Commodity Investing

Maximizing Returns through Fundamental Analysis

ADAM DUNSBY

JOHN ECKSTEIN

JESS GASPAR

SARAH MULHOLLAND

WILEY

John Wiley & Sons, Inc.

Commodity Investing

Founded in 1807, John Wiley & Sons is the oldest independent publishing company in the United States. With offices in North America, Europe, Australia and Asia, Wiley is globally committed to developing and marketing print and electronic products and services for our customers' professional and personal knowledge and understanding.

The Wiley Finance series contains books written specifically for finance and investment professionals as well as sophisticated individual investors and their financial advisors. Book topics range from portfolio management to e-commerce, risk management, financial engineering, valuation and financial instrument analysis, as well as much more.

For a list of available titles, visit our Web site at www.WileyFinance.com.

Commodity Investing

Maximizing Returns through Fundamental Analysis

ADAM DUNSBY

JOHN ECKSTEIN

JESS GASPAR

SARAH MULHOLLAND

WILEY

John Wiley & Sons, Inc.

Published by John Wiley & Sons, Inc., Hoboken, New Jersey.

Published simultaneously in Canada.

Library of Congress Cataloging-in-Publication Data:

Commodity investing : maximizing returns through fundamental analysis /
Adam Dunsby . . . [et al.].
p. cm. – (Wiley finance series)
Includes bibliographical references and indexes.
ISBN 978-0-470-22310-9 (cloth)
1. Commodity futures. 2. Commodity exchanges. 3. Investment analysis.
I. Dunsby, Adam, 1967–
HG6046.C636 2008
332.63′28–dc22

2007041568

Printed in the United States of America

10 9 8 7 6 5 4 3 2 1

Contents

Acknowledgments

We thank Kumar Dandapani for reading and helping to prepare the manuscript, Henry Luk for helping to procure the Chinese rice data, Judy Ganes-Chase for reading and helping with the softs chapters, and Jeff Smith for reading the grain chapters.

PART

One

Basics

CHAPTER 1

Introduction

In 1980 Julian Simon and Paul Ehrlich bet $1,000 on the future price of five metals (chromium, copper, nickel, tin, and tungsten). Simon, who believed that human ingenuity would consistently improve the lot of humanity, bet that prices would fall in real terms, while Paul Ehrlich, who believed that a growing human population would increasingly strain the Earth's resources, bet that they would go up. The Simon–Ehrlich basket of metals was not the first commodity index (that title apparently belongs to the Economist Commodity Price Index), but their bet on the future change in price may have been the first derivative on a commodity index. The prices of all five metals declined in real terms, and Simon won the bet.

Today huge numbers of investors are taking similar bets, except they are betting not thousands of dollars but billions. Passive long-only indexing in commodities has grown from very little in 1991 to probably over $100 billion in 2007. Much of the inspiration (or sales pitch) behind the move to commodity investing is the same as Ehrlich's inspiration in taking the bet with Simon: a general belief that the world's growing population is increasingly straining the Earth's ability to supply commodities such as oil, grains, and metals. Inevitably China is mentioned. Demand is going up, supply is going down. What could be simpler? Or is it? After all, the world's population has been increasing for a long time yet, as we will show, when measured over the course of centuries, the price of commodities has gone down in real terms, not up.

When approaching commodities from an investment perspective extra care must be taken. The prima facie case for investing in commodities is weak. Put simply, commodities are produced to be consumed, and they do not naturally produce investment returns. Contrast commodities with the more standard investments of stocks and bonds. Stocks and bonds by design produce cash flows in the form of dividends, interest payments, or capitalized earnings. They are financial instruments, and the sole reason they exist is to provide investment returns. If they did not provide investment returns, no

one would own them. However, even if natural gas did not belong in one's 401(k), one would still buy it in order to heat one's home.

