene and linear low density polyethylene futures contracts next month as well as the NYBOT's pulp future most of the development of new commodity futures products is taking place in Asia and specifically China. The Zhengzhou Commodity Exchange is preparing to launch a sugar and rapeseed futures contract this year as well as develop new products for coal, natural gas and power. On the Shanghai Futures Exchange a petroleum futures contract is being considered while the Dalian Commodity Exchange is set to launch a soy oil futures contract in the next few months.

In terms of increasing cooperation between exchanges this year could see the merger of NYMEX and NYBOT. This would further enhance NYMEX's status as the world largest physical commodity exchange by market turnover. Listed products would span across both the energy and soft commodity sectors. Cooperation between exchanges is also occurring on a global basis. For example, last month saw the signing of a Memorandus of Undestanding between the Chicago Board Options Exchange (CBoE) and the Dalian Commodity Exchange with the aim to enhance the development of options and other derivative products on both exchanges. In addition, the plans to open the Dubai Commodity Exchange is a joint venture with NYMEX and the government of Dubai. Two aims are the listing of sour crude oil future and well as for Dubai to become the centre of gold futures trading in the region.

NYMEX also plans to launch a London based exchange to compete directly with the IPE and its Brent crude oil futures contract. Regulatory approval for NYMEX's plans are expected to be granted in the second half of 2005. Trading on the exchange will be open-outcry in contrast to the IPE which switched to a solely electronic platform on April 8. Since 1995, traded volumes of the IPE's Brent futures contract has risen by 160% compared to a 124% increase in trade volumes on the sweet crude oil contract listed on NYMEX, Exhibit 7.

Exhibit 7: A comparison of turnover on the benchmark crude oil contracts listed on the IPE and NYMEX since 1995



Source: IPE, NYMEX

Another feature of this decade has been the move towards electronic trading platforms. Last year, TOCOM began offering energy and metals futures trading on NYMEX's internet based trading platform. The IPE's decision this month to end open-outcry is a significant step since at the end of last year only 5% of IPE's volume was accounted for by electronic trades. The IPE's decision also makes the LME the last exchange in London to operate an open outcry system.

Michael Lewis

Michael joined Deutsche Bank in 1990. He is the Global Markets' Head of Commodities Research. Michael's group analyses the macro-fundamental forces driving commodity markets with the ultimate aim of delivering directional, curve and volatility trading strategies with particular focus on the global energy, industrial metals, precious metals, power, freight and coal markets.

Convenience Yields, Term Structures & Volatility Across Commodity Markets

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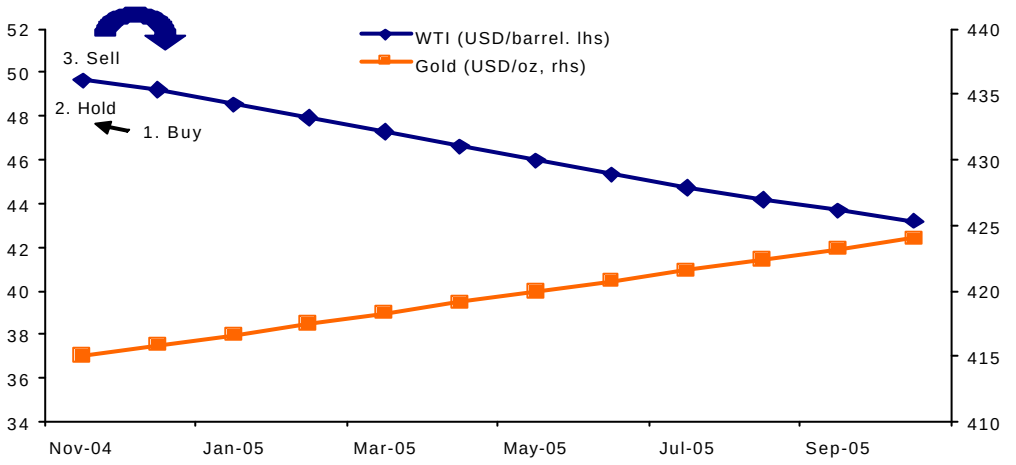
In this article we examine the concept of convenience yield, which is a key variable in determining term structures and volatility levels across the four main commodity classes, agriculture, energy, industrial and precious metals.

The term structure for commodities
The forward curve for foreign exchange rates is simply calculated by the difference between short and long-term interest rates. In commodity markets, the process is more complicated since forward curves also have to contend with, among other things, changes to production costs, weather and inventory levels.

In terms of market definitions, when the forward price of a commodity declines as tenor increases the market is in backwardation. Conversely, contango is where the forward price rises as tenor increases. These two types of term structures are represented by the WTI crude oil and gold price forward curves in Exhibit 1.

Exhibit 1: The WTI and gold term structures & an explanation of the roll yield



Source: DB Global Markets Research, Bloomberg

Commodities offer naturally occurring returns
Investors are familiar with the returns generated by equity and bond ownership, which come in the form of dividends and coupons. However, for commodities, returns come from three main sources:

Formula 1:

Total Returns = Spot Return + Roll Yield + Collateral Yield

The spot return is simply a result of commodities becoming more, or less, expensive over time. In terms of the roll yield, where the price of a commodity is higher for shorter delivery dates an investor earns a positive roll yield by buying the future, waiting for the price to appreciate as the delivery date approaches, then selling and using the proceeds to reinvest at a cheaper price at a future date. Such a strategy is highlighted in Exhibit 1. The final source of return is the collateral yield which is the return accruing to any margin held against a futures position and which we proxy with the US T-bill rate.

Table 1: Commodity returns of the six components of the Deutsche Bank Liquid Commodity Index and an estimation of the convenience yield*

1989-2004	Total Returns	Spot Returns	Roll Returns	Collateral Returns	Storage Costs	Convenience Yield	Days of Stock	Effect of Shortage
Crude Oil	20.17%	5.95%	8.99%	4.84%	22.05%	35.88%	20	Severe
Heating Oil	13.89%	5.34%	3.59%	4.84%	22.05%	30.48%	20	Severe
Aluminium	-0.96%	-1.44%	-1.96%	4.84%	6.31%	9.19%	90	Medium
Gold	0.99%	0.42%	-5.69%	4.84%	0.01%	-0.84%	16500	Mild
Wheat	1.17%	-2.21%	-1.03%	4.84%	11.91%	15.72%	90	Severe
Corn	-3.68%	-2.03%	-5.84%	4.84%	9.97%	8.97%	70	Severe

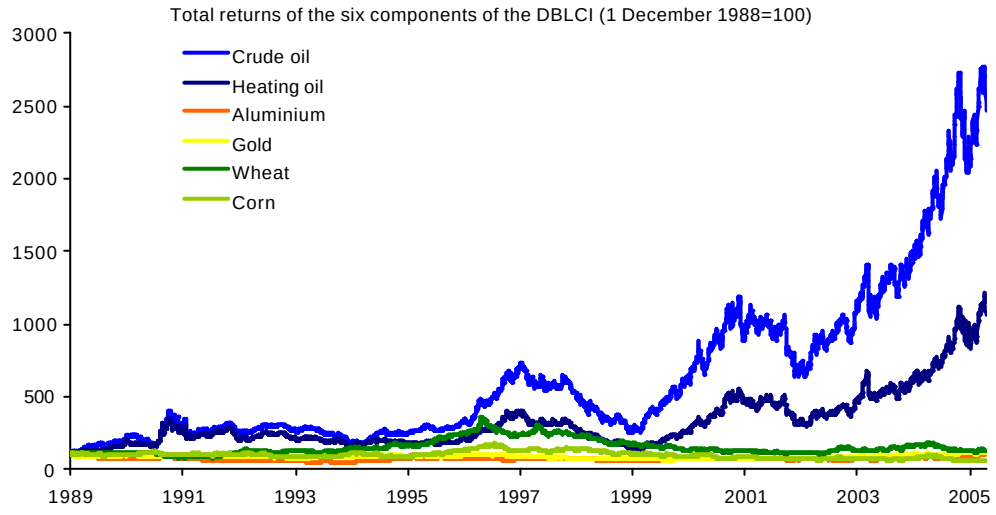
** Convenience yield = Roll returns + storage costs + collateral returns*

Source: DB Global Markets Research

The composition of returns

The main commodity index products in the marketplace are the Goldman Sachs Commodity Index (GSCI), the Dow-Jones-AIG and the Deutsche Bank Liquid Commodity Index (DBLCI). The DBLCI tracks six commodities, rolling positions in crude oil and heating oil monthly and in gold, aluminium, corn and wheat once per year. The composition of returns for the six components of the Deutsche Bank Liquid Commodity Index are detailed in Table 1 above. We find that between 1989-2004, roll returns have averaged 9.0% and 3.6% per annum for crude oil and heating oil respectively. The persistence of backwardation in the crude oil and heating oil markets, and hence the positive roll yield, helps to explain why the main source of returns within any commodity index is largely concentrated in the energy sector. Exhibit 2 highlights how energy products have significantly out-performed all the other components of the DBLCI over the last 17 years.

Exhibit 2: Total returns for single commodity indices in the Deutsche Bank Liquid Commodity Index (1988-2005)



Source: DB Global Markets Research

What drives term structure?

While energy markets are typically characterised by backwardated markets, this is not the case for the precious and industrial metals' markets. In normal market conditions, the forward price for industrial metals tedns to rise as tneor increases, that is, the market is in contango. These differing term structures between the energy and metals complexes can be explained by the Theory of Storage and the existence of convenience yield.

The relationship between the forward and spot price is defined as:

Formula 2:

Forward Price = Spot Price + Interest Rate - (Convenience Yield – Storage)

Formula 2 relies on the fact that by storing rather than selling the commodity, one surrenders the spot price but incurs interest rate and warehousing costs. However, offsetting these costs, are the benefits accruing from holding inventory, or what is called the convenience yield[1].

The convenience yield

A holder of inventories in a particular commodity generates a convenience yield. This is the flow of services and benefits that accrues to an owner of a physical commodity but not to an owner of a contract for future delivery of the commodity[2]. This can come in the form of having a secure supply of raw materials and hence eliminating the costs associated with a supply disruption. Rearranging Formula 2 above implies that:

Forward – Spot = -Roll Yield = (Interest Rate – [Convenience Yield – Storage Cost]) or,

Formula 3:

Convenience Yield = Roll Return + Storage Cost + Interest Cost

To solve for the convenience yield one only has left to estimate the fixed costs of storage for each commodity. For this we use industry estimates, Table 2. Since storage costs are fixed, the share of costs accounted for by storage will be a function of the spot price. For example, in 1989 the average WTI spot price was USD19.60/barrel. Fixed costs for storing a barrel of oil amount to approximately USD0.40/barrel per month and consequently for that year fixed costs were USD4.80 (0.40x12) or 24.49%. Over the 1989-2004 period, storage costs have amounted to an average of 22% per annum. We have repeated this exercise for the other five components of the DBLCI and the results are presented in Table 2.

Table 2: Estimated fixed storage cost for various commodities

1989-2004	Storage cost (USD/month)	Average cost per annum (%)
Crude Oil (WTI)	0.40/barrel	22.05%
Heating Oil	3.00/metric ton	22.05%
Aluminium	7.80/metric ton	6.31%
Gold	0.004/oz	0.01%
Corn	3.33/bushel	11.91%
Wheat	2.00/bushel	9.97%

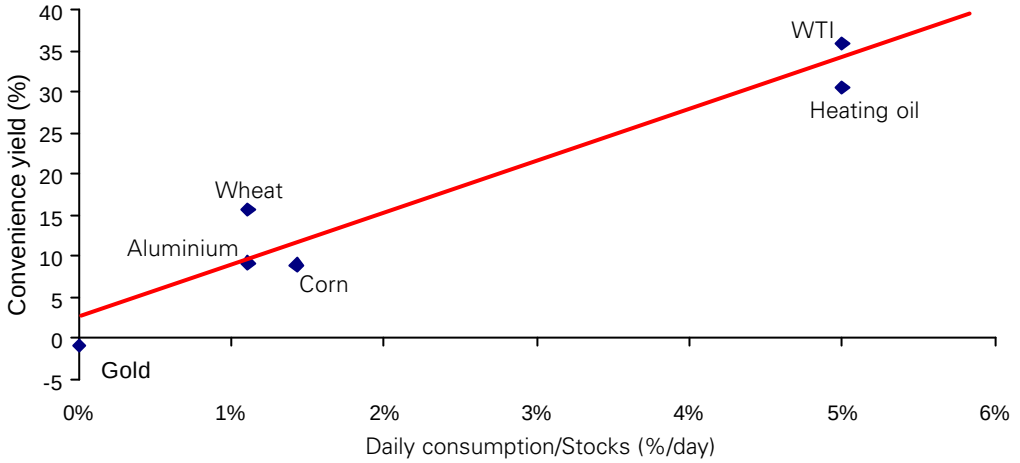
Source: DB Global Markets Research, Industry estimates

With this ammunition we are able to calculate the average convenience yield for each commodity since it will be the sum of the roll return, storage and interest rate costs, Table 1. We then compare the convenience yield to the days of above ground stocks, that is the amount of time it would take to run out of available *commercial* supplies if production ceased and consumption growth remained unchanged.

These results show that convenience yields trend higher the lower the level of inventories. Put another way, the convenience yield rises as the market's precariousness increases. This makes intuitive sense since in tightening market conditions consumers attach a greater benefit to the physical ownership of a commodity. Oil is the most obvious example since if world oil production ceased today the economic consequences would be felt within a matter of days, if not hours. Hence a higher convenience yield or premium is built into the spot price.

The gold market is at the other extreme. It would take many years for the world to exhaust available gold reserves on current demand trends if every gold mine in the world were to close tomorrow. This reflects the fact that annual gold consumption amounts to approximately 3,200 tonnes per annum while total above ground stocks (private plus public sector holdings) exceed 145,000 tonnes. In the absence of additional new mine supply the world would consequently only run out of gold after 16,500 days or sometime in 2050. As a result, any disruptions to gold mine production would have only a marginal effect on the convenience yield. Hence the larger the amount of daily consumption of a particular commodity compared to available inventories the greater the convenience yield. This positive relationship between convenience yield and consumption of stock per day across a number of commodity markets is highlighted in Exhibit 3.

Exhibit 3: Commodity convenience yields vs. the percentage usage of stocks per day (1989-2004)



Source: DB Global Markets Research

It is worth remembering that the convenience yield will vary over time as and when there is an increase in stocks above or below 'requirements'. Indeed the convenience yield is likely to rise very sharply when there is a reduction of stocks below requirements[3]. Commodities subject to sudden changes in inventory levels due to supply or demand shocks are particularly vulnerable in this regard. Such inventory shocks help to explain why certain markets are more prone to move from contango to backwardation in a very short space of time. One can therefore consider the slope of the forward price term structure as an indication of the current supply of storage such that a continuing decline in inventory levels implies an even steeper backwardation and vice versa.

Explaining backwardation & contango via the convenience yield

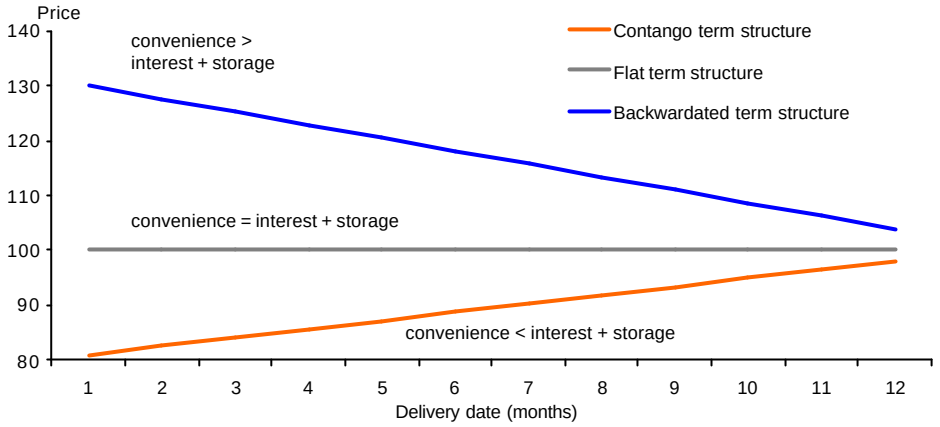
Rearranging one of the formulas derived earlier to solve for the roll yield, that is the difference between the spot and forward price, we find that:

Formula 4:

Roll Yield = Convenience Yield - Interest Rate - Storage Cost

Consequently where the convenience yield exceeds the interest rate and storage costs, it implies a positive roll yield or a backwardated market. This has traditionally been the main feature of the crude oil market and underpins why commodity investment and in particular investment in the energy sector has been a highly profitable strategy to undertake. Conversely where the convenience yield is low and overwhelmed by interest rate and storage costs the roll yield will be negative. A negative roll yield indicates that the spot price is lower than the futures price and is a typical feature of the precious and industrial metals market, Exhibit 4.

Exhibit 4: Commodity curves & convenience yields



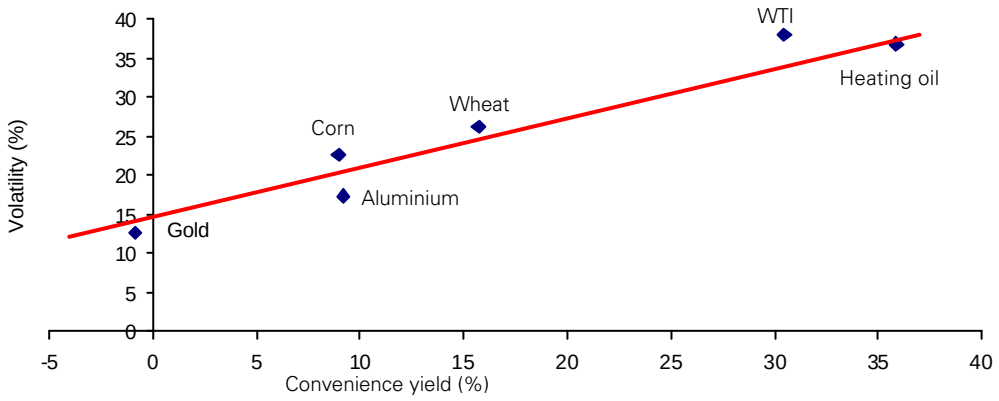
Source: DB Global Markets Research

Interestingly over the past two years, term structures in the six industrial metals' markets have changed dramatically. This reflects strong global demand for commodities, most notably from China, which has led to a dramatic decline in inventory levels across the industrial metals complex. As the physical availability of metal inventories has declined so the convenience yield has risen. This has led term structures to flip from contango to backwardation in all six non-ferrous metal markets. This decline in inventory is also having an effect on commodity volatility.

