Mechanics of the Commodity Market

A Primer on Commodity Investing

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Commodities are currently enjoying a renaissance due to institutional in-vestors such as pension funds and traditional portfolio managers. Many market participants attribute the recent dramatic price increases in commodities to increased demand for consumer goods, particularly from the populous countries of India and China. Demand from Brazil and Russia, two of the fastest-growing economies currently, has undoubtedly also played a part. (Collectively, these four countries are referred to as the *BRIC countries*.)

Globalization and economic and political convergence have been behind the stimulated growth in these economies to a large extent. Besides

increased investment on an enterprise level, increasing state investment in infrastructure in China has also led to enormous demand for commodities. This has caused a shock to the worldwide supply and demand dynamics, leading to at least short-term price increases.

Such dramatic increases in commodity prices are often explained by the *commodity super cycle theory*. According to Heap, a *super cycle* is a lasting boom in real commodity prices, usually brought on by urbanization and industrialization in a major economy.[1] Hence, super cycles are driven by demand caused by an expansion of material-based production due to intense economic activity. The economic situation in China is of crucial importance to the commodity markets. China has greatly increased its share of global commodity consumption over the past few years, and is seen as the major driver of the current commodity boom.

For example, between 2001 and 2005, China's demand for copper, aluminum, and iron increased by 78%, 85%, and 92%, respectively. This clearly shows China's considerable influence on commodity pricing. This super cycle, however, is not characterized by a continuous growth phase, as the events of May 2006 show. Many commodities were under pressure during that time, and actually lost about one-fourth of their value.

Under market conditions like these, the question inevitably arises as to whether this is a temporary price correction or a general trend change. Following the super cycle theory, a long-lasting upward trend in commodities in the future is likely, as most remain far below their historic highs when adjusted for inflation.

Compared to foreign exchange or equity markets, there is almost no way to intervene in commodity markets. Because the production side reacts very sluggishly to market distortions, short-term supply and demand shocks are compensated for only by price movements.[2] These inherent asset class volatilities are the main reason many investors have refrained from investing in commodities, despite the fact they can provide valuable diversification

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[1]Alan Heap, "China—The Engine of Commodities Super Cycle," *Citigroup Global Equity Research* (March 2005). The past 200 years have seen several such upswings, lasting from between 15 and 25 years. For example, in the late nineteenth century, industrialization in the United States triggered such a boom. The postwar period of 1945 to 1975, when enormous resources were needed to rebuild Europe, can also be characterized as a super cycle.

[2]In contrast, central banks possess a variety of money market instruments to maintain the value and stability of their currency. At the same time, central banks can control—at least to some extent—the economic development of an economy through changes in interest rates to avoid inflationary or deflationary tendencies.

benefits to traditional security portfolios because of their low correlation with bonds and stocks.[3]

This chapter first discusses the basics of commodity markets by describing the market participants, the commodity subsectors, and the different kinds of commodity investment vehicles available to investors. Subsequently, we illustrate the return components of index-based, that is, passive long-only, commodity futures investments in the context of the price discovery process, and we investigate the risk/return characteristics of commodity futures indexes. Following this, we provide an empirical analysis of portfolio allocation of traditional security portfolios, explicitly taking commodity futures into account.

MARKET PARTICIPANTS

Futures market participants are normally classified into hedgers, speculators (traders), and arbitrageurs. Commodity producers pass on the price risk that results from highly volatile and difficult to forecast commodity futures markets to speculators, and therefore pay a premium. Commodity producers have a distinct interest in hedging the price of their product in advance (a short hedge).

For example, consider the situation in the classic agricultural market. Farmers face a weather-dependent, volatile supply that is met by a relatively stable demand. Contrary to the maintenance cost for cattle breeding or the purchase cost of seed, the selling price generally is known only upon completion.

We see the opposite in the manufacturing industry: As the manufacturing industry hedges increasing commodity prices (a long hedge), the contrarian position to the commodity producers' short positions is taken. Airline companies, for example, often appear as long hedgers to guard against increasing fuel prices, the underlying in which the airline companies are short. If an existing or expected cash position is compensated for via an opposite future, the market participant is classified as a *hedger*. Hence, for the commodity producer, there is a fixed net profit; for the commodity manufacturer, there is a fixed purchase price.

Speculators represent the largest group in the futures markets. Their main task is to provide liquidity on the one hand, while balancing the long and short hedges on the other hand. Contrary to the commodity producers or the manufacturing industry, which try to avoid susceptibility to

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[3]Kenneth A. Froot, "Hedging Portfolios with Real Assets," *Journal of Portfolio Management* (Summer 1995), pp. 60–77.

unfavorable price developments, the intention of speculators is to take a distinct market position and speculate for a price change. To make a profit, speculators deliberately take on risk by betting on rising or falling prices. As opposed to hedging, speculation is subject to both huge gains and huge losses, since speculators do not hold compensating cash positions.

The third and smallest group of market participants is the *arbitrageurs*, who try to take advantage of time- or location-based price differences in commodity futures markets, or between spot and futures markets, in order to generate riskless profits. Clearly, this group also intends to make profits, but their trading activity does not involve taking risky positions. Moreover, they use economic and financial data to detect existing price differences with respect to time and location. If these price differences exceed interlocal or intertemporal transfer costs such as shipping, interest rates, warehouse costs, or insurance costs, riskless profits can be realized. Consequently, price differences among the markets are adjusted, price relationships among the markets are restored, and arbitrageurs guarantee market balancing.

In the case of cash and carry arbitrage, the resale price of today's leveraged spot position is simultaneously set by selling the commodity futures. This short futures position implies an unconditional commitment to purchase the underlying at maturity. At maturity of the futures, the specified commodities are tendered against the maturing short futures. If the profit from the spot trade of the physical commodity exceeds the value of the futures plus the cost of debt financing, the arbitrageur will realize a profit from what is known as a *basis trade*.

COMMODITY SECTORS

Investments in international commodity markets differ greatly from other investments in several important ways. First, commodities are real assets—primarily consumption and not investment goods. They have an intrinsic value, and provide utility by use in industrial manufacturing or in consumption. Furthermore, supply is limited because in any given period, commodities have only a limited availability. For example, renewable commodities like grains can be produced virtually without limitation. However, their yearly harvest is strictly limited. In addition, the supply of certain commodities shows a strong seasonal component. While metals can be mined almost all year, agricultural commodities like soybeans depend on the harvesting cycle.

Another important aspect of commodities as an asset class is heterogeneity. The quality of commodities is not standardized; every commodity has its own specific properties. A common way to classify them is to distinguish

between soft and hard commodities. *Hard commodities* are products from the energy, precious metals, and industrial metals sectors. *Soft commodities* are usually weather-dependent, perishable commodities for consumption from the agricultural sector, such as grains, soybeans, or livestock, such as cattle or hogs. Exhibit 1.1 show the classification of commodity sectors.

Storability and availability (or renewability) are also important features of commodities. However, because storability plays a decisive role in pricing, we distinguish between storable and nonstorable commodities. A commodity is said to have a high degree of storability if it is not perishable and the cost of storage remains low with respect to its total value. Industrial metals such as aluminum or copper are prime examples: They fulfill both criteria to a high degree. In contrast, livestock is storable to only a limited degree, as it must be continuously fed and housed at current costs, and is only profitable in a specific phase of its life cycle.

Commodities such as silver, gold, crude oil, and aluminum are nonrenewable. The supply of nonrenewable commodities depends on the ability of producers to mine raw material in both sufficient quantity and sufficient quality.

The availability of commodity manufacturing capacities also influences supply. For some metals (excluding precious metals) and crude oil, the discovery and exploration of new reserves of raw materials is still an important issue. The price of nonrenewable resources depends strongly on current investor demand, while the price of renewable resources depends more on estimated future production costs.[4] The monetary benefit from holding a commodity physically instead of being long the respective futures is called the *convenience yield*. The convenience yield reflects market participants' expectations regarding a possible future scarcity of a short-term nonrenewable commodity.

COMMODITIES AS AN ASSET CLASS OF THEIR OWN

There is a broad consensus among academics and practitioners that commodities compared to other alternative assets can be considered—in a portfolio context—as an asset class of their own.[5] By definition, an asset class consists of similar assets that show a homogeneous risk-return profile (a

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[4]The events following Hurricane Katrina in 2005 clearly illustrated the insufficiency of the refinery capacities for crude oil and natural gas. Declining investment in this sector over the years has led to a bottleneck. The absence of investment in the industrial metals sector is also an issue for the supply side.