The purpose of this book is to provide those who would approach commodities from an investment perspective with information, tools, and modes of thinking that will inform their analyses. We do not take the position that commodities are going *Up! Up! Up!* nor do we take the position that they are going *Down! Down! Down!* Rather, we hope that upon completion readers will have a base of knowledge that will allow them to analyze specific commodity investments and strategies according to their individual characteristics and their own times. Undoubtedly, there will be opportunities to profit in the commodity markets for those who have the requisite skills. That being said, it is fair to say that the authors of this work are skeptical that the current rush to passive, long-only commodity investments will yield the intended results.

The selection of commodities as a major investment theme is relatively new. Of course, commodities have been around for a long time, but the notion that an investor or pension fund would allocate a substantial portion of an investment portfolio to plain old commodities such as coffee is recent. Because of this, the investment industry is still learning. There is a shortage of trained commodity analysts, and there is a shortage of good books on the subject of commodity investing. It is our goal to make this book an addition to the short shelf of good ones.

Many academics have written about commodity investing, and much of it is good and useful; on the whole, however, it is detached from the commodities themselves. Academics generally do two things when researching the commodity markets. The first is to look at the overall historical returns of a commodity portfolio and compare them with the returns of other assets such as equities. The second is to explore the shape of the futures curve with the obligatory discussion of Keynes's theory of normal backwardation. These two approaches are useful, and we will apply them to some extent in what follows, but notice that no mention was made of specific commodities. Whether the portfolio contains egg futures or oil futures is not considered interesting. The *academic approach* generally employs the same modes of analysis without regard to the specific commodities analyzed. There is no notion of how an industry is changing or what the long-term supply–demand dynamic is. One of the premises of this book is that investors should have a basic understanding of the individual commodities. If you are approached by a manager who wants you to invest in a North Pole coffee plantation, you should be able to do more than just recite the mantra that commodities have yielded equity-like returns during the past 30 years.

It is important to emphasize that this is a book on commodity *investing* and, for that reason, we will be constantly trying to bring everything back

to the theme of investing. There are many other economically interesting approaches to thinking about commodities. For instance, one might be curious how oil shocks affect the economy. This would fall under the category of the macroeconomics of commodities. One might be interested in the prices of commodities, such as coffee, because these prices affect the terms of trade in developing countries and therefore affect the prosperity of these countries. There are other perspectives, of course, many of which are interesting but none of which will be addressed here.

Another premise of this book is that investors need to understand the source of returns from commodity investments. Can commodities go *Up! Up! Up!* while investment returns go *Down! Down! Down!* Yes; they can and they have. The reason is that investment returns are composed of more than just the change in the price of the commodity. First, it must be pointed out that investors actually do not invest in physical commodities themselves but in commodity futures. Thus *commodity investing* is really short for *commodity futures investing* and *commodity index* is usually short for *commodity futures index* and so on. Since investors own futures, this puts a wedge between the change in price of the spot commodities and the change in price of the futures. This wedge is also a source of returns, and it can be positive or negative. The final source of return is the interest that investors receive for the cash and margin they put up to support their futures investments. Investors in passive, long-only indexes should understand how these different sources have affected returns historically and how they might affect them going forward. For example, commodities have earned positive returns during periods of high inflation, but these are periods when interest rates are also high, increasing the portion of return due to margin interest. Historically the distant oil futures have been priced lower than nearby oil futures, generating positive roll yield and contributing to the positive historical returns from investing in oil futures.

There are various approaches to investing in commodities. The most common, of course, is to invest in an index. But there are others. For example, one could buy commodity-based equities, invest with a trend-following commodity trading advisor (CTA), use judgment to assess the commodity environment and to make the appropriate decision, or construct a quantitative strategy that uses many pieces of information. It is desirable that investment strategies pass two tests: (1) that they make sense and (2) that they have worked historically. For passive indexing there is a debate as to whether condition 1 is satisfied. Certainly many people are convinced that it is. Condition 2 can be addressed more firmly, and we provide that analysis.

The conclusion one draws as to the historical performance of commodity indexing depends on the time period selected. Since 1500, the price of wheat has gone down substantially in real terms and not up all that much in

nominal terms. The commodity price index with the longest history is the Economist Commodity Price Index which dates to the mid-1800s. Since its introduction, it has also gone down in real terms and has been completely inferior to equities as an investment. The Economist Commodity Price Index also dropped in value when the U.S. stock market crashed in the late 1920s, something that should be kept in mind by those who consider commodities a hedge in their equity portfolio.