Commodity volatility & the convenience yield

Since convenience yield is an indication of market precariousness, it is also positively correlated with the level of volatility across various commodity markets, Exhibit 5. Not surprisingly those markets which have the lowest level of available inventory compared to consumption and hence the highest convenience yields typically have the highest levels of volatility, for example crude oil and heating oil. Where inventories are plentiful and the convenience yield is low so too is the volatility, for example gold.

Exhibit 5: Commodity volatility & convenience yields (1989-2004)



Source: DB Global Markets Research

Conclusion

The benefits to a consumer of a holding a particular commodity is directly related to the level of available inventories. This benefit, or convenience yield, consequently drives not only the term structure but also the level of volatility across the main commodity markets. Since energy markets have high convenience yields and traditionally backwardated term structures it helps to explain why within any commodity index, the energy sector is typically the engine room of performance.

Endnotes

[1] The Theory of the Price of Storage, Working (1949)

[2] Brennan and Schwartz (1985)

[3] Speculation and Economic Stability, Kaldor (1939)

Commodity Indexes For Real Return & Efficient Diversification

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"Economic forces are not understood well enough for predictions to be beyond doubt or error....We are expecting too much if we require the security analyst to predict with certainty." Harry Markowitz, Portfolio Selection

Investment in commodities is an idea that has been around since the 1970's[1], but only recently has it become popular with institutional investors. Perhaps that's because traditional stocks and bonds have done so poorly in the last few years. Perhaps it's because investors have recently become more concerned about inflation, and they recognize that their liabilities will go up as inflation increases. Perhaps it's because investors are recognizing the potential diversification benefits that commodities offer. Or perhaps it's because they see other reputable investors who have committed to the asset class in search of potential benefits, which include:

- Diversification from stocks and bonds (zero or negative correlation)
- Positive correlation to inflation and to *changes* in the rate of inflation
- Long-term returns and volatility comparable to equities
- Protection from some economic "surprises" that is not offered by stocks and bonds.

This chapter will explain the fundamental reasons why those benefits have occurred in the past and why they might persist in the future. It is nice to see historical results. But an investor can't rely on historical results without understanding why those results occurred. First we'll explain why commodities are a distinct asset class. Then we'll think of the various ways that an investor might get exposure to the asset class, concluding that a commodity index is the best measure of inherent investable returns. We'll then explain why there are in fact inherent returns to the asset class, and why those returns should be expected to have the characteristics described above. And we will conclude with a brief look at historical results and consideration of how an investor might incorporate commodities in a portfolio.

Commodities as a distinct asset class[2]

Commodities are fundamentally different from stocks and bonds. While they are investable assets, they are not capital assets. Commodities do not generate a stream of dividends, interest payments, or other income that can be discounted in order to calculate a net present value. The Capital Asset Pricing Model does not apply to a bushel of corn. Rather, commodities are valued because they can be consumed or transformed into something else which can be consumed. Their value at any time is determined by basic laws of supply and demand. Analytically, it's the intersection of supply and demand curves that determines their price. And it's the expected intersection of those supply and demand curves in the future that will affect (but not totally determine) the price of a commodity futures contract. This is the unifying feature of commodities that distinguishes them as an asset class different from the other investable assets in a portfolio. These commodities include energy products, livestock, food, fiber, and industrial and precious metals. Unlike financial assets, commodities are *real* assets, also known as "stuff." Stuff which can be used, touched, seen, consumed. Hard assets as opposed to paper assets. Not only are commodities a distinct asset class, but they are an important asset class in the world economy. The commodities included in some of the most popular investable indexes represent about US$1.5 trillion of *annual* global production. It's important stuff.

Ways to get commodity exposure

If an investor wants exposure to commodity prices, the first thing he might think is that he should own commodities. Ideally, he should have a warehouse where he stores some barrels of crude oil in one corner, bushels of wheat in another corner, and a pen of live cattle in the middle of the space. Wrong! Not only is this obviously impractical, but in fact *the price of actual commodities has not even kept up with inflation since World War II!* Even if it were possible to own the physical commodity (as a "consumable asset"), this would not have provided an attractive return in the post-war period.

Some investors think they can get adequate exposure to the distinct asset class of commodities by investing in the equities of commodity producers. By creating a portfolio of oil and gas companies, mining companies, agribusinesses, and the like. This is not the same thing as getting direct exposure to commodity prices (and changes in those prices). Once you own stock of a commodity producer, you are exposed to the financial structure of that company, exposed to other businesses in which the company might be involved, exposed to changes in accounting practices of that company, and exposed to the management talents of that company. Perhaps most important, you are also exposed to the possibility that the management might, for valid reasons, hedge its commodity production, so that you don't get the full benefit of changes in commodity prices. For instance, in one study, 78% of surveyed financial executives said they would give up economic value in exchange for smooth earnings.[3]

To get complete and direct exposure to changes in commodity prices, an investor must go directly to the commodity futures markets. At this point, he faces the question of "active" or "passive". I.e., does he hire an active manager (a commodity trading advisor, or "CTA") to give him the exposure to the asset class, or does he use a passive index. Some active managers might indeed create value. But the investor must ask the question, "Does this truly give me exposure to the asset class?" The best way to answer that question is to ask an active manager, "If I wake up one morning six months from now, and I see that the price of wheat has gone up, can you assure me that this will be positive for my portfolio?" Most CTAs will have to answer, "I don't know. I can't tell you if, six months from now, I'll have a long position in wheat, a short position, or perhaps no position at all." (Most CTAs will also have to tell you that they are likely to be holding positions in non-commodity futures, such as currency and other financial futures, so that they have exposure to a lot more than just commodity prices.) For these reasons, a CTA does not give consistent positive exposure to the asset class of commodities. Instead, just like hedge funds, the CTA is providing exposure to *the asset class of gray matter* (brain power). If the CTA in fact has good gray matter, in the form of technical systems or fundamental judgment, the investor might get good returns. But this is not the same thing as exposure to the asset class of commodities.

Unlike active management, a commodity index can serve as the mechanism for investment in this long-only exposure, or it can serve as the benchmark for active management of commodity futures. As such, an index will capture the inherent returns that have been there in the past.

Definition of a commodity index

A commodity index measures the returns of a passive investment strategy which has the following characteristics:

- Holds only long positions in commodity futures.
- Uses only commodity futures ("consumable assets").
- Fully collateralizes those futures positions.
- Passively allocates among a variety of commodity futures, taking no active view of individual commodities.

By holding only long positions, the investor will be required to "roll" her positions forward over time—unless she wants to own the physical commodity, which we have already established is both impractical and uneconomic. In other words, if she owns, say, the March crude oil contract, she will sell that contract and buy the April contract before delivery begins on the March futures. Then she will later roll from April into May. This process means

that the investor will always be exposed to *changes in the expected future price of the commodity*.

The second bullet point is obvious. We are talking about the asset class of "consumable assets", not capital assets. No financial futures are included.

By "collateralizing" the futures positions, the investor will set aside collateral equal to the notional value of her long only contracts. Going back to crude oil, if she owns one crude contract at, say, US$45 per barrel, times 1000 barrels per contract, she will have exposure to changes in the expected future price of US$45,000 worth of crude. Therefore, she will set aside that amount of collateral to support her long-only position. This means two things. First, the investor will not get a margin call—unless the price of crude drops below zero. More important, the investor's total return will equal the return on collateral plus or minus the change in the expected future price of the commodity. The collateral assumed in most published commodity indexes is T-Bills.

Finally, the investor will not try to predict which commodities will perform the best. Rather, she will allocate her portfolio to a broad range of commodities based on some predetermined algorithm, which typically will cause her to have more of her portfolio exposed to commodities that are more important in world trade. This is clearly not like managed futures. When using a commodity index, an investor doesn't try to be smarter than the market; she merely extracts the inherent return that the market offers….and she restricts herself just to commodity markets. In this sense, a commodity index is indeed a distinct asset class.

Commodity Futures Pricing Model

Some people argue that, if the commodity futures markets are efficient, then there is no inherent return from consistently and passively owning long only futures. Not only do historical results prove those people wrong, but so does fundamental economic and financial logic, as the model described below explains.

It seems that most commentators like to talk about the energy markets, so this chapter will explore another market, live cattle, to explain the source of returns. Most commentators also like to talk about "contango," "backwardation," and "roll yield." In this chapter we'll try to avoid those terms.

Let's assume that I'm a cattleman, and you, the reader, are a long-only investor in the commodity futures market. You have long-only fully collateralized positions in cattle, crude oil, wheat, and all the other commodities of an index. Further, let's assume that your friend, Jackson, is neither a cattleman nor an investor. He is a meatpacker, and he has a commitment to supply, say, a million pounds a day of steak and hamburger to Safeway. Safeway will pay him market price, but he has to be sure that he has the meat to deliver.

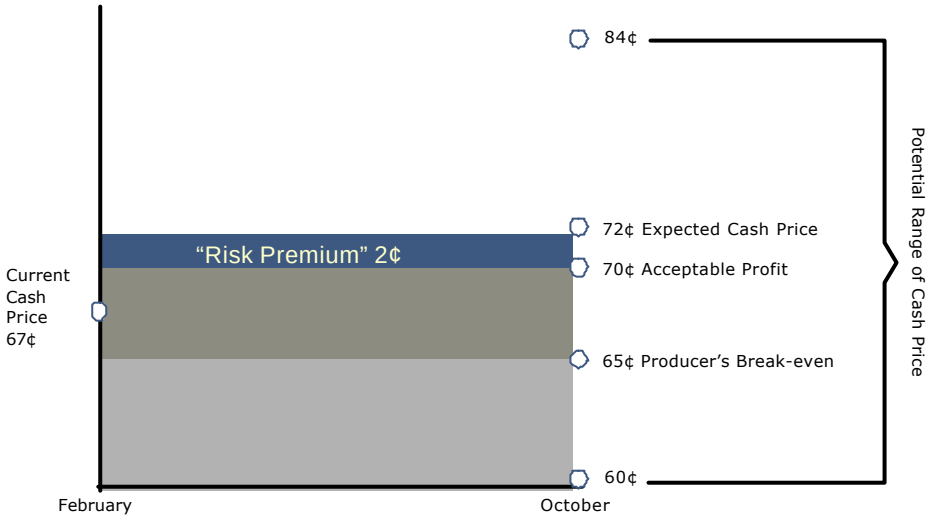
We're assuming efficient markets, which means that we all agree, at least at the margin, on what prices will be in the future.

Let's assume we (you, Jackson and I) are in February, and are looking out to October. We all agree that we think the price of live cattle in October will be 72 cents per pound. But we can't be sure. We might have the entire world go on the Atkins diet, driving up the price of cattle to 84 cents. Or we might have a "mad cow scare" causing everyone to shun beef, and driving the price to 60 cents. We don't know. But there is one thing we know about the future. We know that I have cattle coming to market in October. And when cattle are ready to come to market, they will be marketed, regardless of price. I also know that I have certain costs of production tied up in my cattle, say 65 cents per pound. I will need to sell my cattle for more than 65 cents in October if I'm going to stay in business as a cattle producer. So I approach you, the reader/investor, with a proposal: Since we both agree that the price of cattle is likely to be 72 cents in October, can we agree right now, ahead of time, that I will deliver my cattle to you at that price in the fall? I doubt you would accept my proposal, because I've just asked you to take on all of my price risk for a zero expected return. However, you're a smart investor. You decide to counter my offer with a proposal of your own. You will agree to buy my cattle in October, but at a price of 70 cents—2 cents lower

than where you or I think the price will really be. And I'll be happy to take you up on your offer. I have just paid 2 cents to insure that I will remain in the cattle business! This is a key feature of commodity futures markets (unlike financial futures markets), which are often considered a "zero sum game." There are participants in the commodity futures markets who have objectives different from the investment objectives of you, the long-only investor. Why, you might ask, don't I just go to Jackson the meatpacker, and contract with him for October delivery of my cattle. Simply put, Jackson, as a processor, doesn't need the price protection that I require. He will be selling beef to Safeway in October at market prices. If there are high-priced cattle, then he'll be selling high-priced steak. If low-priced cattle, then he'll sell low-priced steak. And either way, his inventory, on which he has price risk, is only a few days of supply. If Jackson locked in his cost of materials in February, without locking in his final selling price in October, he would actually be increasing his business risk. On average, over the wide range of commodities produced every year, the producer has larger inventories and higher fixed costs than the processor, who is the natural buyer of his products. Therefore the producer needs price insurance more than the processor.

The model I've described is shown in Exhibit 1. This "insurance premium" is not the only source of return to an index, but it's part of the picture.

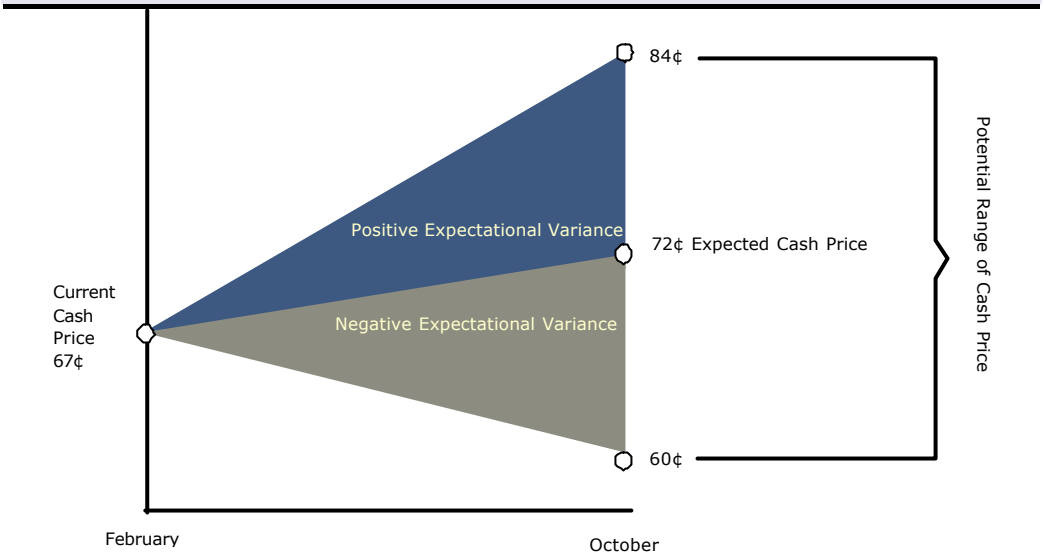
Exhibit 1: Commodity Futures Pricing Model



Source: PIMCO

Now time passes and we get to October. In all likelihood, the price of cattle won't be 72 cents. Something we didn't expect will have occurred. This is shown by Exhibit 2, which demonstrates that actual prices will have varied from our expectations. If we're really rigorous about our assumption of efficient markets, then we've got to say that, over time, the two shaded areas will even out. On average, we'll guess too high as often as we'll guess too low. However, in any one month, or any one year, this variance from expectations will likely dominate short term returns. So this "expectational variance"[4] will not in the long run be a source of return. But it will very much affect the *pattern* of returns in a very important way, as we'll see in a minute.

Exhibit 2: "Expectational Variance"



Source: PIMCO

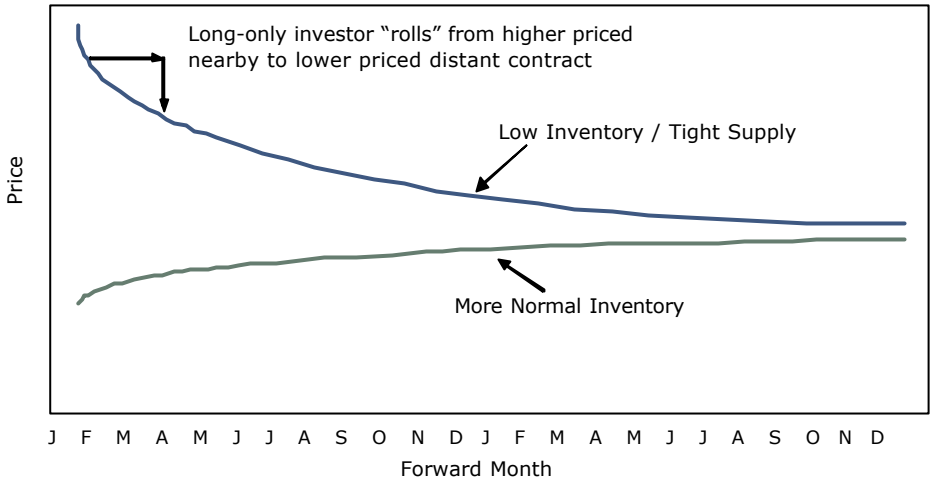
As we approach October, Jackson the meatpacker looks at the supply of cattle in feedlots in his market, and he begins to realize that there aren't as many cattle there as he had expected. Maybe a drought has reduced supplies, as cattle didn't fatten up quite as quickly as expected. Or, if this had been December, perhaps an early freeze would have shrunk supplies. For whatever reason, Jackson begins to worry. What if the cattle aren't there to be bought in the next few weeks? Or what if they are there only at a very high price? What's he supposed to do?

Simple. Jackson buys the October live cattle futures contract. This way, at worst, he can take delivery of cattle at one of several designated locations, to insure that he'll have animals to process. Or, more likely, if this anticipated shortage drives up prices in the cash market, he'll at least have profits from his long October position to help finance the purchase of cattle. Either way, at all costs he must meet his commitment to supply a million pounds a day of beef to Safeway. And Safeway will be paying market price, even if that price has gone up.

What's this likely to do to the futures prices, as Jackson pays up for the *convenience* of knowing that he'll have cattle to process through his plant? You're likely to see the price of the nearby contract go up, as Jackson and other meatpackers pay for the certainty of immediate supply. Economists call that "convenience yield." But perhaps Jackson's view of longer term prices (and your view as well, since the markets are efficient) hasn't changed? We already established that if he took a long term futures position, he would actually be increasing his business risk. This could lead to a situation where the longer dated futures prices are lower than current prices. Now imagine that Jackson had been working at a refinery where he was responsible for procuring crude oil. One day without a crude supply would not just disappoint customers. The cost of shutting down and then starting up a refinery is tremendous. How important is the *convenience* of supply in that situation? Very important.