[5]In reality, most alternative investments such as hedge funds or private equity are not an asset class in their own, but are considered alternative investment strategies within an existing asset class.
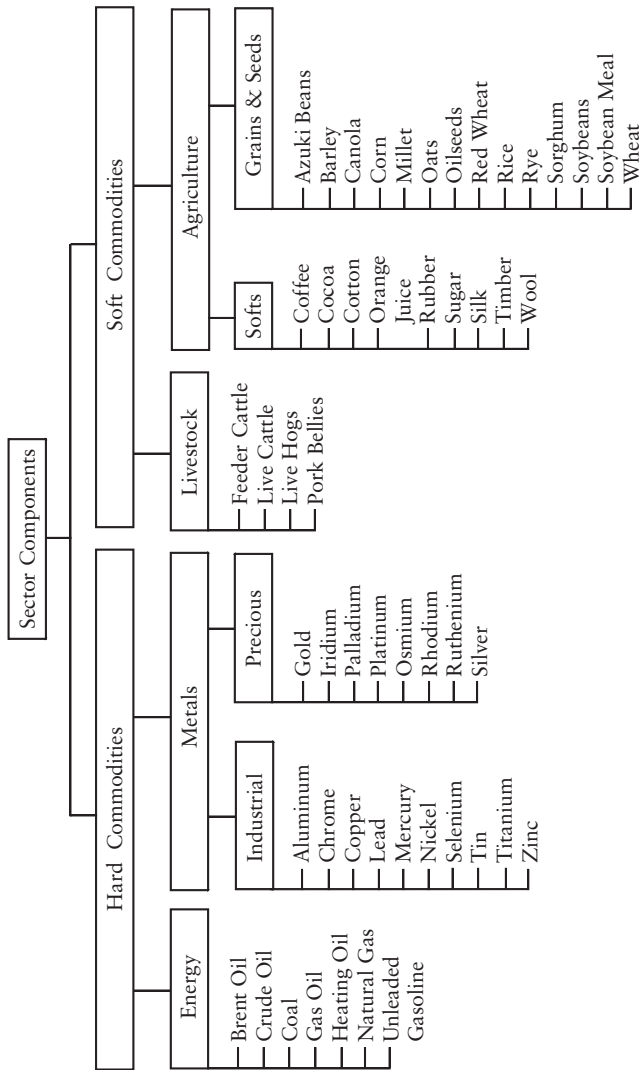
EXHIBIT 1.1 Classification of Commodity Sectors

high internal correlation), and a heterogeneous risk-return profile toward other asset classes (a low external correlation). The key properties are common value drivers, and not necessarily common price patterns. This is based on the idea that a separate asset class contains a unique risk premium that cannot be replicated by combining other asset classes.[6] Furthermore, it is generally required that the long-term returns and liquidity from an asset class are significant to justify an allocation.

To describe existing asset classes, Greer explains the decomposition into so-called super classes: *capital assets, store of value assets*, and *consumable or transferable assets*.[7] Continuous performance is a characteristic of capital assets. Equity capital like stocks provides a continuous stream of dividend payments, while fixed income guarantees regular interest payments in the absence of the default of the obligor. Redemption of invested loan capital can then be allocated among other investments.

Common to all capital assets is that their valuation follows the net present value method by discounting expected future cash flows. In contrast, real estate as an asset class has a hybrid classification. On the one hand, real estate can be classified as a capital asset because it promises a continuous rental stream and has market value. On the other hand, some features of real estate assets can justify their classification as store of value assets (for example, if the real estate is used for the owner's own purpose). Such store of value assets cannot be consumed, nor do they generate income; classic examples are foreign exchange, art, and antiquities.

Commodities belong to the third super class—*consumable or transferable* (C/T) assets. In contrast to stocks and bonds, C/T assets, physical commodities like energy, grains, or livestock, do not generate continuous cash flows, but rather have an economic value. Grains, for example, can be consumed or used as input goods; crude oil is manufactured into a variety of products. This difference is what makes commodities a unique asset class.

Hence, it is obvious that commodity prices cannot be determined by the net present value method or by discounting future cash flows. Thus, interest rates have only a minor influence on the value of commodities. Moreover, commodity prices are the result of the interaction between supply and demand on specific markets.[8] In this context, it is not surprising that the

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[6]Bernd Scherer, "Commodities as an Asset Class: Testing for Mean Variance Spanning under Arbitrary Constraints," *Deutsche Bank—An Investors' Guide to Commodities* (April 2005), pp. 35–42.

[7]Robert J. Greer, "What is an Asset Class, Anyway?" *Journal of Portfolio Management* (Winter 1997), pp. 86–91.

[8]James H. Scott, "Managing Asset Classes," *Financial Analysts Journal* (January–February 1994), pp. 62–69.

capital asset pricing model (CAPM) cannot adequately explain commodity futures returns. As we have noted, commodities are not capital assets.[9]

The line between the super classes is blurred in the case of gold. On the one hand, gold as a commodity is used in such things as electrical circuitry because of its excellent conductivity. On the other hand, gold as a store of value asset is a precious metal and is used for investment, similarly to currencies. The rising demand of commodities since the stock market downturn in 2002 clearly demonstrates this characteristic. Because gold can be leased, Anson has even classified it as a capital asset.[10]

Another specific criterion that differentiates commodities from capital assets is that commodities are denominated worldwide in U.S. dollars, while the value of a specific commodity is determined through global rather than regional supply and demand. In comparison, equity markets reflect the respective economic development within a country or a region.

Prospects for Commodity Market Participation

In general, there are several ways to participate in commodity markets via a number of different kinds of financial instruments. The most important are (1) direct investment in the physical good; (2) indirect investment in stocks of natural resource companies or (3) commodity mutual funds; (4) an investment in commodity futures, or (5) an investment in structured products on commodity futures indexes.

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[9]The two components of risk, systematic (market) and unsystematic (company-specific), are considered within the CAPM framework. Since unsystematic risk is eliminated in a broadly diversified portfolio, investors are only compensated for systematic risk. The risk premium is then the product of systematic risk (beta) multiplied by the market price of risk, defined as the difference between the expected return of the market portfolio and the riskless interest rate. In the CAPM, the market portfolio is composed only of stocks and bonds, so commodity returns cannot be represented by financial market returns. Thus, it is not possible to distinguish between systematic and unsystematic risk. Finally, commodity prices depend on global supply and demand and not on the perception of the market regarding an adequate risk premium for a specific asset class. See Claude Erb and Campbell R. Harvey, "The Tactical and Strategic Value of Commodity Futures," *Financial Analysts Journal* (April/May 2006), pp. 69–97; and Zvi Bodie and Victor I. Rosansky, "Risk and Return in Commodity Futures," *Financial Analysts Journal* (May/June 1980), pp. 27–39.

[10]Precious metals such as gold, silver, or platinum can generate a lucrative stream of income by being leased at market leasing rates. See Mark J. P. Anson, *The Handbook of Alternative Assets*, 2nd ed. (Hoboken, NJ: John Wiley & Sons, 2006).

Buying the Physical Good

First, it seems obvious to invest directly in commodities by purchasing the physical goods at the spot market. However, immediate or within-two-days delivery is frequently not practical for investors. According to Geman, precious metals such as gold, silver, or platinum are an exception, as they do not have high current costs and do not require storage capacity.[11] However, a portfolio consisting solely of precious metals would not be a sufficiently diversified portfolio for investors to hold.

Commodity Stocks

An investment in commodity stocks (*natural resource companies*), which generate a majority of their profits by buying and selling physical commodities, may conceivably be considered an alternative investment strategy. In general, the term ''commodity stock'' cannot be clearly differentiated. It consists of listed companies that are related to commodities (i.e., those that explore, mine, refine, manufacture, trade, or supply commodities to other companies). Such an indirect investment in commodities (e.g., the purchase of petrochemical stocks) is only an insufficient substitute for a direct investment. By investing in such stocks, investors do not receive direct exposure to commodities because listed natural resource companies all have their own characteristics and inherent risks.

Georgiev shows that these sector-specific stocks are only slightly correlated with commodity prices, and hence prices of commodity stocks do not completely reflect the performance of the underlying market.[12] This is because stocks reflect other price-relevant factors such as the strategic position of the company, management quality, capital structure (the debt/equity ratio), the expectations and ratings of company and profit growth, risk sensitivity, as well as information transparency and information credibility.[13]

Stock markets also show quick and more sensible reactions to expected developments that can impact company value. Hence, other causes of independent price discovery exist that differ from a pure commodity investment. Moreover, there may be temporary market disequilibriums, especially for stocks with low free float, where few buy and sell transactions can already cause major price reactions. Finally, natural resource companies are subject to operational risk caused by human or technical failure, internal

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[11]Hélyette Geman, *Commodities and Commodity Derivatives: Modeling and Pricing for Agriculturals, Metals and Energy* (Chichester: John Wiley & Sons, 2005).

[12]Georgi Georgiev, Benefits of Commodity Investment, Working Paper, 2005.