Most analyses of commodity market returns focus on recent years, say from the middle of the twentieth century onward. This is simply because there is more and better data available in recent decades. The New York Mercantile Exchange (NYMEX) crude oil future was not listed until 1983, for example. Thus, most of what we know or *know* about commodity returns is based on analyses from this time period. When looked at in this way commodity investments have done better. They have provided equity-like returns with little correlation to equities.

The authors of this book specialize in the construction of quantitative investment models and have included sections on it. We are quite forward in saying that we do not give away the shop, but we do not tease either. We provide some specific variables to consider, ones we use, and offer insight into methodologies that investors may find helpful. For example, when constructing a model it is always comforting to have an *anchor variable*, a factor to which the commodity of interest should be attracted. Examples might be the price of substitutes or the price of inputs.

The remainder of this book is laid out as follows: Chapters 2 and 3 assess the historical performance of commodities. Chapter 2 presents an analysis of commodity returns over the recent period of modern financial markets with its tremendous richness of futures contracts to use. The available data is more than ample for detailed statistical analysis. We can test how commodities have done compared with equities and bonds. We can explore how commodities performed during periods of inflation and recession. We can see how profitable buying commodities was relative to buying commodity-based equities. For example, would an investor have done better by buying oil futures or by buying shares in Exxon? Chapter 3 uses long-term histories of wheat and the Economist Commodity Price Index to construct long histories of commodity returns as measured by these series. This approach has the advantage of reaching far back into time, but the disadvantage of having only a small number of series to analyze.

The middle section of the book is devoted to the commodities themselves. It can be read through or referred to for the commodities of interest. It is here that the reader will come to understand the commodities, the state of their industries and, where we have something useful to say, the long-term outlook. For example, how much oil is out there? Are we running out soon?

Are we sliding down Hubbert's peak? Will it last forever? We collect the data from the primary sources and summarize it in a useful way. Along with the big-picture issues we present the nuts-and-bolts information that investors will need to understand, such as why the natural gas futures curve has a bumpy shape? There are chapters on energies, grains and oilseeds, the softs (coffee, sugar, and cocoa), and base metals. One category of commodity we do not cover is the precious metals. Precious metals are fundamentally different from other commodities in that they are not produced primarily to be consumed. They are more like currencies and stores of value. Consequently we have less to say about them. Readers interested in gold, for example, can refer to Peter Bernstein's excellent book *The Power of Gold*.

Chapter 20 is titled "Some Building Blocks of a Commodity Trading System," and in this chapter we begin to pull together and explain various components that may prove useful in either constructing an investment strategy or in evaluating a commodity-based investment strategy. Most of the chapter deals with the shape of the futures curve. Next to the price movement of commodities, the shape of the futures curve is the most important factor in determining the outcome of a buy-and-hold strategy. This chapter introduces the theories that are typically used to understand the shape of the futures curve. They include arbitrage, Keynes's theory of normal backwardation, and Hotelling's theory of the economics of exhaustible resources. None of these can provide the complete answer, but that is because there is no complete answer. Commodity markets differ, and there is no one-size-fits-all explanation. Taking the shape of the curve as a given, it is shown that the shape of the futures curve can substantially affect investment returns. Also presented in this chapter are trend-following strategies, anchor variables, and a simple trading strategy. The chapter concludes with a discussion of risk control. So that focus does not drift too far away from commodities the discussion is kept brief (fortunately, because this is a very tedious subject). We focus on two risk control methodologies that are commonly used: value-at-risk and maximum drawdown.