Exhibit 3 is a schematic of forward prices for a commodity. The situation I just described is represented by the top curve. Future prices are lower than current price. For analysts who have grown up on the study of only financial futures, this makes no sense. For instance, how could the future price of the S&P 500 be lower than the current price? It can't, because there is an arbitrage opportunity—you could short the stocks of the S&P and buy the futures. Commodities are different. Can you sell short live cattle? Not likely. There is a term for this downward sloping pattern of forward price, a term which I promised I wouldn't use.

Exhibit 3: Examples of a forward curve

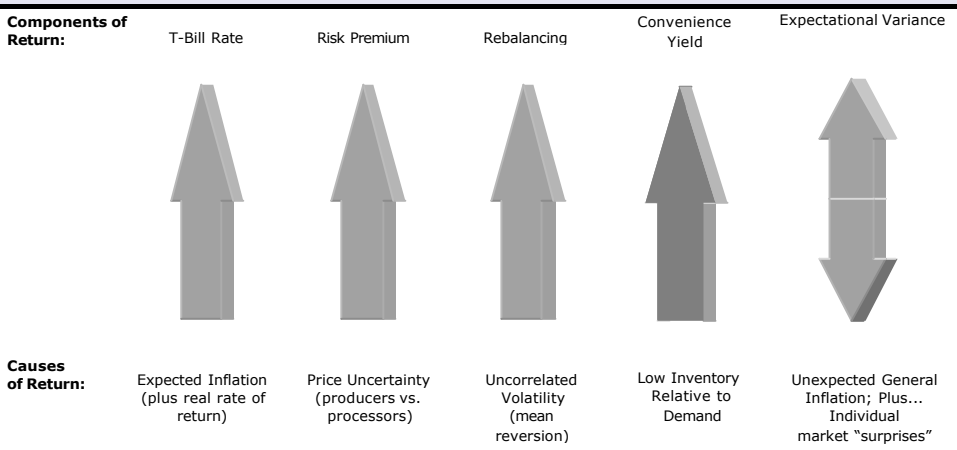


Source: PIMCO

Consider what this does to your portfolio of futures positions, since you are a passive long-only investor. As October arrives, you sell the nearby contract at a higher price and replace it with a lower priced December contract. Then, if in December there is still low inventory and tight supplies, Jackson may be paying up again for the convenience of being able to meet his contractual commitment to Safeway. That could cause the December contract to rise to the same level as the expired October contract. And you might have made money even if the cash price of cattle did not change between October and December.

At other times, when inventories are more plentiful, you are more likely to see a pattern of futures prices like the bottom line on this chart. There is a term for that price pattern also. Let's begin to look at where your inherent return comes from, shown diagrammatically in Exhibit 4. There are several components to your return.

Exhibit 4; Commodity indexes: Basis for returns



Source: PIMCO

The first and easiest component of return is the return on your collateral, since your futures positions are fully collateralized. Published futures indexes typically assume that this collateral is invested in T-Bills, which over a long period of time have returned an expected rate of inflation plus a real rate of return. [True, as this is written in early 2005, T-Bills are yielding less than inflation. But both economic theory and longer term history demonstrate that T-Bills might be expected to provide a positive real yield.]

The next component of return is insurance. This has already been described.

Now it's time to talk about another source of return offered by the commodity markets. This return comes from the fact that you would not expect commodity prices to be highly correlated with each other. Each commodity responds to a supply/demand model, with unique supply/demand factors for each commodity market. The key factors that change our expectation about the price of oil are different from the key economic factors that change our expectation about the price of copper, which in turn are different from the key factors that affect our expectation about the future price of coffee. We take advantage of this fact by constructing a commodity index the same way that Harry Markowitz taught us was the efficient way to construct a portfolio of uncorrelated assets. An index can be designed to have weightings that force it to buy what goes down and sell what goes up. It can rebalance. This rebalancing can give you a third aspect of return to your commodity index—the return that can come from rebalancing a portfolio of assets that are not highly correlated with each other[5].

The next arrow in Exhibit 4 shows the source of return labelled "Convenience Yield." You'll see this arrow is a little lighter. That's because it's there sometimes in some markets, and is dependent on the relative tightness of supply and demand. It's also more important to processors in some commodities than in other commodities.

Finally, let's go back to the "expectational variance" we talked about earlier. In most cases, the factors causing a change in expectations of future commodity prices have little or nothing to do with our expectations about stock or bond markets. A freeze in the Andes Mountains might dramatically affect our expectations about future coffee prices, but it will not affect the movement of the S&P 500, or the bond markets. Likewise with a strike in the copper mines in Chile, or a threat of mad cow disease. This fact supports the idea that movements in commodity futures prices should be generally uncorrelated with stock and bond returns with one important exception: Suppose that we all began to expect higher inflation.

If that happened, if in fact the world began to expect higher inflation, bonds would be dropping in price as interest rates rose. Many people would expect stock prices to drop as well. Yet a commodity index, because it reflects our changing expectation of future prices of over $1.5 trillion per year of "stuff", might be expected to rise in response to an expectation of higher inflation. This response to changes in inflation expectations actually gives us some reason to expect negative correlation between a commodity index and stocks or bonds.

Note that this last arrow points both up and down. Over a long time period, it may not be a source of return, as the market might guess too high as often as it guesses too low. But it is the major determinant affecting the *pattern* of returns to a commodity index over shorter periods of a week, a month, or even a year.

As an aside, ask yourself what kind of "surprises" are likely to affect futures. Most likely are unexpected reductions in supply. We seldom are surprised by a bumper crop or by additional supplies of crude oil, or cattle that suddenly appear. And demand is reasonably stable, unless there's a shock like the threat of mad cow disease. So if supply shocks are more likely than demand shocks, then surprises should tend to be to the upside, which creates positive skew—certainly better than volatility to the downside.

Does a commodity index have an inherent return? Yes. That return consists of:

- Expected Inflation
- Plus (or minus) unexpected inflation
- Plus a real rate of return
- Plus an insurance premium to producers
- Plus another risk premium—sometimes—paid by processors for convenience
- Plus a rebalancing yield, if you choose to rebalance.

And because of the phenomenon of expectational variance, the pattern of index returns should be at least uncorrelated with stocks and bonds, or somewhat negatively correlated to stock and bond returns especially to the extent that unexpected inflation affects returns of all these asset classes.

Historical results

We have just reviewed the fundamental theory regarding the drivers of commodity index returns, and why those inherent returns should be expected to show a desirable pattern. It's as basic as Economics 101 and Finance 101. History supports these arguments. Table 1 shows the correlations and skews of the most used investable commodity indexes since their inceptions.

Table 1: Commodity index statistics

	DJ-AIG[2]	GSCI[3]	DBLCI[4]	DBCLI-MR[5]
Begin Date	31-Dec-1990	31-Dec-1969	31-Dec-1988	31-Dec-1988
End Date	31-Dec-2004	31-Dec-2004	31-Dec-2004	31-Dec-2004
Annualized Return	6.87%	12.00%	12.67%	13.22%
Annualized Volatility	11.66%	19.59%	23.67%	22.12%
Skew	(0.15)	0.99	2.10	1.62
Correlation to S&P500	(0.19)	(0.28)	(0.34)	(0.31)
Correlation to LBAG[1]	(0.09)	(0.07)	(0.13)	(0.16)
Correlation to CPI	0.17	0.17	0.32	0.30
Correlation to changes in CPI	0.12	0.33	0.37	0.37

[1] *Lehman Brothers Aggregate Bond Index*
[2] *Dow Jones-AIG Commodity Index*
[3] *Goldman Sachs Commodity Index*
[4] *Deutsche Bank Liquid Commodity Index*
[5] *DBLCI-Mean Reversion*

Source: PIMCO

They all indeed, for each of the time periods shown, have negative correlation to stocks and bonds and positive correlation to inflation. Most also have positive skew. The longest time series for these indexes is that of the Goldman Sachs Commodity Index, a product which has been calculated (on a back-tested basis) since 1970. This is a time which covers periods of increasing inflation, decreasing inflation, expansion, recession, war and peace. Over this extended period of time, that index has not only shown negative correlation to stocks and bonds, but has also shown a small positive correlation to inflation—and a larger positive correlation to *changes* in the rate of inflation. And it's changes in the rate of inflation that are more likely to hurt stock and bond returns. For instance, if we had a *stable* 10% rate of inflation, bonds could conceivably yield 12-13%, and stocks might not do so badly either. But what is disastrous for bonds and stocks is the move from a low rate of 3% up to a 10% rate of inflation. And that's when commodity pricing theory says that a commodity index should do well. In fact, especially over longer measurement periods, there is higher correlation to changes in the rate of inflation than to the level of inflation. And if you used annual returns instead of quarterly, this improved correlation to changes in inflation would be even more pronounced[6]. Furthermore, in only two years since 1970 did both stocks and a commodity index drop in value. This is true diversification.

To see what actual returns might have been in that wide range of economic environments from 1970 to the present, look again at Table 1. From 1970 through 2004, the GSCI actually had higher returns than the S&P 500, with only slightly higher volatility—and with that diversifying aspect of negative correlation. An examination of returns of the various commodity indexes over shorter periods of time would also show higher returns in the last few years, while returns in the '80s and '90s weren't much better than just the return on T-Bills (a time period when paper assets were benefiting a portfolio). It wasn't just in the 1970's that they did well. Over the most recent five years ending in 2004 this asset class performed well also.

One can begin to see why asset allocation models like commodities. And with a return that's related to inflation, which drives the liabilities of many investors, asset-liability models like commodities even more.

It looks like commodities might indeed shelter a portfolio from inflation, and also provide useful diversification in a wide range of economic environments. Meanwhile, you still have positive exposure to some unexpected events that might affect individual markets.

This could be shown if you looked at commodity index returns when we had the unexpected start of the first Gulf War. Even more interesting is to see the performance of a commodity index during the equity market meltdown of October 1987—commodities were flat. Why? People kept eating their Wheaties and drinking their coffee. No changes in supply and demand for commodities. That's the kind of fundamental economic diversification that makes this asset class so important.

In summary, a commodity index has an inherent return that can be expected to provide diversification in a variety of economic scenarios, when we don't know what scenario to expect.

Before concluding, lets consider one more issue. Let's say you buy into the asset class. That must mean that you want, besides diversification, some inflation protection. Remember that the published indexes, and all the data used in this chapter, assume that T-Bills are collateralizing long-only commodity futures. If you really want inflation protection, why would you use T-Bills as your collateral if you could use inflation-linked bonds (ILBs) instead.

Think about it. Real return characteristics of commodities backed by the real return aspects of inflation-linked bonds. ILBs might capture higher inflation as it actually occurs in higher reported CPI, while the commodity futures exposure might provide protection from rising inflationary *expectations*. And an investor might also consider, over a complete economic cycle, which might be expect to outperform—ILBs or T-Bills. If the former, then an investor could look for a way to collateralize futures with inflation-linked bonds. Just one more attractive feature of commodity indexes is that they can be implemented using a variety of styles for collateral management, including ILBs, or LIBOR, or some other style, as long as that style has a certain amount of liquidity.

Outlook

To this point I have made a case for commodity index investment as a strategic allocation. Diversification. Potential protection from unexpected events. Hedging from the inflation that affects our liabilities. These arguments were made while being agnostic about the economic outlook. In fact, as evidenced by the opening quotation from Markowitz, it's that agnosticism, that recognition that we can't "predict with certainty," which creates the need for the benefits that commodity indexes offer. But for a brief moment, as this is written in the first half of 2005, let's take a look at a possible scenario for the next few years, a secular timeframe. The ideas briefly discussed here are presented much more thoroughly in other chapters of the Deutsche Bank Investor Guide to Commodities.

The U.S. government, the single largest economy in the world, is running large fiscal deficits and, in spite of some recent increases in the Fed discount rate, is still showing an accommodative monetary policy. Typically that might lead to increasing inflation, which could affect other economies as well. And due to continuing large trade deficits, the dollar has been weakening, which also could create higher inflation in the U.S. This threat of higher inflation, however, is being mitigated by the fact that, globally, there is an excess supply of labor and an excess supply of manufacturing capacity. China and India, and other emerging economies, are the most obvious places where this excess supply exists. This insufficient global aggregate demand might continue to mitigate inflationary pressures—at least inflationary pressures in labor and manufactured goods. But there is not an excess global supply of many commodities.

In the 1970's high commodity prices led to excess investment in infrastructure (supply, storage, and transportation), much of it supplied due to government incentives. Then, in the 1980's and 1990's, as returns to capital were poor in commodity industries, investment

capital flowed elsewhere. Meanwhile, the global demand for commodities continued slowly and steadily to increase, as the global economy grew. That demand in many commodity markets is now catching up with aging infrastructure. And that demand is exacerbated by the growth of emerging economies. As those economies become more urbanized, some of their workers are buying their first cars, first houses, first washing machines, and perhaps improving their diets. This means that the per capita demand for commodities is increasing in China, India, and elsewhere—and from a very low base. But infrastructure can't be built overnight. It will take many years and many hundreds of billions of dollars to catch up with this growing global demand. That means three things. First, there are more likely to be bottlenecks, or supply disruptions, which means that "surprises" ("expectational variance") might more likely be to the upside. Second, tight supply and limited infrastructure might also mean, in some industries, that commodity processors will more frequently demand the *convenience* of having access to commodities until supplies are more plentiful. And third, to encourage the flow of capital into commodity industries, the commodity producers need an expectation of stable prices, which means that the demand for producer "insurance" may continue.

Fit in a Portfolio

Other chapters of this Investor Guide to Commodities will, with great analytical rigor, examine the role of commodities in a portfolio, as well as explore the various ways to get exposure to the asset class. But here we offer two analogies that begin to address this question.

Some people compare commodity indexes to fire insurance. You invest in it in case things go bad. If things don't go bad, the rest of your portfolio benefits. The difference between commodity indexes and fire insurance is that, even if you don't have the fire, the index has historically paid you a return anyway.

Others use the analogy of a fine martini, in which a commodity index is the vermouth. It makes the whole thing smoother and a little goes a long way.

In closing, consider another quotation from Harry Markowitz, from the same book:

"Only the clairvoyant could hope to predict with certainty. Clairvoyant analysts have no need for the techniques of this monograph."

For readers who are clairvoyant, who can see into the future, you may not need the benefits of a commodity index. But for a financial analyst who can not predict with certainty, who is not clairvoyant, a commodity index can improve the expected performance of a portfolio in a world where we're not sure what to expect.

Endnotes

1 The first description of an investable commodity index was in The Journal of Portfolio Management, Summer 1978, "Conservative Commodities: A Key Inflation Hedge," by Robert J. Greer.

2 These thoughts on commodities as a distinct asset class are more fully expressed by the author in "What Is an Asset Class, Anyway?" in The Journal of Portfolio Management, Winter 1997.

3 "The Economic Implications of Corporate Financial Reporting," by John Graham and Campbell Harvey of Duke, and Shiva Rajgopal of the University of Washington (Working Paper #10550), as summarized by Peter Bernstein in his newsletter, Economics and Portfolio Strategy, 1 Aug 2004.

4 A term coined several years ago by Grant Gardner of the Frank Russell Company.

5 For a formula that might be used to measure the value of rebalancing in certain instances, see "The Nature of Commodity Index Returns," by Robert J. Greer, in The Journal of Alternative Investments, Summer 2000.

6 Gorton, Gary, and Geert Rouwenhorst. 2005. "Facts and Fantasies about Commodity Futures." Unpublished working paper.

Robert J. Greer

Bob Greer was the first person ever to define an investable commodity index or to advocate it as a separate asset class. He has spoken on this subject at numerous conferences and trade meetings, and has published articles on the subject in The Journal of Portfolio Management, The Journal of Derivatives, The Journal of Alternative Investments, Pensions & Investments, and elsewhere. For eight years he managed the commodity index business, first of Daiwa Securities, and then of Chase Manhattan Bank and JPMorgan. Prior to his management of commodity indices, Mr. Greer spent ten years in the investment real estate business.

These many years of real asset investment experience have come together in Mr. Greer's current position at PIMCO, where he is a Senior Vice President and Manager of Real Return Products, a product line which embraces commodities, inflation-linked bonds, real estate, and active asset allocation. He has also agreed with McGraw Hill to write a The Handbook of Inflation Hedging Investments, oriented to the institutional investment community.

Mr. Greer received a bachelors degree, with honors, in mathematics and economics from Southern Methodist University. He earned an MBA, with honors, from the Stanford Graduate School of Business.

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Commodities as an Asset Class: Testing for Mean Variance Spanning under Arbitrary Constraints

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Summary: Recent oil price volatility has had an unsettling effect on global financial markets. Hence investors are getting more interested in the statistical and economic foundations of commodity investing. We want to investigate whether commodities extend the investment universe for US based investors. Formally we need to test, whether adding commodities to the investment opportunity set (US Equities and US Bonds) significantly improves the utility of mean variance investors. We introduce a Monte Carlo based methodology to test for mean variance spanning under arbitrary constraints. Effectively we simulate the distribution of utility gains from commodity investing under the null hypothesis of spanning. There is evidence that commodities are an asset class in their own right. However, significance is largely reduced after we have included inflation linked bonds. However, this may well be a sample specific problem due to the limited data availability on inflation linked bonds.

Introduction

Recent oil price volatility has had an unsettling effect on global financial markets. Hence investors are getting more interested in the statistical and economic foundations of commodity investing. We want to investigate whether commodities extend the investment universe for US based investors. Formally we need to test, whether adding commodities to the investment opportunity set (US Equities and US Bonds) significantly improves the utility of mean variance investors. Section 2 reviews the term asset class from a financial economists perspective and applies a standard mean variance spanning test to various commodity indices. However, while these tests assume investors that can implement net short positions, real life investors are often constrained to long only portfolios. We therefore introduce a Monte Carlo based methodology to test for mean variance spanning under arbitrary constraints in Section 3. Effectively we simulate the distribution of utility gains from commodity investing under the null hypothesis of spanning. Section 4 provides empirical results for our methodology for long/short as well as long only investors. Finally we test whether an inclusion of Real Bonds (US TIPS) has an impact on the uniqueness of commodities.