[13]For example, consider the poor information policy of Shell in the matter of the Brent Spar oil platform in 1995, which led to a massive stock price decline.

regulations, or external events. This means that when investing in a company listed on the stock exchange, both the associated market risk as well as any idiosyncratic risk must be considered carefully.[14]

However, the risk of commodity stocks is not completely reflected in the price volatility. First, particularly in the energy and metal sectors, there is the paradox that companies threaten their own business fundamentals by extracting exhaustible resources. On the one hand, long-term decreasing total reserves mean rising prices and a positive prospective for investors and commodity producers. On the other hand, commodity producers suffer when resources are depleted.

Second, there is always the risk of a total loss if prices decrease below total production costs and the extraction of a commodity is stopped. By constructing an index consisting of commodity stocks, Gorton and Rouwenhorst show empirically that observed return correlations with commodity futures are even lower than those with the S&P 500.[15] Furthermore, the commodity stock index exhibits lower historical returns than a direct commodity investment.[16]

Commodity Funds

Finally, in contrast to an investment in commodity stocks, one can actively invest in commodity funds, realizing an adequate diversification benefit with moderate transaction costs. Commodity funds differ in terms of management style, allocation strategy, geographic, and temporal investment horizon in the denominated currency, and investment behavior. It is also important for investors to distinguish between active and passive funds (i.e., index tracking funds). Commodity stock indexes (e.g., the MSCI World Materials, the FTSE World Mining, the HSBC Global Mining, the Morgan Stanley Commodity Related Index, the FTSE World Oil, and Gas, or the FTSE Goldmines) and commodity futures indexes can be used to benchmark actively managed commodity funds. *Commodity trading advisors* (CTAs) also present an alternative to actively managed investment products. Today, there are also about 450 hedge funds with energy- and commodity-related trading strategies.

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[14]Note that the majority of large oil and energy companies hedge the risk associated with buying and selling oil products in order to smooth yearly profits.

[15]Gary Gorton and K. Geert Rouwenhorst, "Facts and Fantasies about Commodity Futures," *Financial Analysts Journal* (April–May 2006), pp. 47–68.

[16]For example, the returns of European oil companies covary strongly with Euro-Stoxx, but less with oil price returns. Exceptions are gold and silver stocks, whose beta to the domestic stock index is smaller than the beta to the gold and silver price.

Commodity Futures Indexes

Nowadays, investors can choose from an increasing number of investible commodity futures indexes as a *passive* form of investing in commodities (see Exhibit 1.2). Commodities have an exceptional position among alternative investments because they provide investible indexes for a broad universe of commodity sectors. According to Doyle, Hill, and Jack, between U.S. $55 billion and $60 billion were invested in the Goldman Sachs Commodity Index (GSCI) in March 2007, and another U.S. $15 billion was linked to the Dow Jones-AIG Commodity Index.[17] Estimates for December 2006 state that about U.S. $90 billion of invested capital from pension and mutual funds are invested in commodity-based indexes or products.[18]

For the majority of investors, an index-oriented investment represents the most reasonable way to obtain exposure to commodities or an individual commodity sector. Such an investment can be done cost-effectively using the following two types of financial products:

- Exchange-traded funds (ETFs) on commodity indexes.
- Commodity index certificates closely tied to commodity indexes.

Index funds have the advantage of being relatively easy to trade and reasonably priced. Another advantage of funds over certificates is the non-existing credit risk of the issuer. Because ETFs represent special assets, investor deposits are safe even if the investment company goes bankrupt.

Certificates constitute legal obligations that can be quickly and fairly cheaply issued by banks. In the case of commodity index certificates, the issuing institution invests in futures markets and rolls the futures contracts for a fee. The term of a certificate is normally restricted to a fixed date (e.g., rainbow certificates, whose underlyings are different subindexes or asset classes, or discount and bonus certificates). But there are also open-end certificates.

However, because the indexes, like the commodities themselves, are denominated in U.S. dollars, investors are exposed to currency risk. Quanto certificates, discount certificates with a currency hedge, can be used to mitigate this risk.

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[17]Emmet Doyle, Jonathan Hill, and Ian Jack, Growth in Commodity Investment: Risks and Challenges for Commodity Market Participants, Financial Services Authority, Working Paper, 2007.

[18]In 2001, the total invested capital in the GSCI was between $4 billion and $5 billion. At the beginning of 2007, Standard & Poor's acquired the GSCI Commodity Index, which was subsequently renamed the S&P GSCI Commodity Index.

EXHIBIT 1.2 Commodity Futures Indexes

	Reuters/Jefferies Commodity Research Bureau (RJ/CRB)	Goldman Sachs Commodity Index (GSCI)	Dow Jones/AIG Commodity Index (DJ-AIGCI)
Introduced in	2005	1991	1998
Historical data available since	1982	1970	1991
Number of commodities	19	24	19
Weighting scheme	Within a graduated system of four groups, based on liquidity and economic relevance	Rolling five-year average of world production	Liquidity data, in conjunction with dollar-weighted production from the past five years
Rebalancing frequency	Monthly	Yearly	Yearly
Allocation restrictions	None	None	33% maximum per sector; 2% market minimum per commodity
Relevant futures price on which the index calculation is based	Next futures contract/delivery month	Next month with sufficient liquidity	Next futures contract/delivery month
Roll period	4 Days	5 Days	5 Days
Calculation method	Arithmetic	Arithmetic	Arithmetic

   The main disadvantage of index certificates is that they often use excess return indexes as the underlying instrument. These indexes do not consider all the return components, in contrast to total return indexes, which may lead to lower returns during periods of high interest rates. Investing in a low performance excess return index compared to a total return index can nevertheless be an advantage because the latter bears little or no initial costs and no yearly management fees. Hence, for investors with short-term investment horizons, certificates on excess return indexes with lower returns can be a smart choice during periods of low interest rates.

   Another disadvantage of index-based commodity investments is that due to their construction, they can only consider short-term futures contracts. Commodity funds not linked to commodity indexes, however, can freely determine their optimal term by investing directly in commodity futures contracts. And similarly to purchasing rainbow certificates on different asset classes, there is also the possibility of purchasing commodity funds that do not invest exclusively in commodity indexes, but also include commodity stocks to a certain extent.

Commodity Futures

In addition to options and other derivatives, commodity products are based primarily on futures contracts. A futures contract is a mutual binding agreement between two parties to deliver or accept and pay (or undertake a cash settlement): (1) a qualitative explicitly determined underlying (in this case commodities); (2) in a certain quantity; (3) at a fixed date; and (4) at a fixed, already at conclusion of the contract determined price. Futures can be described as mutually binding, exchange-traded "unconditional" forward contracts, since the conclusion of a futures contract leads to a legally binding accomplishment in the future if there is no compensating contrary transaction.[19]

   Contract sizes in the commodity market are standardized. The smallest tradable unit represents a contract, and the smallest possible price change of a futures is called a *tick*. The value of the minimum price change is the U.S. dollar and cent-denominated tick, multiplied by the contract size (also known as the *point value*) of the commodity. It is common practice to deposit a margin for every futures contract. The amount is determined by the exchange, but it is usually between 2% and 10% of the contract.[20]

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[19]In contrast, in the case of conditional forward contracts such as options, the option holder has no obligation to exercise his option right, and can thus abandon the option at maturity.

[20]However, futures commission merchants may charge higher margins than the exchanges.

However, the margin changes according to the price and volatility of the contract.

In this context, we also distinguish between the initial margin, the minimum deposit required to invest in a futures contract, and the maintenance margin, the minimum deposit required to be on account at the exchange as long as the futures position is held. If the capital deposit on the account falls to or below the value of the maintenance margin due to price variations, the broker issues a margin call to recoup the initial value of the clients' capital. If an investor does not want to increase the margin, he can also close part of or the entire position, and accept a loss. For collateral in terms of the initial margin, investors in futures receive interest income from money market interest.

Generally, for commodity futures, there are two forms of settlement: delivery of the commodity at maturity, which happens in about 2% of the cases, and closing the futures position (i.e., buying or selling the same amount of contracts before maturity). Daily price limits are a specific characteristic of commodity futures markets. They were established to allow the market to stabilize during times of extreme movements (e.g., a cooling-off phase).[21] Hence, daily price limits, again determined by the exchange, represent the maximum possible increase or decrease of a commodity price from the settlement price of the preceding trading day. In the case of limit up (limit down), the sellers (buyers) are outnumbered by buyers (sellers) who are willing to buy (sell) at the upper (lower) price limit. At this price limit, there may still be trading activity, but it may not exceed (limit up) or fall short of (limit down) the price limit.

The following are the contract specifications published regularly by the futures exchanges:

- *The type and quality of the futures underlying*. The type of commodity, abbreviation, and futures exchange.
- *The contract size*. The amount and units of the underlying asset per futures contract.
- *Price determination*. The formal notation of futures prices at the futures exchange.
- *Trading hours*.
- *The tick*. The minimum permissible price fluctuation.
- *The currency* in which the futures contract is quoted.
- *The daily price limit*.