The final chapter deals with the boom in passive, long-only commodity indexes. The amount of money invested in these indexes has dramatically increased in recent years. The king of these indexes is the S&P GSCI Index (S&P GSCI). Originated in 1991, this index now has investments of around $60 billion linked to it. Many investors might be surprised to learn that there is much more to the return of these indexes than just the change in the price of commodities

To summarize some of the main themes and findings of this book, from the perspective of what makes a good investment, the case for owning commodities is not clear. Therefore investors must be both careful and thoughtful when evaluating commodity investments. Commodities have performed

well in recent years, but their long-term performance has not been so good, especially when compared with equities. There is information available to investors that can help them improve returns and avoid investments that are likely to have a poor return profile. Chief among these is the shape of the futures curve. Nobody knows definitively what commodity prices are going to do in the future, but if the futures curves are steeply contangoed (i.e., spot prices below futures prices) it is going to be difficult for passive, long-only indexes to yield attractive returns. In such an environment, an investor who desires exposure to commodities may want to explore other opportunities, such as investments in commodity-based equities.

CHAPTER 2

Commodity Futures as Investments

Are commodities good investments?[1] Investors have poured billions and billions of dollars into commodities believing the answer to this question to be "Yes!" Have commodity investments done well historically? Even when they are not good investments, perhaps commodities can offer insurance; doing well when inflation is high or when there is a stock market crash or some other wealth destroying event. Assuming one decides to invest in commodities, how does one actually do it? Should an investor buy a silo of grain, individual commodity futures, an investable index, or can an investor do better by buying stocks that offer exposure to the commodities of interest? These are the questions of interest in this chapter. We will address these issues primarily from a quantitative and historical perspective, relying heavily on analysis of historical data.

This chapter will consider commodity investments primarily from a passive, long-only standpoint. The interesting questions of whether commodity returns are forecastable and whether dynamic trading strategies can be constructed is left for a later chapter. The specific investment vehicles an investor may wish to consider, such as the S&P GSCI Index or a trend-following CTA, are also presented in a later chapter.

What makes something a good investment? The most basic consideration is whether it earns a positive return. If you put money in, do you expect to end up with more money than when you started? People who invest in stocks or bonds do so expecting to end up with more money than when they started. There are both practical and philosophical aspects to this question with regard to commodities. The first is whether, *a priori,* we should expect commodities to have positive returns. Not everything that exists is necessarily a good investment. Pet rocks, lottery tickets, and old newspapers are examples of things that provide a negative return, at least in expectation. Stocks and bonds are purely *financial* assets. That is, they exist solely to

provide a financial return to their owners. They generally produce positive cash flows over their lives. Commodities do not exist to provide investment returns; they are produced to be consumed (precious metals being the exception). Wheat is not grown to be held in perpetuity, but to be turned into bread; oil is not pumped from the ground to be kept as a store of wealth, but to be used to heat homes or to propel cars.

There are two basic arguments generally given as to why commodity prices should go up. The first basically goes: We're making more and more people who demand more and more stuff but we're not making any more planet Earth. Therefore increasing demand and decreasing supply should drive up the price of commodities. The second argument states that commodities are real things and therefore they should go up at least at the rate of inflation. They should not lose value simply because a sovereign currency, such as the U.S. dollar, does. These arguments may or may not be true. In regard to the first argument, supply may be increasing in some cases. Improved technology has increased grain yields immensely during the past 100 years. Oil reserve estimates are often raised, at least slowing the pace at which the world will run out of petroleum.[2]

Famously, in 1980 environmentalist Paul Ehrlich bet economist Julian Simon that the price of five metals (chromium, copper, nickel, tin, and tungsten) would increase in real terms over the coming decade. Ehrlich was a proponent of the first argument: An increasing population would begin to use up the Earth's resources at an increasing rate. What happened? All five metals declined in real terms and three declined in absolute terms (and Simon made $576). This happened even though the world's population increased by 800 million during that time period. Not surprisingly, since then no major investment bank has come forward with an investable index based on the prices of chromium, copper, nickel, tin, and tungsten.

The point is that commodities are not financial assets. They exist to be consumed, not to produce investment returns. They may increase in price, or they may not. The onus is on the commodities and the commodities-are-an-asset-class believers to establish the utility of commodities in an investment portfolio. A good place to start is the historical data.