How financial economists view asset classes

In practical investment management an asset class is a group of assets that investors regard as homogeneous enough (high internal correlation) as well as unique enough (low external correlation) to consider separate strategic allocations worthwhile. For example: investors viewing non-domestic equities as an asset class will allocate parts of their strategic risk budgets towards non domestic equities in the hope to catch a risk premium that is unique to this asset class and can not be generated by other investments. The risk premium must arise from economic exposures that can neither be diversified, nor generated from other asset classes. Let us introduce an informal statement that can be often heard about commodities to sharpen our intuition.

"If an asset earns a risk premium (above cash), shows little correlation to other asset classes and can not be replicated it must be an asset class."

Unfortunately this is wrong. To see why, we will engineer an asset, that looks like an asset class from the perspective of the statement above, but actually isn't. Suppose we invest into equities and bonds to generate a risk premium above cash. Suppose further we add considerable noise to this asset buying lottery tickets (uncorrelated to real asset classes with high volatility). The more noise we add on top of our equity/bond exposure the more

likely we will see a decrease in correlation with other asset classes. This noise can not be replicated. We created an asset from existing assets and added some noise. This obviously does not create an asset class.

So what is the correct (statistical) interpretation of an asset class? Any suspected asset class (R_i) that actually earns a risk premium above cash (c), that can not be explained by other already existing asset classes $(R_j - c)$ is actually an asset class in its own right. Formally we run a regression between the excess returns of a candidate asset class and other established asset classes.[1]

$$(R_i - c) = a + \sum_j b_j (R_j - c) + e$$

If the constant term in this regression (a) is significantly different from zero, we can consider it as an asset class. This is the basic idea between all test for mean variance spanning. We see correlation as playing only an indirect role. What matters is whether part of the risk premium is not explained by other asset classes. Obviously the higher the correlation, the more systematic exposures and hence explained risk premium exists. But high correlation is not necessarily enough to justify a negative judgement. Neither is low correlation enough to prove uniqueness. After all coin flipping is very diversifying. In fact we test whether a given asset class extends the mean variance frontier (shifts it to the left) in a statistically significant way.

Let us apply the above to a US based investor. Its current investment universe consists of US Equity (proxied by MSCI USA) and US Bonds (proxied by JPM US Government Bonds). We test three commodity indices for mean variance spanning: the Goldman Sachs Commodity Index (GSCI), the Deutsche Bank Liquid Commodity Index and the Deutsche Bank Liquid Commodity Index – Mean Reversion. The data reach from January 1989 to January 2005. We calculate monthly excess returns (over 1 month Libor) in dollars. Summary characteristics are given in Table 1 and Table 2.

Table 1: Unconditional historic correlation and annualized volatility (main diagonal) for investment opportunity set

	GSCI	DBLCI	DBLCI-MR	US Bonds	US Equity
GSCI	0.19	0.93	0.85	0.03	-0.10
DBLCI	0.93	0.20	0.92	-0.04	-0.11
DBLCI-MR	0.85	0.92	0.18	-0.04	-0.08
US Bonds	0.03	-0.04	-0.04	0.05	0.01
US Equity	-0.10	-0.11	-0.08	-0.01	0.15

All numbers are based on monthly excess returns from January 1989 to January 2005

Source: Deutsche Asset Management

Table 2: Monthly risk premium, standard deviation and respective t-value (192 observations)

	GSCI	DBLCI	DBLCI-MR	US Bonds	US Equity
Risk Premium	0.48%	0.75%	0.76%	0.23%	0.60%
Standard Deviation	5.47%	5.79%	5.16%	1.32%	4.19%
t-value	1.20	1.79	2.04	2.43	1.97

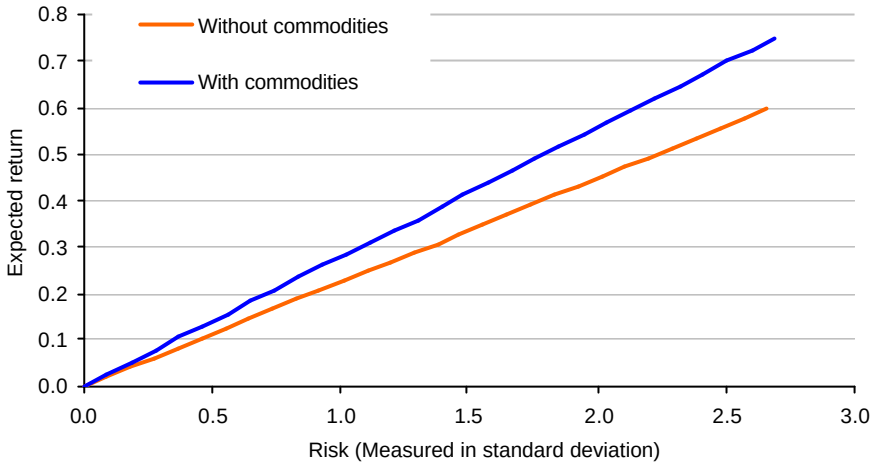
All numbers are based on monthly excess returns from January 1989 to January 2005

Source: Deutsche Asset Management

While the three commodity indices are fairly similar in terms of volatility and correlation, the DBLCI-MR shows the lowest volatility as well as correlation with equities and bonds. At the same time it exhibits the highest monthly risk premium (0.0076%) with the highest t-value ($2.04 = \frac{0.0076}{0.0516}\sqrt{192}$). However this does not necessarily qualify commodity investments as an asset class.

Next we plot two efficient frontiers (assets are required to add up to one, but net shorts are allowed) with and without commodity investments in Exhibit 1.

Exhibit 1: Efficient frontier with and without commodity investments. Short sales allowed. Risk and (excess) returns are on a monthly basis. Commodities are proxied by the DBLCI-MR



Source: Deutsche Asset Management

Both frontiers are straight lines through the origin, as an investment in 100% cash carries neither risk nor risk premium. Portfolios only differ in leverage (positive or negative cash position), but the composition of risky assets remains the same. This explains the straight line. Note that even though including commodities shifts the efficient frontier to the left, this does not allow us to make a judgement about significance. In fact, sampling error in estimates will assure that every ex post observed efficient frontier will always lie to the left of the actual ex ante efficient frontier. Even if a new asset class is spanned in large samples, it will always extend the opportunity set in small samples.

To formally test whether commodities extend the investment opportunity set, we need to remove that part of the risk premium, that is already explained by existing asset classes (here equities and bonds) and test whatever is left (α) for significance. Using the regression approach described above, we arrive at Table 3. It shows the regression coefficients together with their respective p-values. These values calculate the likelihood that a given statistic has been produced by chance, i.e. is purely accidental. A p-value of 5% indicates significance at the 5% level, i.e. only in 5% of all random samples would we see a value of the test statistic that is that high.

Table 3: Estimated parameters from linear regression of commodity excess returns versus equity and bond market excess returns

	GSCI	DBLCI	DBLCI-MR
a	0.0052 (0.19)	0.0088 (0.039)	0.0084 (0.027)
b US Bonds	0.11 (0.70)	-0.14 (0.64)	-0.16 (0.55)
b US Equity	-1.13 (0.16)	-0.15 (0.13)	-0.10 (0.25)

All numbers are based on monthly excess returns from January 1989 to January 2005

Source: Deutsche Asset Management

While we can not reject the null hypothesis (at the 5% level), that commodities are not a unique asset class for the GSCI, we can do so for DBLCI as well as DBLCI-MR. Investing into DBLCI or DBLCI-MR would have significantly extended the investment universe over this time period. The main reason for this is that the risk premium for the GSCI index has not been significant for the respective time period in the first place. Exposures to significantly rewarded risk premiums are statistically insignificant, confirming the intuition, that commodities live a life of their own.[2]

Introducing a general testing procedure

The regression based approach above is the most widely used procedure in testing for mean variance spanning. However, it has several shortcomings. First, the implicit assumption in the regression based approach was that regression betas have been allowed to be positive as well as negative. Note that regression betas effectively are the weights of a tracking error minimizing, replicating portfolio. In the case of investors facing long only constraints (or other real world constraints) we need to check whether diversification benefits rely upon the ability to short asset classes or form leveraged portfolios. Second, we did not include transaction costs. Even, if adding a new asset class extends the mean variance frontier to the left (after realistic constraints have been taken into account), that does not necessarily mean it still does so after transaction costs are taken into account. Third, we only tested for statistical significance. This is well known to be different to economic significance. Statistical tests ask the question: how likely is it to see the mean variance frontier shifting to the left (positive regression intercept) given that excess returns and covariances are measured with sampling error. Economic significance asks the question: by how much did the inclusion of a new asset class increase investors welfare? We hence need a test procedure that also provides figures for economic significance.

We start with the observation that the inclusion of commodities will increase investors' utility in small samples, no matter whether commodities are spanned (risk premium is explained by existing asset classes) or not. This is true, because an asset allocation with n+1 assets must always lead to a higher utility level, than an optimization with just n assets as long as one asset is not spanned. In small samples there will always be some differences (sampling error) that ensures the above. We measure the difference in utility as:

$$\Delta u = \max\left(\mathbf{w}^T\boldsymbol{\mu} - l\mathbf{w}^T\mathbf{O}\,\mathbf{w}^T\right) - \max\left(\mathbf{w}_{-c}^T\boldsymbol{\mu}_{-c} - l\mathbf{w}_{-c}^T\mathbf{O}_{-c}\mathbf{w}_{-c}^T\right) > 0$$

where $\mathbf{w}$ and $\mathbf{w}_{-c}$ denote the investment weight vectors with and without commodities, $\boldsymbol{\mu}$ and $\boldsymbol{\mu}_{-c}$ describe the risk premia with and without commodities while $\mathbf{O}$ and $\mathbf{O}_{-c}$ contain the respective covariances. Assuming $l = 0.15$, the utility difference amounts to:

$$\Delta u = 0.1972 - 0.144 = 0.079$$

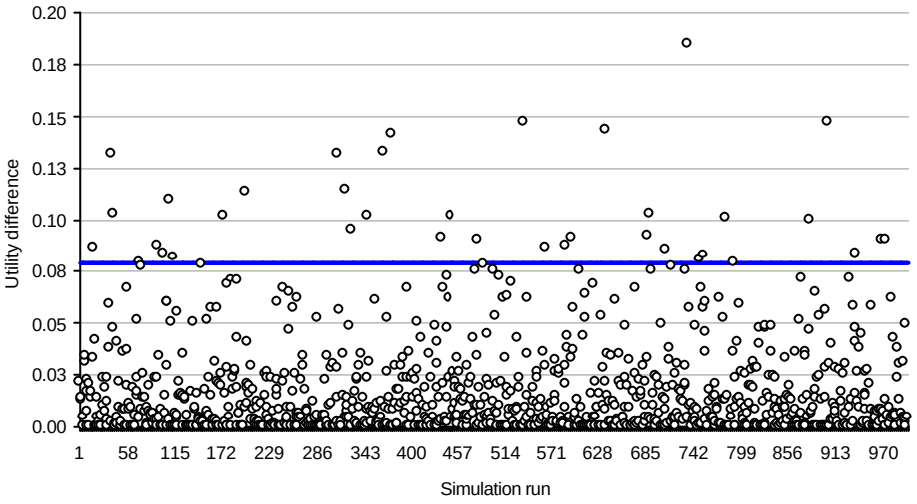
Note that this is equivalent to a return difference of 8 basis points per month (about 1% per annum). The above difference in utility allows consistent comparisons across investment universes. Measuring the vertical distance between efficient frontiers would not. Different frontier slopes imply different risk aversions. Note that Δu can be calculated for arbitrary constraints, unlike regression based tests. Next we need to take care of in sample variation. The process is as follows.

Simulate the return generating process under the null hypothesis of spanning, that is the return for commodities is given by $\sum_j \hat{b}_j \left(\overline{R}_j - c\right)$. Therefore estimated exposure betas are multiplied with the average risk premium. In other words: only the explained part of the risk premium is taken into account.

For each simulation we calculate a new value for Δu_i. Repeating this procedure for $i = 1,...,n$ we arrive at the (otherwise) unknown distribution for Δu und the null hypothesis. All we need to do is to compare the in sample difference (using the historical data) with this distribution and calculate the number of times, where the sampling of Δu yielded larger values than our in sample value. This provides us with the level of significance.

An example of this procedure can be found in Exhibit 2. Each point reflects one simulated realization of Δu_i. Note that all samplings are positive, i.e. the utility difference between an optimization with 6 instead of 5 assets will always be positive (in finite sample). The horizontal line reflects Δu.

Exhibit 2: Samplings of Δu for unconstrained investors with $l = 0.15$. The horizontal line reflects the value of the sample utility difference. Commodities are proxied by the DBLCI-MR



Source: Deutsche Asset Management

If we count the number of realizations above the horizontal lines (39 cases) and divide this by the total number of runs (1000) we arrive at a value of 3.9%. Effectively the value of our test statistic becomes:

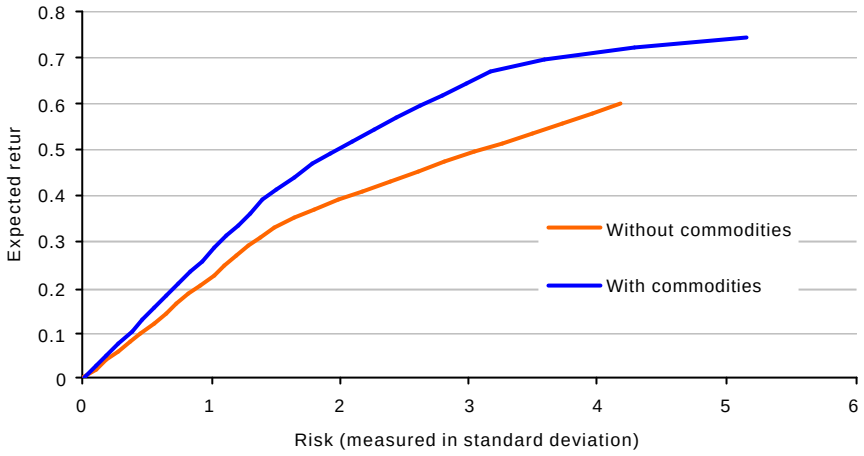
$$\frac{\#\left(\Delta u_i \geq \Delta u\right)}{\#\left(\Delta u_i\right)} = \frac{39}{1000} = 0.039$$

This is virtually the same as the p-value for α in Table 3. Our Monte Carlo methodology recovers the regression based results (as it should). Note that this is irrespective of the assumed risk aversion coefficient. After all, portfolios along the frontier only differ in leverage. Commodities are an asset class under the above setting as long as DBLCI or DBLCI-MR are used. The GSCI index is too volatile relative to the average historic risk premium to reach statistical significance. This might well be a sample specific phenomenon.

Empirical results

We can now turn to the more interesting question, of how real world constraints affect the above calculations. Do commodities loose their relative attractiveness, after short sales constraints have been introduced? Let us start again by plotting both efficient frontiers (with and without short sale constraints).

Exhibit 3; Efficient frontier with and without commodity investments. No short sales allowed. Excess returns are on a monthly basis. Commodities are proxied by DBLCI-MR



Source: DB Global Markets Research

While both frontiers still start at the origin (100% cash investment still remains the least risky portfolio) both frontiers are kinked. Each kink reflects a particular corner solution, i.e. one asset hits the non-negativity constraint and leaves the optimal solutions. With three assets (equities, bonds and commodities), there are only two kinks, while there is only one kink in the case of two assets (universe reduced to equities and bonds).

Why is this important? Two fund separation (each portfolio can be derived from two frontier portfolios) no longer works with long only constraints. Do we therefore need to check for mean variance spanning for each single risk aversion, i.e. for every point across the mean variance frontier? No, because a slight variation of two fund separation still works. Any portfolio between two neighbouring corner solutions (segment between two kinks) is a linear combination of two portfolios along that segment. It is hence enough to test for mean variance spanning at a single point within each frontier segment. Note that we can measure risk aversion by $l = \frac{m}{s^2}$. We can use this to pinpoint individual portfolios within each frontier segment.[3] The results are provided in Table 4. The distribution of our test statistic is sampled via Monte Carlo simulation as described in the previous section.

Table 4: Measures of statistical significance (p-values) for three alternative commodity indices. Each risk aversion pinpoints a different segment along the efficient frontier

	l = 0.01	l = 0.15	l = 0.3
GSCI	0.005 (0.898)	0.027 (0.214)	0.01 (0.197)
DBLCI	0.120 (0.507)	0.068 (0.052)	0.039 (0.047)
DBLCI-MR	0.125 (0.51)	0.076 (0.044)	0.045 (0.030)

All numbers are based on monthly excess returns from January 1989 to January 2005

Source: Deutsche Asset Management

Two main observations become apparent. First there is no evidence that commodities improve investment opportunities for very aggressive ($l = 0.01$) investors in the case of long only constraints. This is entirely intuitive as the maximum return portfolios are concentrated in one single asset. Given the low correlation between assets (and their low volatilities), it is not surprising that testing for differences in means remains insignificant. Second, commodities still significantly improve US investors welfare for high and intermediate risk aversions (depending on the index chosen). The economic significance ranges lies between 4 and 8 basis points per month (48 to 96 basis points per annum)[4].

Extending the universe

The use of commodities is sometimes motivated by its supposed inflation hedging properties. Commodities, particularly energy, are an important input factor. An increase in commodity prices is therefore likely to feed through to broader CPI (consumer price inflation) measures. However, if the correlation between inflation linked bonds (Treasury inflation protected securities, also called TIPS) and commodity indices is substantial, or more precisely if part of the risk premium earned by commodities is already explained by inflation linked bonds, the case for commodities needs a strong conviction in order to argue with the data[5].

We can investigate this by running a linear regression of commodity returns against index returns from the chosen universe. For inflation linked bonds we use monthly returns for US TIPS by Merrill Lynch (Merrill Lynch US Treasury Inflation Linked, available since August 2000). Results are given in Table 5, where numbers in brackets are the respective p-values for the coefficients above.

Table 5: Spanning regression for DBLCI-MR*

	Regression including TIPS	**Regression excluding TIPS**
a	0.0036 (0.49)	0.087 (0.12)
b US Bonds	-1.59 (0.02)	0.31 (0.87)
b US Equity	-0.51 (0.06)	0.04 (0.37)
b US TIPS	1.83 (0.001)	-

**Time period: January 1989 to January 2005*

Source: Deutsche Asset Management

While none of the regressions produced a statistically significant alpha (not even on the 10% level), we see that a considerable part of the risk premium has been explained by the performance of TIPS. The pvalue for the regression intercept (α) drops in significance from 0.12 to 0.49. Including TIPS competes with commodity investments for any given risk budget. While there is always a chicken an egg problem in mean variance spanning tests (which asset class came first), it is more natural to think of TIPS as an asset class as they allow to isolate inflation risk and therefore have a unique economic exposure. Interestingly we see a dramatic shift in sign and size of bond beta (and its significance) when TIPS are included. This indicates that commodity returns are correlated with inflation (difference between nominal and real bonds).