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[21]Franklin R. Edwards and Salah Neftci, "Extreme Price Movements and Margin Levels in Futures Markets," *Journal of Futures Markets* (December 1998), pp. 639–655.

- *The last trading date*.
- *Delivery regulations* (e.g., delivery month, type of settlement).

Investors in commodity futures can profit from price movements of the underlying commodity without having to fulfill the logistical or storage requirements connected with a direct purchase. However, this is only possible if the position is closed before maturity. The advantages of futures investments lie especially in the tremendous flexibility and leveraged nature of the futures position due to the low capital requirements. Thus, a shift of an existing futures position is possible at any time, even in the short term. By holding long or short positions, investors can profit from rising and falling markets. Furthermore, the futures markets are characterized by a high degree of liquidity and low transaction costs.

Despite the numerous advantages of an active investment in commodity futures, it is not always advisable for a private investor to take futures positions in such volatile commodities. Even if diversification by a large number of different futures contracts were guaranteed, the investor would still face the problem of maintaining an exposure to commodity prices without the liability of physical delivery of the underlying contract. This requires continuously closing existing futures positions and reestablishing new positions by opening more futures contracts. This is referred to as *rolling of futures contracts*, and it may be quite costly depending on the forward curve of the futures market.[22] In addition, falling futures prices may constantly trigger margin calls (although margins can be withdrawn if the futures prices increase). Overall, however, compared to traditional assets, managing futures positions requires a great deal of time and effort.[23]

COMMODITY EXCHANGES

The trading of commodity futures takes place at specialized exchanges that function as public marketplaces, where commodities are purchased and sold at a fixed price for a fixed delivery date. Commodity futures exchanges are mostly structured as membership associations, and operate for the benefit of

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[22]An active, indirect investment in commodities can be achieved by purchasing futures contracts and closing them prior to maturity. In order to keep an exposure to commodities, investors must buy another futures contract with a later maturity date (this is called *rolling*, and must be repeated before each maturity date).

[23]It is also possible to invest in commodity swaps and forwards. These instruments, however, are of minor liquidity since they are tailor-made for individual investors. Furthermore, these derivatives are not traded at the exchange, and commodity investment strategies of individual investors cannot be publicly observed.

their members. Transactions must be made as standardized futures contracts by a broker who is also a member of the exchange. Only members are allowed to trade.[24] The main task of a commodity exchange is to provide an organized marketplace with uniform rules and standardized contracts.

The first commodity exchange was founded by Japanese farmers trading rice futures contracts in Osaka. In the United States, the Chicago Board of Trade, founded in 1848, was the first institution. Even today, most commodities are still traded there.[25] The British London Metal Exchange was founded in 1877.

Energy futures trading, however, only began with the foundation of the International Petroleum Exchange (IPE) in London in 1980.[26] Trading of WTI crude oil at the New York Mercantile Exchange (NYMEX) began in 1983; trading of Brent crude oil began in 1988. In terms of traded volume, the Chicago Mercantile Exchange (CME), founded in 1998, is the world's most important futures exchange. There are about 30 commodity exchanges worldwide; the most important are listed in Exhibit 1.3. Based on traded volume, the majority of commodity futures trading takes place in the United States, United Kingdom, Japan, and China.

PRICES AT THE COMMODITY FUTURES EXCHANGES

Backwardation and Contango

One of the primary questions regarding commodity futures is the existence of risk premiums in commodity markets.[27] In this context, we refer to the price discovery and the related term structure of commodity futures markets. Assuming that the spot futures arbitrage relationship holds, the valid futures price of a commodity at time t and the remaining time to maturity T, $F(t,T)$ equals the cash price $S(t)$, multiplied by the continuously compounded riskless interest rate r (storage cost is neglected here):

$$F_0 = S_0 e^{rT} \tag{1.1}$$

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[24]Membership in commodity exchanges is restricted to individuals who often act in the name of investment banks, brokers, or producers.

[25]According to Geman, in the United States most futures exchanges still function as open outcry trading systems, although many exchanges around the world operate on an electronic platform. See Geman, *Commodities and Commodity Derivatives: Modeling and Pricing for Agriculturals, Metals and Energy*, p. 11.

[26]Since 2005, the IPE operates under the name ICE Futures.

[27]See Kat and Oomen, "What Every Investor Should Know About Commodities: Part I."

EXHIBIT 1.3 Major Commodity Exchanges

Exchange Name	Abbreviation	Country	Traded Futures	Web Site
Chicago Board of Trade	CBOT	U.S.	Agricultural products and oil	cbot.com
Chicago Mercantile Exchange	CME	U.S.	Agricultural products and livestock	cme.com
New York Mercantile Exchange	NYMEX	U.S.	Energy and metals	nymex.com
Intercontinental Exchange	ICE	U.K.	Energy	theice.com
London Metal Exchange	LME	U.K.	Metals	lme.co.uk
Winnipeg Commodity Exchange	WCE	Canada	Agricultural products	wce.ca
Tokyo Commodity Exchange	TOCOM	Japan	Energy and metals	tocom.or.jp
Shanghai Metal Exchange	SHME	China	Metals	shme.com
Dalian Commodity Exchange	DCE	China	Agricultural products and oil	dce.com.cn
Brazilian Mercantile and Futures Exchange	BM&F	Brazil	Agricultural products	bmf.com.br
Risk Management Exchange	RMX	Germany	Agricultural products and livestock	wtb-hannover.de
National Commodity and Derivatives Exchange	NCDEX	India	Agricultural products and metals	ncdex.com

In contrast to financial securities, commodities, however, do involve storage costs. Let U_t denote the cash value of storage costs, which are assumed to be proportional to the commodities' price and can thus be interpreted as a negative return:

$$F_0 = S_0 e^{(r+U)T} \tag{1.2}$$

However, the aforementioned arbitrage relationship does not hold for commodities. Note that the spot futures parity varies from the future parity, which states that the futures price observed today is an undistorted estimate of the cash price $E_t[S(T)]$ at maturity. If we consider the forward curve of a specific commodity displaying the future price at different maturity dates of the contract, we observe two different trends: In the case of *backwardation*, the term structure curve has a negative trend (i.e., futures prices with longer time to maturity are lower than current spot prices, $F_{t,T} < S_t$ for increasing T). Hence, the investment return lies on average above the forward premium (i.e., an investor can generate profits by holding long positions in the respective futures contracts). In the case of *contango*, however, the opposite holds, based on the assumption of rational expectations. In a *contangoed* situation, the futures price lies above the actual spot price—hence the forward curve displays a positive slope.

In the literature, there are numerous explanations for this, but each sheds light on only a fraction of the complex "futures puzzle."[28] Lewis attributes the varying term structures between commodity sectors to the *theory of storage cost*, and to the existence of a *convenience yield* (Y).[29] Considering the futures price of consumption goods, we must adjust equation 1.2 for the physical ownership of a scarce commodity:

$$P_0 = S_0 e^{(r+U-Y)T} \tag{1.3}$$

[28]For a review of the different approaches, see Claude Erb and Campbell R. Harvey, "The Tactical and Strategic Value of Commodity Futures," *Financial Analysts Journal* (April–May 2006), pp. 69–97; and Barry Feldman and Hilary Till, "Separating the Wheat from the Chaff: Backwardation as the Long-Term Driver of Commodity Futures Performance; Evidence from Soy, Corn and Wheat Futures from 1950 to 2004," Working Paper, 2007.

[29]According to Kaldor's theory of storage, the convenience yield reflects the utility of holding the physical commodity, in contrast to a pure contractual agreement about the delivery of the specific commodity. The utility results from the prevention of costs associated with disruptions in the production process. See Hélyette Geman, "Energy Commodity Prices: Is Mean-Reversion Dead?" *Journal of Alternative Investments* (Fall 2005), pp. 31–45; and Nicolas Kaldor, "Speculation and Economic Stability," *Review of Economic Studies* (October 1939), pp. 1–27.

The convenience yield varies over time (e.g., in the case of an unexpected increase or decrease in commodity supply). Commodities exposed to strong stock price variations from sudden supply or demand shocks are likely to exhibit a change or even a reversion in the term structure. The slope of the term structure curve thus indicates the stock of a commodity, and reflects market expectations for its availability in the future.[30]

Backwardation and contango depend strongly on the respective supply and demand situation of global commodity markets. Anson distinguishes between markets that offer price risk hedges for producers on the one hand, and hedges for commodity consumers on the other.[31] According to the theory of normal backwardation, the demand for short hedges greatly exceeds that for long hedges—hence, speculators have incentives to take these excessive positions. In order to compensate speculators, the short hedgers provide a risk premium that constitutes a deduction from the expected spot price. A contangoed market may arise when buyers depend on delivery schedules (e.g., in the manufacturing industry). Thus, there may be a surplus of long hedgers, which may lead to a falling term structure curve.

The theory of backwardation is confirmed by the empirical evidence that the slope of the term structure curve is determined by the storability of the individual commodity (the *storage hypothesis*). Eagleeye and Till conclude that the key to a successful long-term investment lies in choosing an index that gives more weight to sectors with low storage capacity. They refer to the GSCI due to its high proportion of energy (74.57% as of January 2006).[32]

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[30]The theory of *normal backwardation*, which dates to Keynes, is closely linked to the theory of convenience yield. Normal backwardation states that the futures price is lower than the expected spot price in the future, $F(t,T) < E[S(T)]$. Keynes argued that in commodity markets, backwardation does not describe an abnormal market situation, but is due to the fact that commodity producers hedge their price risk more frequently than commodity consumers. See John M. Keynes, *A Treatise on Money* (London: Macmillan, 1930). This argument has set off an academic discussion lasting until today. See, for example, Colin A. Carter, Gordon C. Rausser, and Andrew Schmitz, "Efficient Asset Portfolios and the Theory of Normal Backwardation," *Journal of Political Economy* (April 1983), pp. 319–331; Lester Telser, "Futures Trading and the Storage of Cotton and Wheat," *Journal of Political Economy* (June 1958), pp. 233–255; and Paul Cootner, "Returns to Speculators: Telser versus Keynes," *Journal of Political Economy* (August 1960), pp. 398–404.

[31]Anson, *The Handbook of Alternative Assets*.

[32]Joseph Eagleeye and Hilary Till, "Commodities—Active Strategies for Enhanced Return," in *The Handbook of Inflation Hedging Investments*, edited by Robert J. Greer (Hoboken, NJ: John Wiley & Sons, 2005), pp. 127–158.

EXHIBIT 1.4 Backwardation in Commodities

| Sector | Observation Period | Number of Observations (in months) | | | Percentage of Backwardation |
		Total	In Calculation	In Back-wardation	
Agricultural	1970–2006	444	281	69	15.54%
Energy	1983–2006	288	275	140	48.61%
Industrial Metals	1977–2006	360	236	66	18.33%
Livestock	1970–2006	444	275	150	33.78%
Precious Metals	1973–2006	408	264	14	3.43%

To verify the storage hypothesis, we analyze the individual subindexes of the GSCI. We thus determine the monthly share in percent of backwardation and contango over our observation period (January 1970–December 2006) for the agricultural, energy, industrial metals, livestock, and precious metals sectors.[33] We choose the GSCI because of its availability and its long data history. Its subindexes are available in all three index versions (total return, excess return, and spot return), and it provides the longest actually calculated index series since 1992.

As Exhibit 1.4 shows, backwardation is no temporary phenomenon. The energy sector and the livestock sector, which contain the majority of nonstorable commodities, are characterized by a high percentage of backwardation. The precious metals sector, on the other hand, has been almost exclusively in contango due to its low storage costs.

Return Components of Commodity Futures Investments

To compare the long-term performance of commodities and other asset classes, we assume a fully collateralized commodity futures investment. Such diversified long-term passive commodity portfolios are characterized by long-only positions in commodity futures. In comparison to futures investments, which may require a margin depending on capital invested, the futures position is fully collateralized with cash. This means that, for such an unleveraged total return index, the initial and maintenance margins, as well as the entire outstanding cash, are invested at the riskless interest rate. Hence, the return of such an investible index can be decomposed into the

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[33]For this purpose, we compare the monthly returns of the spot and the excess return indexes. If the excess return exceeds the spot return, the market is backwardated, and vice versa; months with a spread of less than 0.1% are not considered.

following three return components:[34] the spot return, the roll return (generated by switching from the maturing futures contract into the next closest futures contract), and the collateral return (the interest payment on the cash position). If we consider a commodity futures portfolio instead of an individual futures contract, an additional component may exist, the so-called rebalancing (diversification) return:

$$\text{Total return} = \text{Spot return} + \text{Roll return} + \text{Collateral return}$$
$$+ \text{Rebalancing return} \qquad (1.4)$$

The majority of investors focus on an increase in physical commodity prices, that is, the *spot return*, R_S, defined as the percentage change of the spot price S_t of the respective commodity:

$$R_S = \frac{S_t - S_{t-1}}{S_{t-1}} \qquad (1.5)$$

The spot price is influenced by fundamental factors like changes in supply, global demand variations, or unexpected price changes.[35] These price changes at the spot market are immediately reflected at the futures market.

Theoretically, the spot return is the component of the commodity futures return that is most strongly correlated with unexpected inflation.[36]

Forecasting spot prices is difficult because their factors are unpredictable. The prices of the respective commodities can vary greatly due to differences in commodity type, extraction method, production, and use. Industrial metals, for example, are used in manufacturing. Thus, their demand depends strongly on worldwide economic development. In contrast, the supply of agricultural products is determined mainly by the harvest,[37] which in turn depends on other factors (similarly to the energy sector). Extreme drought, frost, or thunderstorms can reduce the harvest or even destroy it entirely. In

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[34]For example, Ernest M. Ankrim and Chris R. Hensel, "Commodities in Asset Allocation: Real-Asset Alternative to Real Estate?" *Financial Analysts Journal*, (May/June 1993), pp. 20–29; Erb and Harvey, "The Tactical and Strategic Value of Commodity Futures," and Robert J. Greer, "The Nature of Commodity Index Returns," *Journal of Alternative Investments* (Summer 2000), pp. 45–52.

[35]Adam De Chiara and Daniel M. Raab, "The Benefits of Real Asset Portfolio Diversification," *Euromoney International Commodities Review* (2002), pp. 3–10.

[36]Ankrim and Hensel, "Commodities in Asset Allocation: Real-Asset Alternative to Real Estate?"

[37]Supply exhibits a strong seasonal component. Agricultural commodities can only be produced at specific times, and in amounts that may fluctuate.

addition, all commodities are dependent on political factors. Besides numerous market barriers, which are known ex ante, other factors like political instability or war can lead to volatility in commodity prices.

The *roll return R_r* results from the extension of the futures contract and the shape of the term structure curve. The roll return reflects the profit from the convergence of the futures price toward the spot price over time, and the subsequent rolling of the maturing futures into the next nearest month's futures contract. If the commodity market is in backwardation (contango), the rolling from the maturing to the next shortest futures contract generates positive (negative) income.[38] Given that the futures price $F_{t-1,t}$ and the spot price S_t are equal at contract maturity, the selling price of the near month futures contracts prior to expiration varies from the new futures contract, $F_{t,T}$, by the amount of backwardation (contango) (see Exhibit 1.5). This means we can express the roll return at time t as:

$$R_r = \frac{F_{t,T} - F_{t-1,t}}{F_{t-1,t}} = \frac{F_{t,T} - S_t}{S_t} \qquad (1.6)$$

where a negative (positive) value corresponds to a positive (negative) roll return and thus to backwardation (contango).
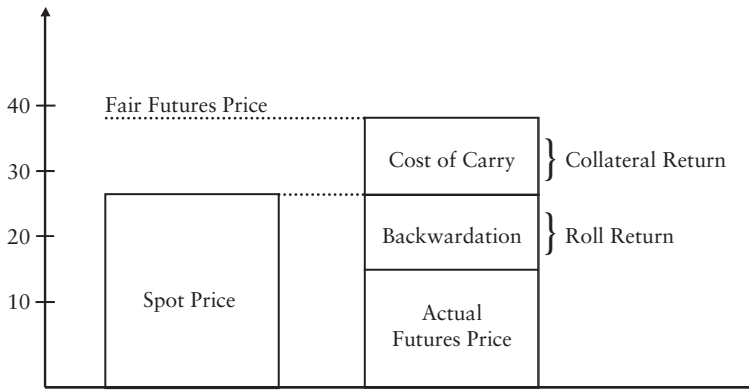

EXHIBIT 1.5 Return Components of Commodity Futures

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[38]Note that the futures contract is rolled before maturity. Thus the roll return results from selling the maturing future and investing the returns into the next nearest futures contract. The roll return is positive when the market is in backwardation, and negative when it is in contango. In a contangoed situation, the spot price to which the initial futures contract converges is lower than the price of the new futures contract.

Generally, when investing in a futures contract, it is only necessary to deposit a margin payment (a fixed percentage of the underlying capital), and not the total position. In contrast, a collateral return is based on the assumption that the whole futures position is collateralized by cash. Interest is thus paid on this capital at the U.S. Treasury bill rate, which is explicitly considered in the total return index.

Booth and Fama introduced the *rebalancing return* as a fourth return component by stating that a significant return portion of a value-weighted commodity index stems from the reallocation of the sectors or commodities in the index.[39] This is because the individual commodities are only marginally correlated, or not correlated at all.[40] If the price movements follow a random walk or in contrast return to their long-term average level—that is, production costs (mean reversion)—the construction of a value-weighted commodity index can generate a surplus in this asset class.[41] As a result of spot price volatility, there is a regular shift in index composition. If a commodity in the portfolio shows continuous appreciation, this commodity's share of total portfolio value will increase as well.