Summary

We introduced a general Monte Carlo based methodology to test for mean variance spanning under arbitrary constraints. It is easy to use for everybody that has a mean variance optimizer at hand. Apart from calculating statistical significance it also allows to measure economic significance (utility difference). For US based investors, commodities significantly expand the investment universe. This result also holds after we have introduced long only constraints. Only for very aggressive investors there is no significant improvement in investors welfare. However, as soon as we consider inflation linked bonds into our analysis, the case for commodities needs additional economic arguments rather than relying purely on statistical data. This is not surprising as inflation linked bonds as well as commodities are both used as inflation hedges.

Endnotes

[1] Most formal tests on mean variance spanning use total returns (not risk premia). These tests also need the sum of exposures (betas) to existing assets to add up to one. However as we use excess returns over cash, betas (effectively weights of a replicating portfolio) do not need to add to one. The missing allocation can always be filled up with cash (negative cash in case of leverage) to create portfolios that add up (to one). For a review on mean variance spanning tests, see Roon F.J. Nijman (2001), Testing for Mean Variance Spanning, A Survey. CEPR, Tilburg University.

[2] More sophisticated statistical procedures that account for missing data and would therefore allow to account for the covariance structure between commodities and time series that have a longer history implicitly assume mean variance spanning, which makes them of little appeal.

[3] More formally we identify corner solutions first. Then we calculate the implied risk aversion for an arbitrary portfolio between two neighbouring corner solutions. This gives us the risk aversions to work with.

[4] Note that the utility difference can be directly translated into a return difference using the security equivalent.

[5] Given the high volatility of commodity investments the inflation hedging argument is already weak, as this kind of "hedge" would expose investors at the same time to considerable (non inflation related) noise. It is further weakened by the existence of an asset that can pinpoint inflation risks.

Dr Bernd Scherer

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Collateralized Commodity Futures: Good Portfolio Diversification & The Prospect of Equity–Like Returns

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Investors looking for a liquid and low-cost strategy that diversifies the risk of stocks and bonds and offers the prospect of equity-like returns should consider a strategic allocation to indexed collateralized commodity futures (CCF).

CCF strategies comprise index-matching long positions in commodity futures backed by high quality collateral of the same value. The futures are rolled into more distant contracts prior to maturity of the initially purchased contracts. This is done on a mechanical basis consistent with rules-based index construction. Deutsche Bank provides and supports a CCF index series that can be used to implement a CCF strategy. CFF indexes are also available from Goldman Sachs, Dow-Jones, Standard & Poors, Commodity Research Bureau and Beeland Management Company.

Past CCF performance relative to stocks and bonds

Exhibit 1 captures the return behavior of the Deutsche Bank Liquid Commodity Index (DBLCI) relative to other public market investments and inflation over the 16-years ending December 2004. The DBLCI was introduced in 2003 and back-calculated to December 1, 1988. The DBLCI uses six commodities to capture the performance of four commodity sectors: energy, grains, industrial metals and precious metals. The return behavior of the DBLCI is very similar to the Goldman Sachs Commodity Index (GSCI), which is most identified with CCF investing.

Exhibit 1: Annualized returns, standard deviations & correlations

1989-2004	**Return**	**Standard Deviation**	**Correlation**						
			DBCLI	DBLCI-spot	Russell 1000	MSCI EAFE	LB Aggregate	CG 3-month T-Bill	US CPI
DBLCI	12.67%	20.00%	1.00						
DBLCI Spot Index	3.49%	22.04%	0.95	1.00					
Russell 1000 Index	12.21%	14.55%	-0.34	-0.36	1.00				
MSCI EAFE Index	4.93%	16.72%	-0.27	-0.25	0.77	1.00			
Lehman Brothers Aggregate Bond Index	8.12%	3.97%	-0.13	-0.13	-0.03	-0.07	1.00		
Citigroup 3 Month T-Bill	4.56%	0.59%	0.06	-0.04	0.09	-0.18	0.27	1.00	
US CPI	2.90%	0.82%	0.37	0.25	-0.30	-0.43	-0.07	0.32	1.00
Max Annual % Return (1989-2004)			63.93	59.76	37.77	39.17	18.47	8.64	6.61
Min Annual % Return (1989-2004)			(31.94)	(24.56)	(21.65)	(23.20)	(2.92)	1.07	1.55
Year of Max Return			1999	1999	1995	2003	1995	1989	1990
Year of Min Return			1998	2001	2002	1990	1994	2003	2001
Sharpe Ratio			0.41	(0.05)	0.53	0.02	0.89	0.00	--

Quarterly data 1989-2004

Source: Russell Investment Group

Over this period, the DBLCI earned a 12.67% annual return. This was above the 12.21% return for Russell 1000 Index, and well above the return to non-US stocks as represented by the MSCI EAFE Index and US bonds as represented by the Lehman Brothers Aggregate Index. The standard deviation of DBCLI returns at 20.00% was modestly higher than equities. Of particular note are the negative correlations of DBLCI returns with those of stocks and bonds. For investors holding portfolios of mainly stocks and bonds, the negative correlations signal that a CFF investment offers a significant opportunity to diversify total portfolio risk.

Three components of CCF returns

Exhibit 2 portrays the three components of CCF returns. Interest earned on the high-quality collateral underlying the purchase of the commodities futures is the first component of CCF returns. The interest return includes the proceeds of active cash management.

The second component is the premium earned by CCF investors by providing commodity producers with insurance against future movements in the expected future spot price. Why should there be an insurance premium in futures commodities market? Because, as John Maynard Keynes (1930) observed, "the commodity futures market provides a mechanism by which one group of risk-averse traders (producers), who have committed themselves to supplying commodities subject to price uncertainty, is insured by another group of risk-averse traders (investors)." The difference between the expected future spot price and the futures price "is simply an insurance premium paid by producers to investors who take an offsetting, long open position".

Beware that the insurance premium is not observable in advance because the market's consensus of the expected future spot price is unobservable. However, its existence and magnitude can be estimated by examining historical returns of a CCF index strategy. Using a back-calculated equally-weighted CCF index, Gorton and Rouwenhorst (2005) estimate a 5.23% average annual risk premium above T-Bills over a 45 year period ending 2004. This is about equal to the risk premium to stocks and double the risk premium to bonds over the same period.

Exhibit 2: Three components of CCF returns

Return on collateral assets	+	Insurance premium paid to investors by commodity producers to protect against future movements in spot prices	+	Deviation of spot price from expected prices at expiry of contract, sometime called "expectational variance"	=	RETURN
T-bills, credit exposure, yield curve trading, rolling futures; low return, low volatility		Magnitude and volatility not directly observable; premium has been estimated *ex post* at about 5% above return on collateral assets, or about 3% above bonds		Magnitude and volatility not directly observable and driven primarily by commodity spot prices; 0% expected return, very volatile, low correlation with stock and bonds		

Source: Russell Investment Group

How big will this insurance premium be in the future? Estimates vary widely, with Erb and Harvey (2005) arguing there is no risk premium to be earned from a passive exposure to a CCF index. Russell currently assumes a 2.5% return premium over mid-term government bonds when conducting asset allocation studies. More information on Russell's CCF forecasts are outlined below. The third component is the deviation of the spot price from the expected spot price when the original futures contract was purchased. This deviation is often referred to as "expectational variance". Assuming commodity markets provide unbiased estimates of future spot prices, the deviations of actual spot prices from the expected

spot price will average to zero over time. This means expectational variance is not a systematic source of CCF returns. However, the variation of actual prices around expected spot prices are high and generate most of the volatility in CCF returns, which is evidenced by the 0.95 correlation between DBLCI spot and futures returns. But importantly, these variations are uncorrelated or even negatively correlated with stocks and bonds.

An alternative explanation of CCF risk premium

Many suppliers of CCF products argue that the risk premium originates with processors experiencing low inventories who need to maintain their operations in the face of unexpected declines in commodity supply. Rather than temporarily close their plants, processors purchase more commodities, which increases the spot prices and near-term futures relative to more distant contracts. Investors profit by buying long-dated futures low, and then selling high as the futures approach expiration. Buying, selling and then buying additional futures to maintain given exposure is often described as "rolling futures" and the associated return as the "roll return".

Rationale for low correlations

Why do CCF products have low correlations with stocks and bonds? Should correlations not be positive given that rising commodity prices are obvious indicators of strong current economic activity? The explanation is straightforward: The performance of CCF products tends to be tied to current activities, while stocks and bonds are largely anticipatory.[1]

During and shortly after an economic peak, demand exceeds supply, delivery capacity is stretched, and inventories run down. CCF products usually have positive returns during this period, because the short-term demand causes price spikes in near-term futures contracts. At the same time, equity prices decline rapidly in anticipation of falling demand, while bond performance improves as investors shift capital away from equities. During a recession and recovery, the situation reverses itself. Demand is initially slow, delivery capacity is slack and inventories are replenished. Commodity returns fall, but gradually improve as the economy recovers. At the same time, equity performance improves in anticipation of improved demand, and bond prices decline.

CCF forecasts and portfolio allocation advice

Past returns may give investors insights into the differential behavior of competing investment opportunities but to decide how to invest for the future investors must develop capital market forecasts. Exhibit 3 summarizes Russell's conditional capital market forecast, as of December 2004, for CCF and selected traditional asset classes for a US investor with a 20-year investment horizon. These forecasts are used when conducting asset-liability studies for institutional investors interested in implementing a policy allocation to CCF.

Exhibit 3: Russell US asset allocation assumptions

			Correlation				
Asset Classes	**Expected Return**	**Standard Deviation**	**US Equity**	**Non-US Equity**	**Agg. Fixed**	**Cash**	**Commodities**
US Equity	8.6%	18.2%	1.00				
Non-US Equity	8.6%	19.2%	0.61	1.00			
Agg. Fixed	6.1%	3.4%	0.22	0.19	1.00		
Cash	4.4%	3.4%	0.26	0.27	0.63	1.00	
Commodities	8.2%	21.2%	0.15	0.21	0.19	0.27	1.00

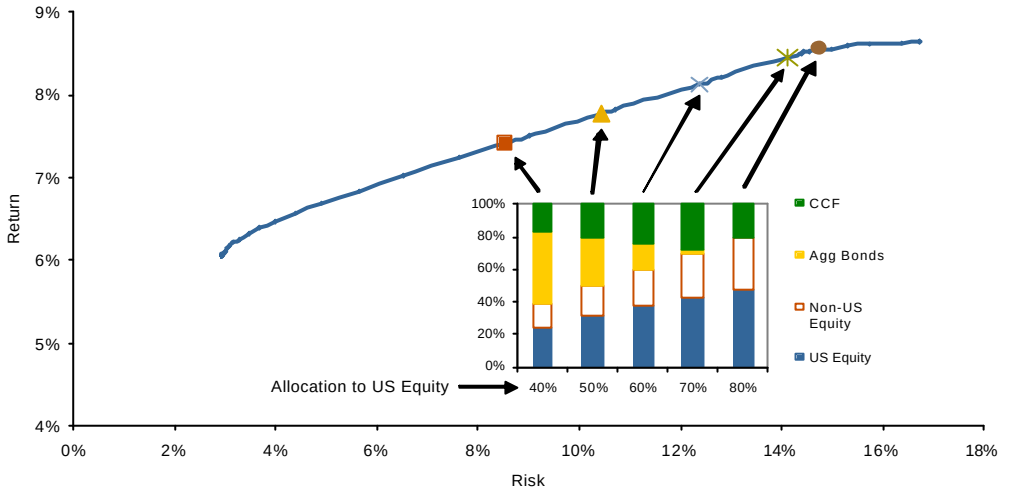
Commodities are modeled as 250bps over intermediate government bonds

Source: Russell Investment Group

Three observations are in order. First, the forecast for CCF returns are based on Russell's analysis of the GSCI, which has returns starting 1973. Our analysis focused on GSCI returns starting in 1987, the first year the GSCI fully incorporated energy sector commodities. Russell views the GSCI and DBLCI as near substitutes, so the asset class characteristics developed by Russell apply equally to CCF strategies using either index. Second, the CCF expected return and standard deviations are roughly in line with historical experience. The expected return is equity-like with an equity-like level of volatility. Third, unlike historical experience our CCF forecasts have positive correlations with stocks and bonds, albeit still low enough to make CCF an attractive risk diversifier. The low correlation of CCF with traditional asset classes made modeling difficult, so we settled on a relationship that produced positive but still low correlations with other return series modeled by Russell. This makes CCF a less attractive investment relative to historical experience, which errors on the side of caution with respect to the risk-diversifying behavior of CCF returns.

Exhibit 4 summarizes unconstrained mean-variance efficient allocations to US stocks, non-US stocks, US aggregate bonds and collateralized commodity futures using Russell's 20-year capital market forecasts. Even with forecast correlations that are higher than historical experience, CCF feature prominently across the risk range favored by most institutional investors. Efficient allocations to CCF range from a low of 15% to a high of 25%. These high exposures reveal clearly the ability of CCF to improve a portfolio's risk-adjusted returns.

Exhibit 4: Efficient allocations to stocks, bonds and commodity futures



Source: Russell Investment Group

However, mathematical optimization is not the same as behavioral optimization. Experience teaches that Boards and Committees overseeing assets in trust are very reluctant to invest in asset classes that do not appear in the portfolios of their peers, even when there is strong evidence that these asset classes could meaningfully improve a portfolio's risk-adjusted returns. This is certainly true for CCF with their wide price swings and the popular connotation that commodities are for speculators. For example, a quick survey undertaken by Russell found that five very large pension funds had invested in CCF, at an average policy allocation of 3.5%. Maximum policy allocation was 5%.[2] These allocations are far short of the mathematically efficient allocations suggested in Exhibit 4.

Russell advises that an initial exposure to CCF should not exceed 5%, and that smaller trial exposures are reasonable. Based on experience relative to performance expectations, initial CCF policy exposures could be maintained, expanded or discontinued High liquidity and low fees facilitate toe-in-the water exposures. Russell's supportive but also cautious advice on CCF recognizes that fiduciaries managing other people's money are held to very high standards. Our advice also recognizes that many aspects of the behavior of CCF returns are not fully understood.

Some cautionary notes

While Russell believes that CCF investments provide investors with good risk diversification and the prospect of earning an equity-like return over the long term, these characteristics are certainly not guaranteed and not all investors are well suited to CCF exposures. Investors contemplating a strategic exposure to CCF should evaluate the following cautionary notes.

CCF risk premium could be squeezed

Whether interpreted as insurance premium or a positive roll return, the CCF risk premium could be squeezed if CCF products grow in popularity. A large flow of money into CCF products would bid up futures prices, thus squeezing the risk premium. How much money must be directed towards CCF products to reduce the risk premium is an unanswered question. This is likely to be a longer-term concern because CCF products have enjoyed limited acceptance by institutional investors. However, this may be changing. Market observers have noted a marked increase in CCF investors. For example, *The Wall Street Journal* reported recently that about 150 institutions across the globe are now estimated to have exposures to the GSCI in 2004, up from 50 in 2000.[3]

From a slightly different perspective, Erb and Harvey (2005) contend that the excess returns enjoyed by CCF indexes such as the GSCI have been largely driven by the choice of the index weighting schemes, and that there is no guarantee these weighting schemes will be similarly rewarded in the future. They argue that tactical management of commodity futures weights will yield higher returns and lower risk than passive CCF indexes.

CCF risk premium delivery unpredictable

CCF investors should be long-term investors. As with traditional equity investing, the CCF risk premium is earned "on average" over long periods. It does not show-up predictably year by year. Recall that the 5% per annum risk premium estimated by Gorton and Rouwenworst (2004) was earned over a 45 year period. These 45 years undoubtedly encompass many sub-periods over which the realized risk premium was far below the expected risk premium. One of our London-based clients likened returns to CCF and traditional equity investing to English buses: after an unpredictable but usually long wait they arrive in bunches. On average, they are always on schedule, but seldom on schedule when standing in the rain.

Learn to love, not fear CCF volatility

CCF products are best suited for those investors who can learn to love, not fear, the high volatility that comes with CCF investing, because in combination with stocks and bonds, CCF volatility can actually reduce total portfolio volatility. Although this perspective is intellectually satisfying, experience shows that many Boards and Committees narrowly focus on asset class volatility without reference to total portfolio volatility. Consider the returns to the DBLCI in 1998 and 1999: A 32% drop followed by a 64% increase. Many investors will find this a stomach-turning roller-coaster ride regardless of their risk-reducing impact on total portfolio risk, and their allegiance to CCF can quickly wane.

Pick an index that best meets your investment preferences

Investors considering an allocation to CCF must decide which of six available CCF indexes to track. While each exploits the same underling return drivers, each is constructed and managed using different rules. These differences will produce different performance patterns and expose investors to different risks[4].

Russell believes that three indexes will most often satisfy the investment and implementation preferences of institutional investors: Goldman Sachs Commodity Index (GSCI), Deutsche Bank Liquid Commodity Index (DBLCI) and the Dow-Jones-AIG Commodity Index (DJ-AIGCI). Each index should deliver a return stream that diversifies the risk of holding stocks and bonds, while also delivering equity-like returns over the long term. The key distinguishing feature across the three indexes is their strategic exposures to volatile energy commodities.

The GSCI provides investors with an unrestricted production-weighted exposure to energy, the commodity that is tied most directly to global economic activity. Energy exposure has been as high as 77%. The GSCI return pattern is volatile. Since its introduction in 1991, the GSCI has gained wide industry acceptance and has become the default benchmark for evaluating CCF strategies.

Investors wanting a GSCI-like strategic exposure to energy, but with annual rebalancing to a pre-set energy exposure should consider the DBLCI. This index annually rebalances sector exposures to pre-set fixed weights: 55% energy and smaller exposures to grains and metals. To maximize liquidity, the DBLCI uses only six commodities to capture the behavior of four commodity sectors. This exposes investors to idiosyncratic risk relative to the GSCI. The DBLCI was introduced in 2003.