According to their construction principles, the commodity indexes we describe here constitute a fixed weight for all commodities with respect to relative index value. Thus they must be rebalanced on a regular basis: Futures that have increased in value are sold; those that have decreased in value are purchased.

Unlike a pure buy-and-hold strategy, where the value of the portfolio increases linearly with market value, such a dynamic asset allocation strategy enables investors to participate strongly in booming markets.[42] Thus, a "free lunch" may be obtained via the lower systematic risk achieved by reducing the standard deviation of the portfolio, without any effect on arithmetic return.[43] According to this, the rebalancing approach[44] mentioned

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[39]The rebalancing return is often called the diversification return. See, for example, David G. Booth and Eugene F. Fama, "Diversification Returns and Asset Contributions," *Financial Analysts Journal* (January/February 1992), pp. 26–32.

[40]Based on a comparison between the Dow Jones-AIG Commodity Index and a self-constructed index with constant weights, Chiara and Raab show that a yearly rebalanced index leads to higher returns as long as the underlying commodities are not perfectly correlated. See Chiara and Raab, "The Benefits of Real Asset Portfolio Diversification."

[41]Greer, "The Nature of Commodity Index Returns."

[42]André F. Perold and William F. Sharpe, "Dynamic Strategies for Asset Allocation," *Financial Analysts Journal* (January/February 1988), pp. 16–27.

[43]John Y. Campbell, "Diversification: A Bigger Free Lunch," *Canadian Investment Review* (Winter 2000), pp. 14–15.

[44]The literature often mentions a constant-mix strategy in the context of fixed portions relative to the total portfolio.

above leads to significantly higher returns, especially in volatile, trendless markets like the commodity market.

Exhibit 1.6 decomposes the annualized monthly total returns of the sector indexes into their individual return components and corresponding standard deviations. Over our entire sample period, all subindexes show positive total returns.[45] The industrial metals, precious metals, and agricultural sectors show on average negative roll returns, while energy and livestock commodities generate positive returns from the roll procedure. This coincides with the *theory of storage*.

Exhibit 1.6 also clearly shows that the *collateral yield*, at about 6%, constitutes a relatively large part of the total return, thus explaining the tremendous difference between the returns of the total and excess return indexes. Furthermore, the average spot return, which is highly volatile, is of special interest and is positive for all individual sectors. Hence, the majority of total return variation is based on the spot price. This result concurs significantly with the studies of Ankrim and Hensel[46] as well as Erb and Harvey.[47]

The following section takes a closer look at the different types of futures indexes that can be used for performance measurement. These indexes are closely linked with the sources of futures return. The total return index as a performance index results from the actual futures return plus the

EXHIBIT 1.6   Return Components of the Goldman Sachs Subindexes

Sector	Spot Return		Roll Return		Collateral Return		Total Return	
	$\mu(\%)$	$\sigma(\%)$	$\mu(\%)$	$\sigma(\%)$	$\mu(\%)$	$\sigma(\%)$	$\mu(\%)$	$\sigma(\%)$
Agricultural	4.60	19.68	−3.86	5.60	6.15	0.87	6.89	19.44
Energy	7.87	31.14	2.55	7.64	5.26	2.03	15.68	31.54
Industrial metals	7.52	22.62	−1.07	6.31	6.21	0.93	12.65	23.74
Livestock	4.02	19.41	1.20	8.26	6.17	0.95	11.38	18.30
Precious metals	8.96	23.13	−6.22	2.49	6.24	0.91	8.98	23.15

[45]The periods under consideration for the individual subindexes follow those in Exhibit 1.4.

[46]Ankrim and Hensel, "Commodities in Asset Allocation: Real-Asset Alternative to Real Estate?"

[47]Erb and Harvey, "The Tactical and Strategic Value of Commodity Futures."

interest rate payment on the collateral. The futures return itself is composed of the spot and roll return, and is called the excess return:

$$\text{Total return} = \text{Collateral return} + \text{Futures return}$$

$$= \text{Collateral return} + \text{Spot return} + \text{Roll return} \qquad (1.7)$$

$$\text{Excess return} = \text{Spot return} + \text{Roll return} = \text{Futures return} \qquad (1.8)$$

A *spot return index* does not represent the prices at the spot market, but rather measures the price movements at the futures market, since reliable prices are not immediately available for all commodities. Hence, we can calculate the spot return index by using the *near-month contract* or *spot month contract* as a proxy for the spot price of each individual commodity.[48] Just before maturity, the calculation is related to the next contract. The replacement is done without considering any discrepancies in value between the shortest and the second-shortest future.[49] Thus, the spot return index is a general indicator of existing price trends in commodity markets, and cannot be used as a performance measure or for comparison with other financial asset returns.

In the case of the *excess return index*, by switching from a maturing to a new contract (which is actually done from the fifth to the ninth working day of the month), a futures contract is rolled. The roll performance is captured in the index, so that the performance of the excess return index is composed of the spot return on the one hand, and the roll performance on the other (e.g., see the GSCI Energy Index in Exhibit 1.7). Because investors might hold and roll the underlying commodity futures themselves, the index is theoretically replicable, and can thus serve as a basis for financial instruments. According to its construction, the underlying of the excess return index is assumed to be an *un*collateralized futures instrument (i.e., a leveraged spot position).

In contrast to the excess return indexes, the total return index is based on a fully cash-collateralized commodity investment. Hence, in the long run, tremendous return differences can arise between the total and the

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[48]Viola Markert, Commodities as Assets and Consumption Goods: Implications for the Valuation of Commodity Futures, Doctoral Dissertation, University of St. Gallen and Basel (2005); and Gorton and Rouwenhorst, "Facts and Fantasies about Commodity Futures."

[49]As a result of the roll procedure, there is an increase or decrease in the index depending on the forward curve of the underlying commodity.
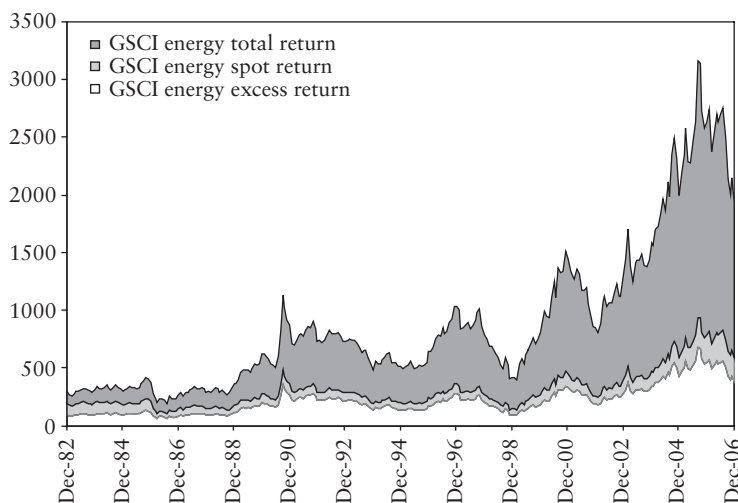
EXHIBIT 1.7   Excess Return of Commodity Futures

excess return indexes.[50] However, we cannot compare the excess return in-
dex directly with the total return index; that is, the excess return plus
Treasury bill rate does not equal the total return. We must consider the in-
fluence of the reinvestment of the Treasury bill collateral income into com-
modity futures, as well as the deposit of the profits (withdrawal of losses)
from the futures contracts into (out of) the Treasury bills.

MODELS OF EXPECTED RETURNS

The literature contains several models that can be used to arrive at com-
modity futures returns expectations. In this context, Erb and Harvey men-
tion four:[51]

   ■ The capital asset pricing model (CAPM)
   ■ The insurance perspective

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[50]It can be advisable to invest in, for example, a certificate on a total return index in
comparison to an underperforming excess return index, because there are no initial
up-front payments and no yearly management fees. Thus, it may be sensible to pur-
chase certificates on the seemingly worse excess return index during times of low
interest rates. Note also that there are opportunity costs from investing in total re-
turn indexes, since the entire capital must be invested in Treasury bills and cannot
be allocated more efficiently.
[51]Erb and Harvey, "The Tactical and Strategic Value of Commodity Futures."

- The hedging pressure hypothesis
- The theory of storage

Under the CAPM framework, the market beta drives the prospective capital asset returns. However, as we discussed earlier, commodity futures are not considered capital assets. Thus, application of the CAPM model is of limited use.

The insurance perspective argues that risk premiums are available if hedgers use commodity futures to avoid commodity price risk. Hedgers (producers) hold commodities in stock, and therefore must have a short position in commodity futures. To attract speculators, hedgers must offer an insurance premium. Therefore, the futures price for a commodity is less than the expected spot price in the future ("normal backwardation").[52] Unfortunately, expected futures spot prices are unobservable. This theory suggests that all long positions in commodity futures have a positive expected excess return, which consequently justifies "long-only" investments. But this model implicitly assumes that hedgers hold commodities in stocks, and seek to mitigate price risk by selling commodity futures.

We can consider the hedging pressure hypothesis as a continuation of the insurance perspective. It also highlights the fact that consumers who demand commodities may want to hedge their risk. Anson uses the example of Boeing as a consumer of aluminum.[53] The airplane producer is short in aluminum because it does not own any aluminum mining interests and can therefore eliminate the risk of higher futures prices by taking a long position in aluminum futures. This causes the futures price to be higher than the expected spot price in the future. Under these circumstances, investors seeking to earn an insurance premium will choose to short the commodity futures. The hedging pressure hypothesis argues that investors will receive a risk premium that is a positive excess return for going short in a "normal contangoed" commodity futures market.

The theory of storage emphasizes the role of inventories, and conceptually links inventories with commodity futures prices. The difference between futures prices and spot prices can be explained by storage costs and the so-called *convenience yield* of holding specific commodities in inventory. The underlying idea is that the holder of a storable commodity has a consumption option that is implicitly embedded in a convenience yield. Inventories act as a damper on price volatility because they provide an additional way to balance supply and demand. This theory predicts an inverse relationship between the level of inventories and the convenience yield—the

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[52]John M. Keynes, *A Treatise on Money* (London: Macmillan, 1930).
[53]Anson, *The Handbook of Alternative Assets*.

lower the inventories, the higher the convenience yield. Difficult-to-store commodities should therefore have lower inventory levels and higher convenience yields than easy-to-store commodities. According to Till, examples of difficult-to-store commodities include heating oil, live cattle, and live hogs.[54]

RISK AND PERFORMANCE CHARACTERISTICS

Based on their historical return, risk, and correlation performance, commodity investments have an advantage over traditional assets, but they exhibit some similarities to stocks. Kaplan and Lummer, for example, conclude in their empirical investigation that commodities show an equity-like performance over the long run.[55] This finding is also supported by many other studies such as Greer, who concludes that the performance of unleveraged commodity indexes from 1970 to 1999 was on average positive, and comparable to equities with regard to return and volatility.[56]

Bodie and Rosansky[57] analyze an equally weighted commodity futures portfolio between 1949 and 1976, and Gorton and Rouwenhorst[58] between 1959 and 2004. Both studies confirm equity-like returns for commodities. In addition, during the high inflation period of the 1970s, commodities had the highest real returns by far of all the asset classes. Gorton and Rouwenhorst found differences with traditional assets. They show that commodity returns exhibit positive skewness, in contrast to stocks, which have negative skewness and thus include higher downside risk.[59]

Exhibit 1.8 shows the performance of both traditional and alternative assets starting with a reference basis of 100 in December 1993. After consolidating in 2006, the GSCI, which is heavily invested in energy, currently shows very strong performance, along with indirect real estate and hedge funds. In contrast, equity investments in emerging markets show the smallest price increases.

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[54]Hilary Till, "Two Types of Systematic Return Available in the Futures Markets," *Commodities Now* (September 2000), pp. 1–5.
[55]Paul D. Kaplan and Scott L. Lummer, GSCI Collateralized Futures as a Hedging and Diversification Tool for Institutional Portfolios: An Update, Working Paper, 1997.
[56]Greer, "The Nature of Commodity Index Returns."
[57]Bodie and Rosansky, "Risk and Return in Commodity Futures."
[58]Gorton and Rouwenhorst, "Facts and Fantasies about Commodity Futures."
[59]Gorton and Rouwenhorst, "Facts and Fantasies about Commodity Futures."
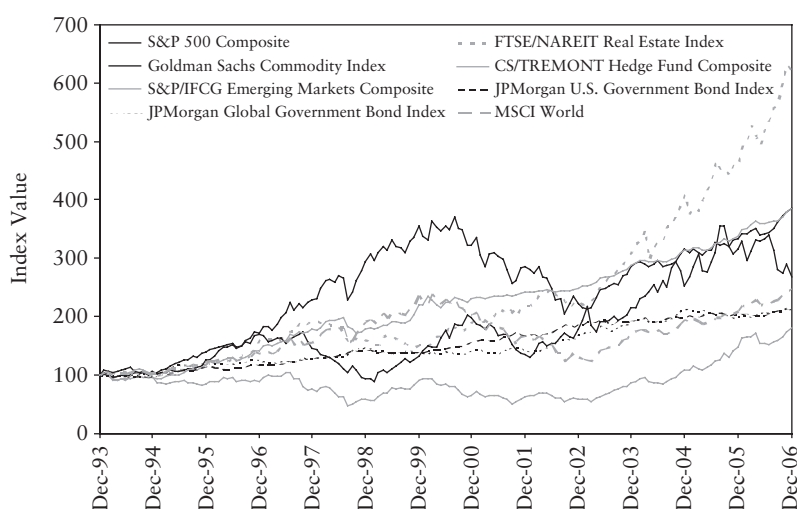
EXHIBIT 1.8 Performance of the Goldman Sachs Commodity Index
Compared to Other Financial Assets

During the January 1994–December 2006 period, commodities had an
annualized return of 9.64%, with a volatility of 20.25% (see Exhibit 1.9).[60]
Thus, compared to other observed asset classes, commodities have a high
average volatility. However, note that the downside risk of the S&P 500
Composite, the S&P/IFCG Emerging Markets, and the FTSE/NAREIT Real
Estate Index are higher because of their negative skewness; commodities
possess positive skewness.

The most beneficial investment in terms of the Sharpe ratio is the CS/
Tremont Hedge Fund Index. However, hedge fund investors also face high
excess kurtosis. When considering only return and volatility, an indirect in-
vestment in real estate also seems less favorable due to negative skewness
and positive excess kurtosis. Furthermore, the poor performance of emerg-
ing market equities seen in Exhibit 1.8 is also confirmed by the descriptive
statistics, especially considering the exorbitant volatility.

As mentioned above, commodities serve an important diversification
function in asset allocation due to their long-term low correlation with
stocks, bonds, real estate, hedge funds, and, to a lesser extent, their absolute
performance characteristics. According to Greer, commodity indexes have a

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[60]The high variability can be explained by the GSCI's large share in energy. The en-
ergy sector currently represents over 70% of the total index (as at end 2006), and is
itself composed of 40% crude oil, which has experienced extreme volatility over the
last few years.

EXHIBIT 1.9 Annualized Average Monthly Return and Volatility (January 1994–December 2006)

	r_{ann}	σ_{ann}	r_{Min}	r_{Max}	Skewness	Excess Kurtosis	Sharpe Ratio
GSCI Composite	9.64%	20.25%	−14.41%	16.88%	0.063	0.024	0.281
S&P 500 Composite	11.43%	14.27%	−14.46%	9.78%	−0.622	0.838	0.524
MSCI World	7.91%	13.43%	−13.45%	8.91%	−0.658	0.890	0.294
Emerging Markets	6.76%	20.62%	−25.56%	12.37%	−0.765	1.877	0.136
Hedge Funds Composite	10.71%	7.66%	−7.55%	8.53%	0.099	2.465	0.882
Real Estate Index	14.99%	13.04%	−14.58%	10.39%	−0.510	1.472	0.846
JPMorgan U.S. Govt. Bonds	5.91%	4.65%	−4.68%	3.71%	−0.509	1.084	0.421
JPMorgan Global Bonds	5.98%	6.23%	−4.30%	5.65%	0.320	0.336	0.325
T-bill rate	3.96%	0.49%	0.07%	0.53%	−0.644	−1.049	—

negative correlation with stocks and bonds and a positive correlation with the inflation rate, especially unexpected changes in inflation. There are, however, significant differences among the individual commodity sectors: Energy, metals, livestock, and sugar show the best inflation hedging potential. Greer also finds very high correlation coefficients among different kinds of commodity sectors.[61]

According to Kat and Oomen, commodity futures and traditional assets like stocks and bonds are uncorrelated.[62] In specific phases, the correlation admittedly increases—therefore not all commodities are useful for portfolio diversification in every market phase. However, even in down markets, commodities as a group do not lose their diversification potential. According to Anson, there are three reasons for low or negative correlations between commodities and stocks/bonds.[63] First, inflation has a positive effect on commodity prices, but a negative effect on equity and bond markets. Second, investor expectations in commodity markets are different from those in equity and bond markets. Finally, a trade-off between capital return and commodity return exists in industrial production.

Exhibit 1.10 shows the return correlation structure between the total return indexes of various asset classes. As can be seen, correlation is only significant at the 5% level between commodities and hedge funds, which turn out to be relatively low at 0.167. This can be traced back to the commodity trading advisors and managed futures funds included in the CS/Tremont Hedge Fund Composite Index.