The DJ-AIGCI provides investors with a less volatile stream of CCF returns. The index annually rebalances sector exposures to ensure that any one commodity sector, including energy, does not exceed 33%. These restrictions are specifically designed to reduce return volatility. The DJ-AIGCI was introduced in 1998.

The Reuters-CRB Index, the Rogers International Commodity Index and the S&P Commodity Index are also often referenced when considering CCF investing. However, for various different reasons, these indexes are unlikely to appeal to many institutional investors.

Consider a staggered implementation

Finally, given the high volatility of CCF products, investors should consider a staggered implementation of a policy allocation. This is particularly important after a sharp rise in CCF returns to avoid being caught by a sudden drop in returns. An opening bad experience could undermine support for an otherwise rewarding long-term CCF exposure.

Conclusion

Facing an investment future that seems to be characterized by low returns relative to those enjoyed over the past decades, investors are anxiously looking for uncorrelated and systematic sources of equity-level returns. Collateralized commodity futures seem to offer such a return stream, but they are clearly not suited for every investor and are certainly not without their risks. However, a dispassionate evaluation of the factors driving CCF returns – including their high volatility and the unpredictable delivery of a risk premium – indicates that CCF exposures can be a savvy investment for the right investors.

Endnotes

[1] Gorton and Rouwenhorst (2005) pp. 20-22

[2] Survey conducted using Google in August, 2004

[3] Sesit (2004)

[4] For a more detailed discussion of the six available indexes, see Ilkiw, Carroll and Waheed (2005)

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From 1986 to 1989, John was an asset-liability management consultant with William M. Mercer Limited. From 1983 to 1986, he was director of the pension and income security policy branch in Ontario. Before that time, John served as a senior advisor on pension issues for Ontario's Ministry of Treasury and Economics. He joined the Ontario civil service in 1974 to research Canada Pension Plan financing and benefit issues.

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Commodities: An Orthogonal Asset Class

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Summary
Return-oriented investors do not pay a premium for benchmark returns on financial assets e.g., matching the stock and bond indices used to benchmark institutional portfolios (beta). Demonstrating a consistent ability to add alpha, on the other hand, is value added to these managers and their boards. Further along the investment continuum, the ability to deliver orthogonal alpha i.e., returns uncorrelated with and independent of the financial assets in the portfolio commands an even greater premium.[1]

Risk-averse managers value investments that lower portfolio volatility and stabilize returns. This, too, is achieved with assets that provide orthogonal returns: By lowering portfolio volatility and stabilizing returns, these managers improve their portfolios' Sharpe Ratios.[2]

Until recently, both types of managers typically did not think of commodities as the natural choice to meet both sets of goals vis-à-vis risk reduction and orthogonal returns. This is puzzling, given the historical performance of commodities.[3] This is changing.

Risk averse investors prefer higher commodity allocations
Commodities are volatile, which may explain why investors historically have not allocated to this asset class. Prices respond almost immediately to unexpected changes in the weather, sudden supply and demand shocks, changes in regulation, climate, geopolitical risks and a host of transitory affects arriving randomly (e.g., a refinery fire).

These volatile asset prices can be harnessed into a commodity index, such that the index itself has relatively low, equity-like volatility, even though its components are highly volatile in isolation. This is due to the low to negative correlations among the individual commodities' returns, as is demonstrated in Table 1, which shows the correlations among the elements of the Deutsche Bank Liquid Commodity Index (DBLCI).

Table 1: DBLCI quarterly returns correlation matrix (1992Q1-2004Q4)

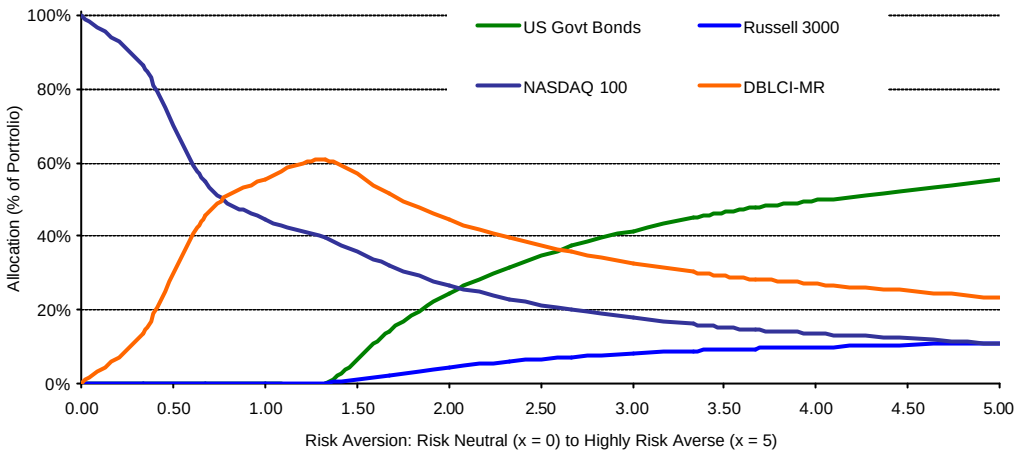
	Crude Oil	Heating Oil	Gold	Aluminium	Wheat	Corn
Crude Oil	100%					
Heating Oil	85%	100%				
Gold	20%	20%	100%			
Aluminium	24%	19%	17%	100%		
Wheat	-16%	-1%	23%	-11%	100%	
Corn	13%	14%	18%	7%	1%	100%

Source: Deutsche Bank

As counterintuitive as it may seem, this volatility benefits risk-averse portfolio managers: They can use commodity index products to improve portfolio returns and reduce overall portfolio variance. In fact, highly risk-averse portfolio managers value commodity index products more than their risk-neutral counterparts. This was demonstrated in Anson (1999).[4] We used Anson's model to map asset-class allocations as a function of risk aversion in a portfolio consisting of US government bonds, domestic equities (proxied by the Russell 3000 and NASDAQ 100) and the Deutsche Bank Liquid Commodity Index–Mean

Reversion (DBLCI–MR) index. Historical quarterly returns, volatilities and correlations covering the period from 1992 through 2004 were used to model asset allocation as a function of risk aversion. (See Endnotes for specification.)

Exhibit 1: Asset allocations as a function of risk aversion



Source: DB Global Markets Research, Bloomberg

Key:
DBLCI-MR: Deutsche Bank Liquid Commodity Index-Mean Reversion;
US Govt Bonds: EFFAS US Govt Bond All > 1yr (European Federation of Financial Analysts Societies, US Govt Bond All);
Russell 3000: Russell 3000 Equities index;
NASDAQ 100: National Association of Securities Dealers Automated Quotations system.

A few points regarding the Risk Aversion (RA), or "x" axis: On the continuum above, x = 0 is analogous to a pure NASDAQ tech fund or the portfolio of a 20-year-old programmer whose equity holdings are company shares she's received as part of her compensation, which are highly correlated to the NASDAQ 100. At the other end, at x = 5, is the RA of a portfolio manager with a high allocation to bonds e.g., an insurance company portfolio, which uses high-grade fixed-income instruments (but typically not commodities) to match liability duration.

The following historical inputs (1992Q1–2004Q4) were used to model risk aversion in the above model.

Table 2: Asset allocation as a function of risk aversion (1992Q1-2004Q4)

Historical inputs	Asset Class	Excess Return	Standard Deviation	Sharpe Ratio
1.	US Govt Bonds	3.42%	5.02%	123.39%
2.	Russell 3000	8.38%	16.32%	51.31%
3.	NASDAQ 100	15.15%	33.82%	29.92%
4.	DBLCI-MR	8.55%	17.53%	48.78%
Correlation Matrix	US Govt Bonds	Russell 3000	NASDAQ 100	DBLCI-MR
US Govt Bonds	100%			
Russell 3000	-33.8%	100%		
NASDAQ 100	-38.7%	85.9%	100%	
DBLCI-MR	-7.5%	-18.5%	-12.7%	100%

Source: Deutsche Bank

Exhibit 1 shows that as risk aversion increases, the investor's allocation to commodities via the DBLCI–MR initially increases. This is most dramatic for a small increase in risk aversion – i.e., from a purely risk neutral starting point, where the investor seeks the highest expected return and is indifferent to volatility (at x = 0, the allocation to the NASDAQ 100 = 100%), to somewhat risk averse at x = 1.33, where the allocation to commodities exceeds 60% (a result not atypical in model-driven optimizations of this type).

Further along the risk-aversion scale (as the "x" coordinate approaches 5), we see an increasing allocation to US Government bonds. This is intuitively consistent: As risk aversion increases, the investor seeks to hold more of the lowest-risk asset and reduces holdings of other risky assets. Interestingly, the rate at which commodities holdings are reduced diminishes as risk aversion increases, levelling out at about 20+% in this simulation.

High allocations to commodities are not unusual in portfolio optimizations such as the one we performed (we constrained the process by not allowing negative, or short, allocations to any asset class). Such models seek an optimal portfolio based on return, volatility and correlations of the various assets. In purely mathematical terms, these models – given assets with comparable first and second moments (expected return and volatility) – will sort and allocate based largely on the orthogonality of each asset available to the model. To the degree that assets' expected returns and variances are comparable, the model will seek returns that are statistically independent of the returns of the other assets available to the optimization function. This is the closed-form expression of portfolio diversification.[5]

Of course, boards and portfolio managers ultimately decide on allocations as a function of their goals, constraints and risk tolerance. The models provide a systematic methodology to assess the various investment alternatives. These models are used to illustrate Markowitz's admonition to portfolio managers; to wit: "… (A) rule of behavior which does not imply the superiority of diversification must be rejected both as a hypothesis and as a maxim."[6]

Commodities versus traditional asset classes

Commodity index investments were not well understood among portfolio managers in the past, and certainly were not widely held. This despite the fact commodities produce consistent returns that are competitive with equities, which are uncorrelated with financial-asset returns.

As economists turn their attention to commodity index products, this is changing. In a recent working paper published by the National Bureau of Economic Research, Gorton and Rouwenhorst (2005) found that over the 43-year period from 1959 – 2002 commodities produced:

- Returns comparable to the return on the S+P 500
- Lower standard deviation of returns than stocks
- Negative correlation with the return on the S+P 500 and long-term bonds
- Opposite exposure to inflation compared to stocks and bonds
    - Stocks and bonds are negatively correlated with inflation
    - The correlation of commodity futures with inflation is positive at all horizons.[7]

Using quarterly returns data over the 1992–2004 period, we found similar results, as the following table demonstrates.[8]

Table 1: Quarterly returns correlation matrix (1992Q1-2004Q4)

	DBLCI	DBLCI-MR	GSCI[1]	DJ-AIG[2]	USG	Russell 3000	MSCI	NASDAQ 100
Alpha[3]	11.04%	10.23%	5.66%	5.60%	4.29%	0.00%	-2.01%	0.13%
Sharpe Ratio	52.52%	48.78%	23.77%	38.53%	68.06%	51.31%	29.92%	44.79%
Excess Return[4]	9.26%	8.55%	4.18%	4.58%	3.42%	8.38%	5.16%	15.15%
Volatility	17.63%	17.53%	17.60%	11.88%	5.02%	16.32%	17.25%	33.82%
Correlation Matrix								
DBLCI	100%							
DBLCI-MR	92.9%	100%						
GSCI	91.3%	80.1%	100%					
DJ-AIG	85.8%	80.4%	89.0%	100%				
USG	-6.1%	-75%	2.7%	-3.6%	100%			
Russell 3000	-19.4%	-18.5%	-16.3%	-16.7%	-33.8%	100%		
MSCI	-5.9%	-4.1%	-5.8%	2.0%	-34.5%	81.5%	100%	
NASDAQ 100	-14.2%	-12.7%	-15.2%	-20.1%	-38.7%	85.9%	68.4%	100%

[1] *GSCI = Goldman Sachs Commodity Index (©2005 Goldman Sachs & Co. used with permission)*

[2] *DJ-AIG = Dow Jones AIG Commodity Index*

[3] *This is the regression alpha in the following estimator of excess returns:*

$$r_p - r_f = a_p + b(r_m - r_f), where$$
$$a = \text{intercept term of regression}, b = corr(p,m)\, s_p / s_m$$
$$(r = return, p = portfolio, m = market (Russell 3000), f = risk\ free\ rate)$$

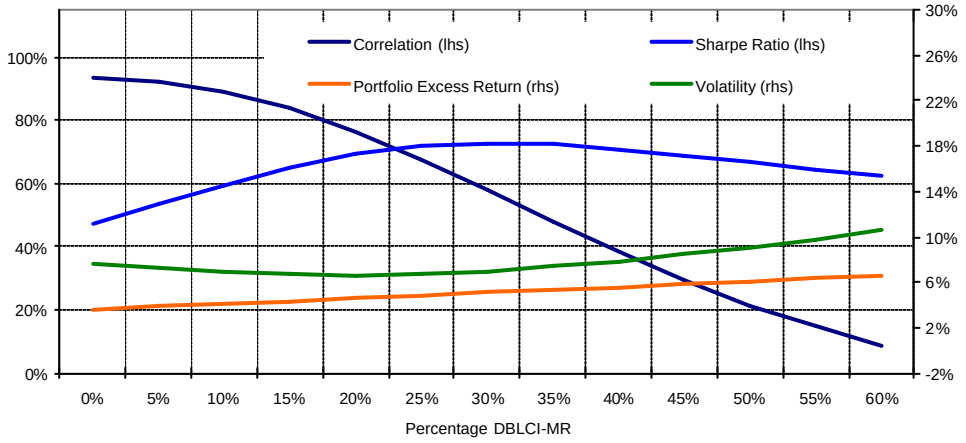
See Sharpe, William F., and Alexander, Gordon J., Investments (Prentice Hall, 4th ed., 1992), pp. 746-747

[4] *Excess Return is measured via 3-month T-bill rate*

Source: Deutsche Bank, Bloomberg

Clearly, commodities produce orthogonal alpha. The practical benefit of adding commodities (via the DBLCI–MR) to a portfolio can be seen in Exhibit 2, which uses the above historical statistics as return, volatility and correlation inputs to a simplified portfolio model. The portfolio initially consists of equal parts US Treasury Bonds, Russell 3000, MSCI (ex US), and cash (earning T-Bill returns).

Exhibit 2: Demonstrating the effect of adding DBLCI-MR to a stylized portfolio



Source: DB Global Markets Research

The optimal portfolio in this historical simulation – here defined as the portfolio with the highest Sharpe Ratio – is obtained when the DBLCI–MR weight in the portfolio is equal to 30% of total assets.[9] This produced the following results:

- Portfolio volatility decreases to 7.00% per annum from 7.65%.
- Excess returns (vs. the 3-month T-bill rate) rise to 5.08% from 3.60%.
- The lower volatility and higher excess return raises the portfolio Sharpe Ratio to 72.6% from 47.1%.
- Portfolio alpha increases to 0.75% from -0.01%.
- And the portfolio's correlation with "the Market" i.e., the Russell 3000 in this simulation, falls to 57.83% from 93.62%.

Noteworthy also is the fact that the portfolio's Sharpe Ratio increases with modest additions of DBLCI–MR commodity exposure i.e., the portfolio's Sharpe Ratio is increasing even with a 5% allocation to commodities, and continues to increases up to the optimal allocation of 30% in this example.

As an aside, some managers run their portfolio optimization programs "backwards" to see what the implied return on commodities works out to, given the allocations they have *actually* made. Typically, most (but not all) managers allocate less than 5% of total assets to commodities, implying a negative expected return to commodities. Nonetheless, the optimization model still will allocate to commodities, given the orthogonal nature of the returns they produce.

Conclusion

Commodities can be an important part of the optimal portfolio. Risk-averse investors desiring stable overall returns and reduced volatility, as well as alpha-oriented managers seeking consistent non-correlated returns both benefit from including commodity index products in their portfolios.

It is highly unlikely portfolio managers will allocate 60% of their portfolios to commodities, let alone 30%. (We have observed ranges of 1% to 5%, with some outliers above 10%.) However, as the above results demonstrate, even modest allocations to commodities can help raise portfolios' Sharpe Ratio over the long haul.

Endnotes

[1] See Mark J.P. Anson, *Strategic versus Tactical Asset Allocation*, in The Journal of Portfolio Management, Winter 2004, pp. 8 – 22, for a discussion of alpha and beta drivers vis-à-vis portfolio management.

[2] See William F. Sharpe, *The Sharpe Ratio*, Reprinted from The Journal of Portfolio Management, Fall 1994, at http://www.stanford.edu/~wfsharpe/art/sr/sr.htm.

[3] See National Bureau of Economic Research Working Paper Working Paper 10595, *Facts and Fantasies about Commodity Futures*, by Gary Gorton of the Wharton School and the NBER, and K. Geert Rouwenhorst of Yale's School of Management (June 14, 2004), at (http://www.nber.org/papers/w10595). In the opening remarks in their paper, they note: "Commodity futures are still a relatively unknown asset class, despite being traded in the U.S. for over 100 years and elsewhere for even longer."

[4] See Mark J.P. Anson, *Maximizing Utility with Commodity Futures Diversification* in The Journal of Portfolio Management, Summer 1999, Vol. 25 Issue 4, pp. 86 – 94.

We used the specification in Anson (1999):

Utility function: $J = R_P - As_P^2$,

where:

$$R_P = \sum_{i=1}^{n} x_i R_i$$

$$s_P^2 = \sum_{i,j}^{n} x_i x_j s_i s_j r_{i,j}$$

R_P = Portfolio return

A = Risk-aversion parameter

s_P^2 = Portfolio variance

R_i = Individual asset return

$s_i s_j r_{i,j}$ = covariance of assets i and j, which is the product of the volatility of asset i and the volatility of asset j * correlation of assets i and j

x_i = allocation in asset i , subject to

$$x_i \geq 0$$

$$\sum_{i=1}^{n} x_i = 1$$

[5] See Robert C. Merton, *An Analytic Derivation of the Efficient Portfolio Frontier*, Journal of Financial and Quantitative Analysis, Volume 7, Issue 4 (Sep., 1972), 1851 – 1872, for optimization model.

[6] See Harry M. Markowitz: *Portfolio Selection,* The Journal of Finance Vol. VII, No. 1, March 1952, and *Foundations of Portfolio Theory*, The Journal of Finance Vol. XLVI, No.2, June 1991 for the seminal discussions on portfolio theory. See also http://cepa.newschool.edu/het/profiles/markow.htm

[7] *Op cit* (Gorton and Rouwenhorst, 2004).