On the other hand, the return correlation between the money market and the commodity market is negative. Hence, the results of several academic studies[64] are confirmed for our sample period: Commodities show a high diversification potential in traditional *and* alternative security portfolios. Chong and Miffre support the findings that the conditional correlations between commodity futures and the S&P 500 decrease during times of down markets, that is, exactly when market risk increases and

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[61]Greer, "The Nature of Commodity Index Returns."
[62]Harry M. Kat and Roel C. A. Oomen, "What Every Investor Should Know About Commodities, Part II: Multivariate Return Analysis," *Journal of Investment Management* (Third Quarter 2007).
[63]Anson, *The Handbook of Alternative Assets*.
[64]See, for example, Kat and Oomen, "What Every Investor Should Know About Commodities: Part I"; Hilary Till, "Taking Full Advantage of the Statistical Properties of Commodity Investments," *Journal of Alternative Investments* (Summer 2001), pp. 63–66; Evert B. Vrugt, Rob Bauer, Roderick Molenaar, and Tom Molenaar, Dynamic Commodity Timing Strategies, Working Paper, 2004; and Gorton and Rouwenhorst, "Facts and Fantasies about Commodity Futures."

EXHIBIT 1.10 Correlation Matrix

	GSCI Commodity Index	S&P 500 Composite	MSCI World	S&P/IFCG Emerging Markets	CS/Tremont Hedge Fund Comp.	FTSE/NAREIT Real Estate	JPMorgan U.S. Govt. Bonds	JPMorgan Global Govt. Bonds	U.S. Treasury Bill Rate
GSCI Commodity Index	1								
S&P 500 Composite	0.003	1							
MSCI World	0.068	0.937[b]	1						
S&P/IFCG Emerging Markets	0.136	0.643[b]	0.724[b]	1					
CS/Tremont Hedge Fund Comp.	0.167[a]	0.487[b]	0.493[b]	0.503[b]	1				
FTSE/NAREIT Real Estate	0.005	0.299[b]	0.314[b]	0.350[b]	0.223[b]	1			
JPMorgan U.S. Govt. Bonds	0.079	−0.098	−0.159[a]	−0.216[b]	0.098	0.032	1		
JPMorgan Global Govt. Bonds	0.156	−0.016	0.064	−0.069	−0.050	0.118	0.597[b]	1	
U.S. Treasury bill rate	−0.063	0.084	0.008	−0.180[a]	0.102	−0.066	0.105	−0.084	1

[a],[b] Denote significance of the correlation coefficient at the 95% and 99% confidence levels, respectively.

diversification is strongly needed.[65] The conditional correlations between commodities and fixed income, on the other hand, increase during times of increased bond volatility.

PORTFOLIO OPTIMIZATION WITH COMMODITIES

In this section, we analyze whether an allocation in commodities yields any diversification benefits for a portfolio consisting of U.S. and global stocks, fixed income, and a riskless asset represented by the Treasury bill rate (i.e., whether the efficient frontier shifts into the upperleft corner in the expected return-standard deviation diagram). According to Markowitz,[66] these portfolios are considered from the set of all efficient portfolios (efficient in the sense that no others exhibit a superior risk-return combination). These efficient portfolios are located on the borderline formed by the set of all portfolios between the *minimum variance portfolio* (MVP) and the *maximum return portfolio* (MaxEP).

Exhibit 1.11 shows how portfolio efficiency can be improved by including commodities in a traditional portfolio, thus rotating the efficient frontier counterclockwise around the MVP (the Treasury bill rate). The
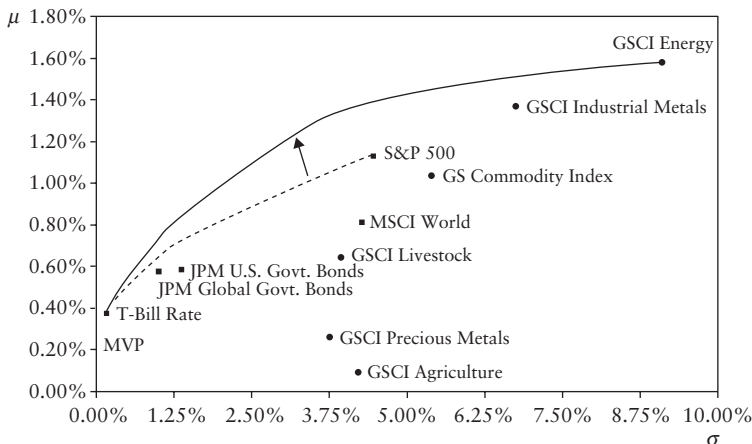
EXHIBIT 1.11 Expected Return-Standard Deivation ($\mu - \sigma$) Portfolio Optimization (monthly returns in percent)

[65]James Chong and Joelle Miffre, Conditional Risk Premia and Correlations in Commodity Futures Markets, Working Paper, 2006.
[66]Harry M. Markowitz, ''Portfolio Selection,'' *Journal of Finance* (March 1952), pp. 77–91.
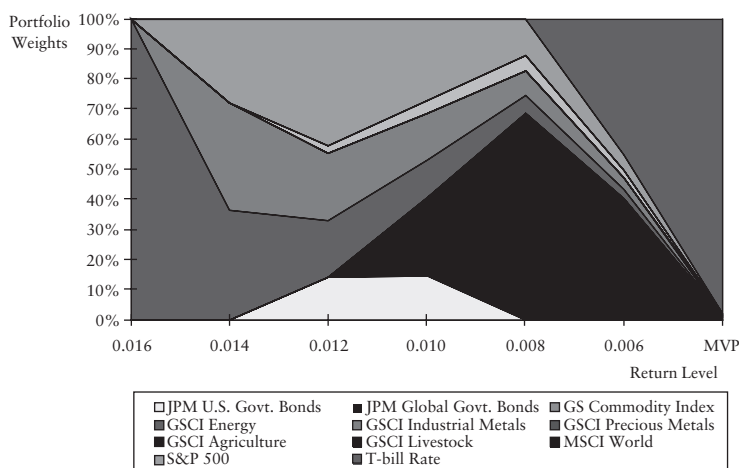
EXHIBIT 1.12 μ-σ-Portfolio Allocation (monthly returns in percent)

upward shift of the efficient frontier also provides higher risk-adjusted returns. The efficient frontier of the traditional portfolio is limited by a 98% investment in Treasury bills for the MVP, and 100% in the S&P 500 for the MaxEP.

Starting from the MVP and incorporating individual commodity sectors, the share of global bonds initially increases to 69% (see Exhibit 1.12). Subsequently, the proportions of the energy and industrial metals sectors increase continuously, together with the share of U.S. stocks. At a monthly return level of about 1%, livestock is represented with a share of about 4% to 5%. However, agricultural and precious metals are excluded entirely from the allocation. At a monthly return level of about 1.4%, the portfolio only consists of an allocation in the S&P 500 (28%), the energy sector (37%), and the industrial metals sector (35%).

Thus, with an increasing return level, the proportion of commodities in the portfolio expands as the allocation in U.S. stocks increases. It is remarkable that the GSCI Composite is not included in any allocations. It seems advisable to invest directly in the respective individual subsectors.

CONCLUSION

In an environment of historically low interest rates, markedly reduced upward potential, and continuously decreasing risk premiums for traditional asset classes, there is growing demand from institutional and private investors for alternative investments. An allocation to commodities offers not

only a hedge against inflation, but also effective diversification because of its low correlation with traditional asset classes.

In the long run, commodity investments show equity-like returns, but are accompanied by lower volatility and shortfall risk. The advantages hold for passive investment in commodity futures indexes, which are considered indicators of commodity market price movements. However, the futures indexes of individual providers differ with regard to sector weights, index construction, and calculation method—hence there are tremendous variations in risk-return characteristics.

In a total and excess return index, an important return component results from the risk premium connected with the roll yield. This results from rolling commodity futures positions with a backwardated term structure. A direct investment in commodities generates positive roll returns in certain backwardated markets. Investors in passive commodity futures indexes must take into account that, independent from the term structure curve, only long positions can be held. According to Akey, one solution may be to use an active and tactical benchmark in the form of a commodity trading advisor index (a CTA index).[67]

In view of current global market demand, we assume that the growth of commodity consumption, particularly in the BRIC countries (Brazil, India, Russia, and China) will continue to generate high demand for commodities in all sectors. But because low commodity prices over the last two decades did not lead to sufficient investment in increased production capacity, we expect that pricing pressure on the commodity markets will intensify. In addition, we expect to see short-run scarcity in the commodity supply due to increasing inventories. In light of this tremendous development and according to the commodity super cycle theory, we predict a lasting boom in the commodity markets in the near future.

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[67]Rian P. Akey, "Commodities: A Case for Active Management," *Journal of Alternative Investments* (Fall 2005), pp. 8–30.