[8] These statistics are based on historical analysis prior to the listing of DB's commodity indices. The DB commodity indices were launched in February 2003. All returns are calculated per respective index rules.

[9] The optimal portfolio is determined by adding DBLCI – MR such that:

(x% DBCLI-MR) + [(1-x%) * ((25% R3K) + (25% USG) + (25% MSCI + (25% Cash))]

Commodities (DBLCI – MR) were added such that the relative weights of the initial assets remained constant, although the absolute weights went down.

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Commodity Allocation From A Private Client Perspective

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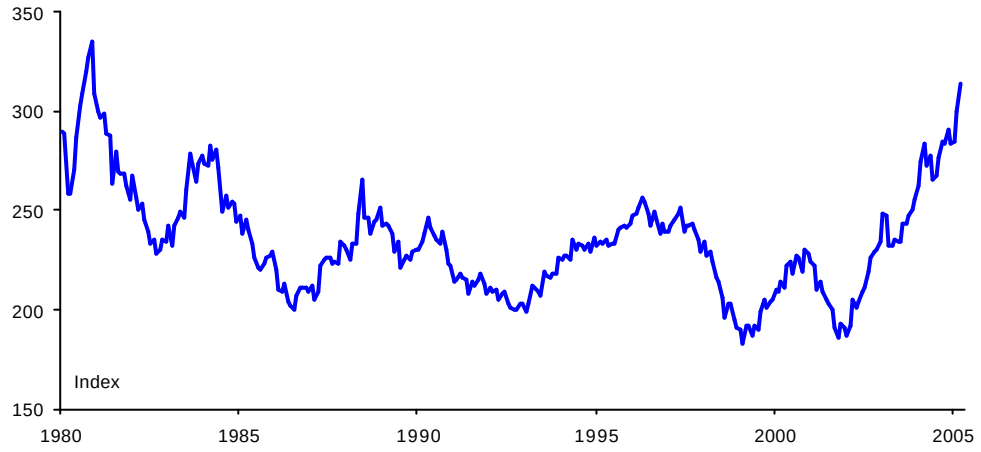
Supply

Since the oil price shock in the eighties, commodity prices had, by and large, been on a long-term downtrend ever since. An indication of this long-term trend is highlighted by the Commodity Research Bureau (CRB) index in Exhibit 1. This fell 45% from its November 1980 high of 337.60 to a low of 182.9 in February 1999. Although this trend was interrupted by large swings, which sometimes persisted for several years, these were not strong enough to break the downtrend. Since economic sectors with declining prices are not particularly attractive to invest in, companies as well as individual investors were increasingly hesitant with capital spending in the commodity complex.

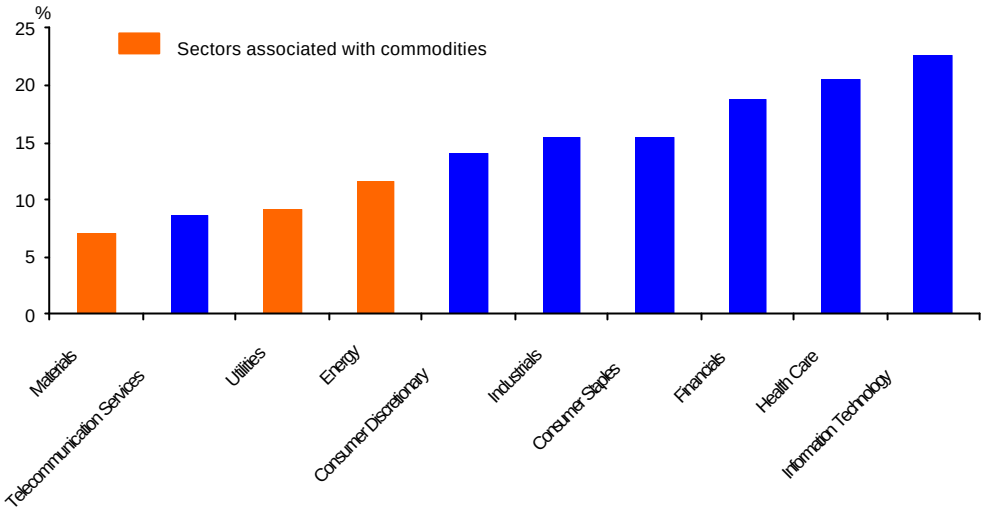
Exhibit 1: Commodity Research Bureau (CRB) index (1980-2005)



Source: Bloomberg

This is confirmed by examining average annual returns of the major economic sectors in the S&P 500 throughout the 1990s. This shows a significant underperformance of commodity related sectors compared to other sectors of the economy, Exhibit 2. Since relative price performance is a major driver of the allocation of capital, investments tended to flow towards those sectors with higher returns on capital while investments in commodity related sectors were curtailed. Capital withdrawal forced companies to cut costs. Over time, this lack of investment resulted in a deterioration of the materials handling equipment and a reduction of production which has led to supply-side capacity constraints, which we are now experiencing today.

Exhibit 2: Average annual returns in the major economic sectors or the S&P500 (1990-2000)



Source: Bloomberg

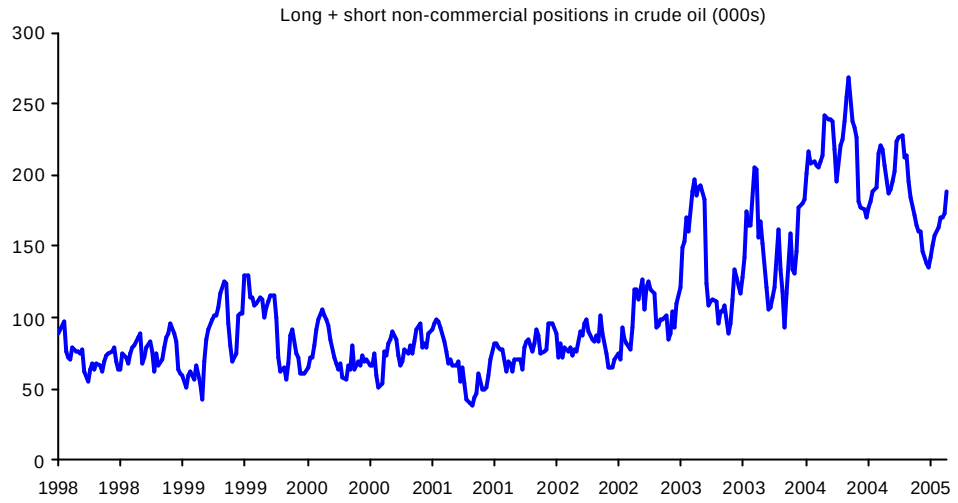
Demand

The demand for commodities has changed significantly since the entry of China to the World Trade Organisation (WTO) in 2001. Extraordinary strong growth initiated a demand shock for many basic resources as structural changes began to get under way in China (urbanisation, expansion of infrastructure). This led to an insatiable appetite for building materials, which are not always available domestically – at least not at the required quantities. As a result, China became one of the principal global consumers in many commodity sectors. No reversal of this process is to be expected as economic catch-up continues. In 2004 World GDP is estimated to hit USD35trillion. About one quarter of this is produced in developing economies with the growth rates in these economies expected to be roughly twice as fast as economic activity in industrialised countries. Due to the range of products fabricated by developing countries and the fact that they often use less expensive and less efficient technologies, the raw material consumption per USD of GDP is roughly twice as much as in the industrialised countries. As most of the future growth dynamics is expected from developing countries, the increase in commodity demand is not a one time effect but will persist and be largely driven by these countries.

Price development and investor interest

The increase in raw material demand has occurred at a time of strong global growth and limited spare capacity to expand commodity production. As producers have not been able to quickly adjust their output, commodity prices have soared. While price increases are not only starting to induce increases in exploration spending of commodity producers, it is also stimulating the interest of financial investors. The rising interest of non-commercial market participants can be seen by the increasing number of commodity futures contracts traded on global commodity exchanges. In the US, the Commodity Futures Trading Commission publishes detailed weekly data on the trading volume of commodity futures, which differentiate between commercial and non-commercial market participants. Data on the oil market, for example, show a clear upward trend of the contract volume traded by non-commercial market participants along with the increase in oil prices since 2002.

Exhibit 2: Total CFTC non-commercial oil contracts



Source: CFTC

Commodity allocation in security portfolios

After the distress of the extended equity bear market in the years 2000 to 2002, risk aspects in investment policy and asset allocation have attracted more attention. As commodities offer attractive diversification benefits when added to portfolios with traditional securities such as equities and bonds, commodity investments have received more interest from this perspective as well. However, given that commodity prices tend to move in a volatile fashion with a high degree of uncertainty of future returns, they should be treated more like growth assets in the portfolio context. The high volatility and the cyclicality of commodity returns would argue for low allocation weights. On the other hand, in order to achieve a material effect on overall risk-return of the portfolio, the allocation should not be too low. Commodity allocation recommendations depend on the risk attitude of the investor as well as the allocation of the main part of the portfolio. As a rule of thumb commodity allocations of 3% to 10% are recommended for conservative portfolios. In order to implement such diversification strategies, adequate investment vehicles must be chosen.

Commodities and financial market instruments

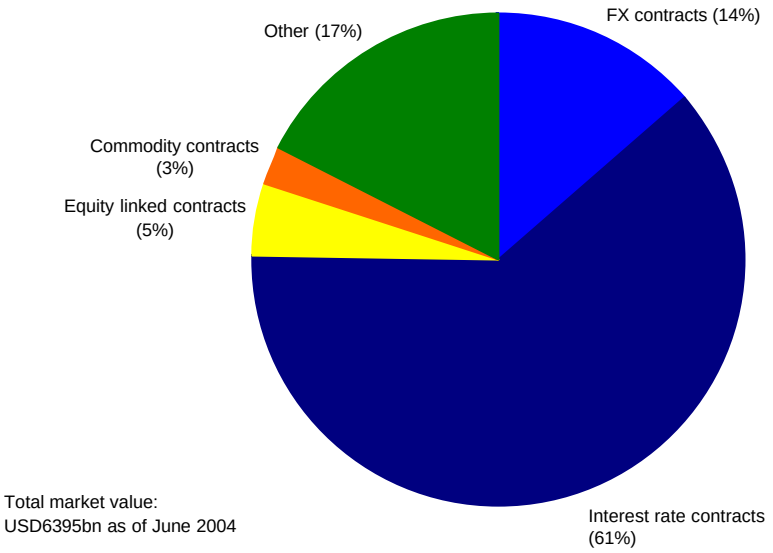
Traditionally, private investors often gained exposure to commodities via investing in equities operating in one way or another in the commodity sector. The problem with this procedure is, that the companies, although operating in the commodity sector, are still linked to influences and developments of the overall equity market. Moreover, company specific policies and procedures can lead to significant deviations, time lags, etc. with respect to the price developments in the respective commodity sectors. The original investment aim of adding assets with low correlation to equities could thus be diluted.

In order to get exposure, which is directly linked to price developments in commodities, one could choose direct investments in commodity futures traded on commodity exchanges such as e.g. in Chicago or London. For private investors, however, investing in commodities via commodity futures is, in general, costly and difficult to handle. To avoid such difficulties, indirect investment vehicles seem to be a better way to implement such strategies. The financial services industry has reacted to these needs and has created a variety of new commodity investment vehicles, which are more suitable for the investment needs of private clients. Such indirect vehicles are, as a rule, wrapped into structures such as funds, exchange traded funds, warrants or certificates, which are either directly linked to the price of specific commodities or to an index of several commodities.

Financial market activity in the commodity sector has therefore increased. Data on the dynamics of market developments across asset classes are difficult to obtain. The Bank for International Settlements (BIS) publishes data on the OTC market. Although the OTC mar-

ket is only a limited part of overall financial market activity and consequently one must be careful in interpreting these data, they can provide an indication of the relocation of interest in the respective asset classes. According to the BIS data, the outstanding amount of OTC derivatives in June 2004 was USD 6395bn. With 2.6% of the overall amount, commodity contracts were the smallest group, but showed by far the strongest growth momentum in year on year terms rising 66% compared to an overall decline of 19% for total outstanding OTC derivatives.

Exhibit 4: Outstanding OTC Derivatives



Source: BIS (December 2004)

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Commodities As A Strategic Investment for PGGM

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PGGM

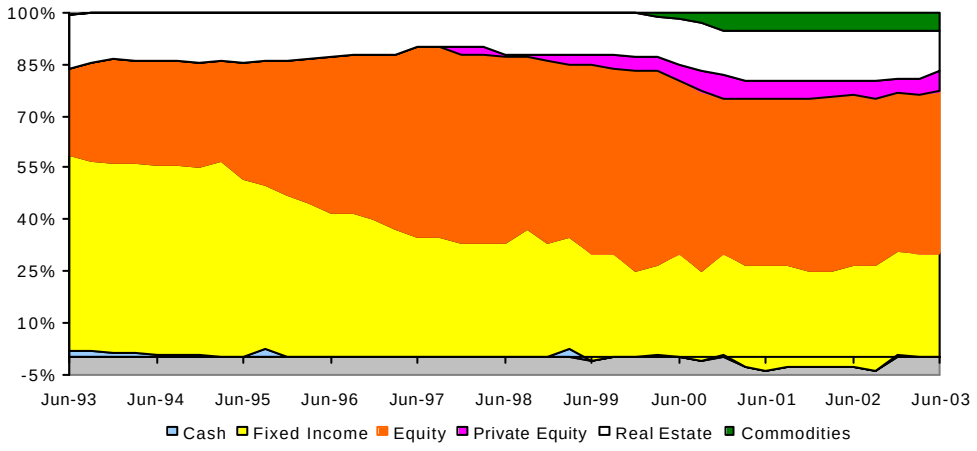
The pension fund PGGM provides former and current employees in the healthcare and social work sector in the Netherlands, in total approximately 1.8 million people and their families, with a comprehensive and broad-ranging pension package at as low a contribution as possible. The fund has around EUR57 billion under management, which makes it the 2nd largest pension fund in the Netherlands and the 3rd largest in Europe. The assets are managed by around 130 investment professionals, including operations and risk management, who have to ensure that the assets yield a return that is sufficiently high to supply the fund's participants with the pension that they expect.

Commodities as a strategic investment for PGGM

The determination of the strategic asset mix is PGGM's most important investment decision. The amount of money under management cannot be shifted around on a daily basis very easily. What PGGM strategically decides to invest in is ultimately the predominant factor for its return. The choice of assets is far more important than opportunistic timing, as is the way of implementing an investment in a particular asset class. Typically the choice of assets and their weights in the total investment mix decides whether a profit or a loss is made in a particular year, and whether those returns are in single or double digits. Timing and opportunistic tactical positions can make a difference of 1% or 2%, which, over a total amount of more than EUR50billion, is still rather important.

Looking at the development of PGGM's strategic mix through time, we see a gradual reduction of the allocation to fixed income. That has to do with the fact that PGGM wants to provide a pension that grows with wage inflation. To match the resulting liabilities exclusively with (index linked) fixed income would require unacceptably high contributions from the participants. In order to keep the contributions at an acceptable level, part of the assets are invested in higher yielding assets that bear investment risk. What is remarkable is that not all has gone to equities, but also to alternative assets like real estate, private equity and, since 2000, to commodities. In total about a quarter is invested in alternative assets. Once the decision is made to move to more (equity) risk bearing assets, the need for diversification grows. Diversification should ensure the desired return is achieved at the lowest level of risk. For PGGM, more than anything else, the added value of commodities lies in its power to reduce the overall risk without sacrificing the expected overall return.

Exhibit 1: PGGM's asset allocation mix



Source: PGGM

Asset Liability Management (ALM) analyses provide the basis for the construction of PGGM's strategic mix. These studies illustrate how things work together. Looking at results of ALM analyses it is, however, important to keep reminding oneself that an ALM study does in itself not provide an expected return or risk. These results are provisional on the specific assumptions that serve as input to the model. To study the suitability of commodities as an asset class, PGGM used very conservative and prudent assumptions about the risk-return characteristics of commodities as a stand alone investment. It was assumed that commodities would have a return just below that of fixed income and a volatility higher than equities and private equity. This made commodities a lousy stand alone investment: the lowest expected return and the highest risk of all the asset classes considered in the ALM analysis. The added value of commodities should therefore be derived from either its positive correlation with PGGM's liabilities (wage inflation) or from the negative or low correlation with other assets, providing diversification.

The added value of commodities from its positive correlation with wage inflation is limited. For this correlation to make an impact and to provide a substantial reduction in PGGM's sensitivity to inflation would require a very high allocation to commodities. Because of the low assumption of commodities' expected return such a high allocation to commodities would imply a rather low expected return for the PGGM mix. The contribution required from PGGM's sponsors would become unacceptably high, prohibiting such a high allocation to commodities.

Contrary to the effect of the positive correlation with the liabilities, when it comes to the diversification power of commodities as an asset class, a little goes a long way. Here the real added value comes out. Reducing a 30%/55%/15% mix in fixed income/equities/real estate by 20% and investing this 20% in commodities would reduce the required contribution from PGGM's sponsors by more than 15%, without increasing the total amount of risk. This alone justifies a passive long only allocation to commodities, without expecting a high yield from it.

On the basis of these analyses PGGM decided in early 2000 to allocate 4% of it assets to commodities. Although this 4% is lower than the 20-25% (numerical) optimal allocation that some studies have indicated, it still enabled a substantial reduction in the required contributions. Considerations at the time that led to the limitation to 4% were the novelty of commodities to PGGM and the total size of the market. Early 2000 the estimated amount invested in passive long only commodities programmes was US$6 billion compared to an estimated US$40 billion as of the first quarter of 2005. The 4% allocation of PGGM would add around US$2 billion to that, giving PGGM a 25% share of the total.

This 4% allocation might seem small, but it shouldn't be sniffed at. As mentioned, it already provides a substantial diversifying effect. One should be conscious of the fact that what matters is not so much the allocation in terms of assets, but the risk it represents. Looking at risk, and you can think of a measure like the monthly value at risk that a particular asset has within PGGM, commodities represents a much larger part of the total mix. Equities still pose most of the risk – together with private equity. But the amount of risk represented by commodities is comparable to fixed income and real estate, although fixed income and real estate have a 39% and 15% allocation in assets respectively. That has everything to do with the high volatility of the commodity markets. Another illustration of the strong impact a rather small allocation to commodities can have is that more than 50% of the total return of PGGM in the first quarter of March 2005 was attributable to the less than 5% allocation to commodities.

What is a suitable benchmark?

Once the decision to allocate to commodities had been made, the question how to get exposure to the asset class arose. For PGGM it was clear from the start that commodities as an asset class for the reason PGGM likes it, that is its diversification properties, meant commodities futures rather than commodities linked equities were the most efficient route to gain exposure. In PGGM's analysis commodity-linked equities, and in particular oil companies, have a stronger correlation to general equities indices like S&P 500, than to the under-

lying commodity price. Moreover, as explained in earlier chapters in this publication, the return arising from rolling futures can add to the return as well as to the diversification. This is particularly true for energy futures. Commodity companies lack this component. Actually commodity companies are partly responsible for maintaining the shape of the term structure from which the roll return is derived. In that sense they are indirectly paying the roll premium, while the investor in futures receives it.

Consequently PGGM had to look for a benchmark for a passive long investment in commodities futures. This benchmark had to meet the following requirements:

- The benchmark should capture the distinguishing characteristics of the asset class. So the diversifying properties of commodities should be clearly present in the benchmark.
- The benchmark should be replicable. The return of the benchmark should theoretically be equal to that of a clearly defined futures strategy that can realistically be implemented without problem. This, for instance, excluded benchmarks that needed rebalancing with every tick move.
- Preferably the market would provide products based on the benchmark, such as futures, structured notes, options on the particular index.
- Various counterparties should be available to provide products in the benchmark. This would exclude proprietary indices.
- There should be sufficient liquidity in the futures that constitute the index.
- The construction of the benchmark should be totally transparent, preferably based on objective rules rather than more or less arbitrary ones.
- The benchmark should be publicly accessible without effort, for instance daily quotations on Bloomberg, Reuters.

From the benchmarks available in early 2000, PGGM found that only the Dow Jones-AIG Commodity Index and the Goldman Sachs Commodity Index (GSCI) qualified. Both indices base the weights of individual commodities on value of its total world production. This purely objective rule goes some way to ensure that the commodities that matter most to the world economy (and therefore to PGGM's other assets) get the highest weighting. Both indices have additional rules ensuring a minimum level of liquidity in individual commodities. The Dow Jones-AIG Commodity Index distinguishes itself from the GSCI by imposing a limit on the weight of a particular commodities sector, see chapter 6 for more details. The main effect is that the Dow Jones-AIG Commodity Index has a considerably lower weight in energy futures than the GSCI. As a consequence the GSCI has a much higher volatility than the Dow Jones-AIG Index. Many consider this as a main disadvantage of the GSCI. Looking at the indices as stand alone investments they have a point. PGGM however thinks commodities should be considered in the context of the total assets and liabilities. In that context PGGM preferred the higher volatility of the GSCI over the lower volatility of the AIG-Dow Jones. Commodity volatility is volatility PGGM likes, it is volatility it needs in the portfolio context. The paradox is that in the analyses the GSCI reduced the volatility of the overall portfolio more than the Dow Jones-AIG Commodity Index. The Goldman Sachs Commodity Index Total Return thus became the benchmark for PGGM's investments in commodities.

It is interesting to note that in closer examination considerations similar to those that led to preferring GSCI over Dow Jones-AIG, PGGM decided in early 2002 to change its benchmark to one with a higher energy content and consequently a higher volatility. It changed the benchmark to 75% GSCI Total Return+ 25% Goldman Sachs Energy Sub-index Total Return. A commodities sector sub-index uses exactly the same methodology as the main index, only limits itself to the commodities belonging to a particular sub-index. The subindices enable an investor to construct a benchmark that suits its preference. PGGM clearly prefers energy over non-energy commodities.

The reasons for this preference are:

- Energy has the clearest link to the global economy, and therefore implicitly supplies the best diversification with other assets of PGGM.
- Energy is relatively difficult to transport and store. This is reflected in the number of forward days cover, the amount of days the world's industrial processes can be sustained only using the present stock levels. Energy has a lower amount of forward days cover than most other commodities. This makes energy more susceptible to bottlenecks in the supply chain. The premium for short term delivery, reflected in the shape of the futures curve, is therefore higher for energy than other commodities. In other words, the roll return for energy is higher than for other commodities. In the daily price volatility the roll return almost disappears. However, over the long-term it makes all the difference, as the price returns tend to mean revert to inflation/cost of production whereas a positive roll return delivers a clear yield. Long-term passive investing in energy is receiving a yield for providing risk capital to the market rather than speculation on short-term price movements.
- The roll return in energy is the highest when the market expects supply disruptions. This often coincides with periods during which financial assets are not doing well. In this way, the roll return adds to the diversification.
- Energy is better than most commodities in providing a hedge against geopolitical crises.
- Energy is more volatile on its own, but has a higher diversifying power. A benchmark with a higher energy content is more volatile, but for the overall mix the expected return becomes higher, while the overall volatility decreases.
- Based on return and correlations, energy can almost be considered a different asset class from the other commodities.

The customization of its commodities benchmark has served PGGM well, since implementation of the higher energy content, energy has outperformed the non-energy commodities by more than 150%.

On a last word on benchmark choice, it is PGGM's experience that the energy content of a particular index is the predominant factor determining its characteristics. To consider the added value of other differences, for instance in rules concerning the roll, rebalancing, capturing mean reversion etcetera, it makes sense to first artificially bring the energy weight to an equal level of the index to which it is being compared.

Investment vehicles for implementing the strategic investment

Having determined the benchmark, the second implementation issue was the method of getting invested. Considering the possible investment vehicles important considerations were:

- Costs.
- Tracking error.
- Claim on internal resources.

With respect to the tracking error, PGGM initially looked for as low a tracking error as possible. Diversification with other assets was the primary reason to invest in commodities. Therefore it didn't make sense to potentially sacrifice this property for a little bit of extra alpha.

The first question one asks oneself when it comes to the investment vehicle is: internal management or external management? PGGM definitely looked for possibilities to get the commodities exposure by means of external management. It made sense to do so. Commodities was a totally new asset class to PGGM, the organization did not have specific commodities expertise internally. However, most *asset managers* in commodities at the time (2000) were geared towards active management, not towards the passive long in-

vestments linked to a benchmark. There were one or two asset managers that did provide a GSCI-tracking mandate. However, these were large organizations that hardly committed dedicated staff to commodities. These mandates showed considerable tracking errors historically. There had been years of about 4% deviation with the GSCI Total Return. PGGM definitely didn't want to start its first year in commodities with an underperformance of that size with respect to their benchmark. Moreover, the costs turned out to be quite high: outperformance fees kicked in at performance levels that PGGM could improve on at no extra costs using other investment vehicles. So, although external managers were a serious option initially, PGGM quite quickly decided against it. To be fair to the asset managers, their costs have come down considerably more recently.

The next possibility that PGGM didn't pursue was that of *structured notes, commercial paper*, with redemption and coupons solely based on the GSCI Total Return. These instruments are intended for the retail market and small institutional investors. For PGGM cheaper and more flexible ways are available.

The ultimate internal management vehicle is replication of the benchmark by *managing and rolling in house the individual futures* that constitute the benchmark, or a representative (low tracking error) basket consisting of a smaller set futures. Arguably this is the lowest cost option. However, it didn't compensate for the potentially high tracking error and the huge impact on PGGM's internal organization. At the time, in 2000, PGGM did not use futures structurally and the infrastructure, systems/procedures, for it was still in development.

Managing and rolling index futures, futures on the GSCI itself, was another possibility. The rolling process here is possibly a bit less labour intensive than rolling all the individual futures. Still, for PGGM the disadvantages of in-house futures remained: potentially high tracking error and a large impact on the internal organization. Added to that there were concerns about the lack of open interest in the index futures, considering the size of PGGM's investment.

PGGM decided for a vehicle which in a way is a hybrid between internal and external management: the total return swap. The *total return swap* is an over-the-counter (OTC) derivative structure in which PGGM receives the Goldman Sachs Commodity Index Total Return from the counterparty in exchange for paying the T-bill component of the GSCI Total Return plus fees to the counterparty. This structure provides a zero tracking error for the commodities exposure. The fees are to cover the transaction costs for rolling the futures as well as to compensate the counterparty for taking on the rolling risk. Although PGGM was able in the first year to negotiate around 50% of what was initially quoted, the fee levels were still quite high compared to the costs of rolling futures yourself. This had a lot to do with the relative lack of counterparties willing to engage in a total return swap on the GSCI. In 2000 PGGM only found four suitable counterparties. With the recent growing popularity of commodities as an asset class one should easily find more than ten today. Fees have come down accordingly. But even with the high fees in 2000, total return swaps were cheaper than asset managers. And even with high fees in 2000, PGGM preferred paying the total return swap fees over the potential high tracking error of managing and rolling futures in house. Moreover total return swaps delivered PGGM the flexibility of internal management: one could manage the commodities exposure by getting in and out of total return swap as desired. At the same time, the rolling of the futures is 'outsourced' to the counterparty, thus limiting the claim on PGGM's internal organization. As far as required expertise is concerned, the total return swaps do require some derivatives expertise. But, because of the zero tracking error, in principle no specific commodities futures expertise is required anymore to get the exposure to the commodities index. The total return swap is a very clean way to get 'beta'. It is each organization's individual consideration whether or not one is prepared to pay the fees for it.

Practical implementation

Suitable as it may be, the total return swaps still require a lot of practical issues to be resolved before transacting can start. A lot of those have to do with the off-balance character of the total return swap. The resulting *separation of on-balance and off-balance exposure*

will require extra care and adjustments in administration and reporting. Another consequence of the off-balance character of the total return swap is that one should decide what *to do with the capital* that has been allocated to commodities. The total return swaps do not require any funding, so this capital has to be invested in something else. If one doesn't want to introduce leverage within the commodities portfolio, this capital has to be invested in cash. The effect of this shouldn't be underestimated. PGGM's treasury department all of a sudden got an extra duty to run a permanent money market investment of more than EUR2 billion. Customized money market mandates with specialist managers were set up to run part of that money.

Another important practical issue is the counterparty risk arising from the over-the-counter (OTC) character of the total return swaps. First of all this requires to put ISDA agreements in place with all swap counterparties. PGGM moreover requires monthly resets where the accumulated marked to market of the swap is paid out. That way, the counterparty risk remains limited to the monthly accumulated index return. For the intra-month counterparty risk one can put additional Collateral Support Annexes to the ISDA in place.

The OTC character of the total return swaps, together with the relatively low amount of institutional investment in commodities also caused difficulty in finding an off-the-shelf deal-capture and administration system, necessitating some customized solutions.

So, what about alpha possibilities?

From the preceding text it should be clear that the added value of commodities as an asset class for PGGM arises from its power to diversify the strategic mix. For this reason, together with PGGM's initial inexperience in the commodities markets, PGGM started implementing its commodities exposure aiming for a passive investment only. Within a few months since implementing however, PGGM recognized that commodities provided excellent possibilities to achieve positive results from taking active risk. Since then commodities have successfully contributed to PGGM's alpha targets, within the total active risk budget.

Creating positive returns from active risks is never easy. Commodities markets have some properties however that should make them more suitable for finding interesting alpha opportunities than some other, more efficient, markets. One important reason is the fact that unlike most asset classes, most participants in the commodities markets are not investors. They are producers and consumers buying and selling commodities in order to keep their industrial processes operating, and hedging their production or consumption. These participants will not act on every investment opportunity that arises in the commodities markets. Moreover, their particular behaviour might create alpha possibilities occasionally.

The implementation of the strategic passive long only investment (the 'beta') in commodities by means of total return swaps with a zero commodities tracking error enables PGGM to consider the alpha possibilities completely separate from its beta implementation. Active positions can be implemented as an overlay by means of long or short positions in individual futures, whilst the benchmark exposure is maintained via total return swaps. This means, for instance, that PGGM's preference for energy for its strategic commodities exposure does by no means imply that its active positions in commodities are predominantly in energy.

There is, however, one link between the active positions (alpha) and the strategic (beta) exposure that one should always be aware of. The alpha positions should never be allowed to undermine the primary reason for the strategic investment in commodities; the diversification with the other assets. This prevented PGGM for instance in March 2003, in the run up to the second gulf war, to take a direct underweight position in energy despite a bearish view on the energy complex. It was important to maintain the exposure to energy just in case the war would escalate causing high oil prices and damaging the return of most of PGGM's assets. To protect the strategic mix was more important here than just pursuing an alpha opportunity.

Although the number of different commodities might be limited, there are still quite a lot degrees of freedom to take active risk in the commodities markets. Without specifying PGGM's active risk policy in commodities, one can think of the following types of active risk positions:

- **Directional: Over/underweight** (de)leverage, protection.
  - This is very difficult to time with the high volatility in commodities, but potentially the rewards can be very high.
- **Sector spreads**
  - For instance: Energy Index vs. Precious Metals Index.
- **Commodity spreads**
  - Equivalent: WTI crude oil vs. Brent crude oil.
  - Source-product: WTI crude oil vs. gasoline.
  - Similar: Heating oil vs. natural gas.
- **Time spreads**
  - Same commodity, different maturities long and short.
- **Statistical relationships**
  - Trends, Seasonality, Mean Reversion, Curve Shape.
- **Volatility**
- **Timing**
  - Technical analysis
- **Active positions on the collateral (cash)**
  - Some credit risk
  - Cash duration

Finally it is important to stress again that PGGM does not consider the high energy content in its benchmark as an active position or alpha, but a strategic (beta) decision attempting to maximize the added value of commodities in the strategic asset mix.

Conclusion

PGGM's most important investment decision is the determination of its strategic mix. A passive long only investment in an index of rolling commodities futures serves to increase the expected return of the strategic mix, but most of all to reduce its overall volatility. This added value of commodities in the strategic mix is mainly due to the passive investment in energy futures.

The structure of the commodities markets provides interesting active risk opportunities. By implementing the strategic passive positions separately from the active risk positions, it is possible to profit from opportunities completely detached from the strategic reasons to invest in commodities.

Jelle Beenen

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Before moving to the financial industry Jelle Beenen worked as a mathematical physicist at Imperial College in London. He obtained MSc degrees in Physics and Mathematics at Twente University (the Netherlands) and a PhD degree in Mathematical Physics at Imperial College London.

Appendix

Facts and Fantasies About Commodities Futures
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K. Geert Rouwenhorst, School of Management, Yale University
http://papers.nber.org/papers/w10595

Glossary

API Gravity: One of the main quality indicators for pricing crude oil. The higher the API gravity the lighter the crude. API gravity = 141.5/specific gravity of crude at 60° Fahrenheit - 131.5.

ARA: Amsterdam-Rotterdam-Antwerp port and refining area in Netherlands-Belgium.

Backwardation: Market condition in which forward prices decline as tenor increases.

Barrel: Standard measure of quantity for crude oil and petroleum products. A barrel measures 42 US gallons.

BOE Barrels of oil equivalent. Volume of natural gas expressed in terms of its energy equivalent to oil. About 6,000 cubic feet of gas equals one barrel of oil equivalent.

Baseload The minimum expected customer power requirements at a given time. As baseload demand is generally predictable and steady, it is less expensive than peak power.

CIF: A CIF shipping cost costs means the cost of cargo, insurance and freight to a named destination are all included in the price.

Collateral Yield: The return accruing to any margin held against a futures position.

CCF: Collateralised Commodity Futures.

Contango: Market condition in which forward prices rise as tenor increases.

Convenience Yield: The yield that accrues to the owner of a physical inventory but not to the owner of a contract for future delivery. It represents the value of having the physical product immediately to hand and offers a theoretical explanation, albeit of limited predictive value, for the strength of backwardation in the commodity markets.

Crack Spread: A calculation of the worth of a barrel of crude oil in terms of the value of its refined products, such as gasoline and heating oil. To calculate the spread, the cents-per-gallon product price is multiplied by 42 (the number of gallons per barrel) and subtracted from the crude oil price. For example, when heating oil futures cost US$1.50 per gallon and NYMEX division light, sweet crude oil is priced at US$55 a barrel, the heating oil crack spread in dollars per barrel = US$1.50 x 42 = US$63.00 – US$55.00 = US$8.00.

DBLCI: Deutsche Bank Liquid Commodity Index. The DBLCI tracks six commodities, rolling positions in crude oil and heating oil monthly, and in gold, aluminium, corn and wheat once per year. Reuters: DBLCI. Bloomberg: DBCM.

DBLCI-MR: DBLCI-Mean-Reversion is a rule-based variant of the DBLCI. It under-weights those commodities amongst the six which are expensive relative to their long-term average, and over-weights those which are relatively cheap.

Expectational Variance: The deviation of the spot price from the expected spot price when the original futures contract was purchased. Assuming commodity markets provide unbiased estimates of future spot prices, the deviations of actual spot prices from the expected spot price will average zero over time.

Excess Return: A security's returns minus the returns from a no-risk security, typically a US T-bill, during the same time period.

FOB: Under a free-on-board (FOB) contract, the seller provides the oil or oil product at a lifting installation and the buyer takes responsibility for shipping and freight insurance.

Fuel Cell: A device that converts fuel energy to electrical energy by means of an electrochemical process. Fuel cells chemically combine the molecules of a fuel (most commonly hydrogen) and an oxidiser (e.g. air) to create heat without burning, thereby reducing the thermal inefficiencies and pollution that characterise traditional means of combustion.

Peak Load: Periods during the day when energy consumption is highest. The introduction of additional gas and electricity to cover this demand is known as peak shaving.

Roll Return: The return earned by holding futures and 'rolling' them to a new contract as they expire.

Spot Return: The return earned by holding a single futures contract for a period of time.

Sharpe Ratio: The amount of return on an investment less the return of a risk-free asset per unit of risk, which is proxied by its standard deviation.

Spark Spread: The difference between the price of electricity sold by a generator and the price of fuel used to generate it, adjusted for equivalent units. The spark spread can be expressed in dollars per megawatt hour (MWh) or US$ per million British thermal units (mmBtu) or other applicable units. To express it in US$/MWh, the spread is calculated by multiplying the price of gas, for example (in US$/mmBtu), by the heat rate (in Btu/kilowatt hour), dividing by 1,000 and then subtracting the electricity price (in US$/MWh).

TIPS: Treasury Inflation Protected Securities. A US Treasury bond whose principal increases at the same rate as the US Consumer Price Index.

WTI: West Texas Intermediate. US crude oil used as a benchmark for pricing much of the world's crude oil production. Futures traded on NYMEX, delivery Cushing, Oklahoma.

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