Before we can turn to the data, however, there are a few issues that need to be addressed. The first is which commodities should be analyzed? We restrict ourselves to commodities for which there are futures contracts. This is quite a big leap, because while many commodities have listed futures, many do not. There are no apple futures, no carrot futures, and no used-car futures. This bifurcation also brings to the foreground the important distinction that investors in commodity markets invest almost always in commodity future contracts and not in the underlying commodity. This has important implications for returns that will be explored in Chapter 20, "Some Building Blocks of a Commodity Trading System."

Commodity futures are listed on exchanges all over the globe. There are tapioca chip futures listed in Thailand, greasy wool futures listed in Australia, West Texas Intermediate (WTI) crude futures listed in the United States, and many, many more. Some of these futures contracts trade very little or not at all. For example, future contracts on urea, a major component of human urine, are listed on the Chicago Mercantile Exchange (CME)—Bloomberg symbol TCA. In December 2006 the open interest was zero. (Urea is used in fertilizer.) Milk futures are also listed on the CME (Bloomberg symbol DAA). In December 2006, the open interest across all of the listed milk contracts was a few thousand, but any given day's volume was only a few hundred. By contrast, at the same time the corn future on the Chicago Board of Trade (CBOT) had an open interest of nearly 600,000 just in the front contract, and this single contract had a volume of about 30,000 a day.

Another issue is redundancy in contracts. For example, the United States and Canada have four wheat contracts between them. The New York Mercantile Exchange (NYMEX) and the Intercontinental Exchange (ICE)—formerly the International Petroleum Exchange (IPE)—both have very successful crude oil contracts. Similar stories can be told for other commodities. A more subtle issue is commodities that are downstream products of other commodities. For example, heating oil and gasoline are made from crude oil, and all three have contracts listed on the NYMEX. Their prices tend to move together. Similarly, soybean oil and soybean meal are made from soybeans. All three have future contracts listed on the CBOT, and their prices also typically move together.

The commodities we chose for analysis include those that (1) are the most liquid, (2) are nonredundant, (3) are primarily traded on U.S. exchanges, and (4) have high investor interest. The list is presented in Table 2.1. Of these, canola is the only one not denominated in U.S. dollars. It is traded on the Winnipeg Commodity Exchange and denominated in Canadian dollars.[a] The industrial metal contracts aluminum, nickel, and zinc are traded outside of the United States on the London Metals Exchange (LME) but are denominated in U.S. dollars. The copper contract chosen is the one that trades in the United States on the COMEX. The COMEX contract is less heavily traded than its London counterpart, but it has the advantage of being a future contract, as opposed to a forward contract and is thus easier to work with analytically. We have chosen to include for individual analysis the downstream products such as heating oil and bean oil with the justification that there is strong interest in these commodities in their own right.

Not on the list are commodities that are no longer traded. There used to be egg futures, potato futures, and chicken futures along with others. These

[a] It is converted to U.S. dollars in the following text.

TABLE 2.1 List of Commodities

Commodity	Start Date	Exchange
Crude Oil	5/31/83	NYMEX
Unleaded/RBOB Gasoline	2/28/85	NYMEX
Heating Oil	2/29/80	NYMEX
Natural Gas	5/31/90	NYMEX
Canola	4/30/90	WCE
Wheat	8/31/59	CBOT
Corn	8/31/59	CBOT
Soybeans	8/31/59	CBOT
Soybean Meal	8/31/59	CBOT
Soybean Oil	8/31/59	CBOT
Cotton	8/31/60	CSCE/NYBOT
Cocoa	9/30/59	CSCE
Coffee	5/31/75	CSCE
Sugar	2/28/62	CSCE
Lean Hogs	2/28/70	CME
Live Cattle	4/30/65	CME
Copper	8/31/59	COMEX
Gold	1/31/75	COMEX
Silver	2/28/67	COMEX
Aluminum	2/29/80	LME
Zinc	2/28/77	LME

contracts failed for various reasons. When studying returns, it is potentially a serious mistake to ignore the returns of instruments that used to exist but exist no longer. For example, if in a study of equity returns one ignored all of the companies that had gone bankrupt, the remaining return series would be an upward biased estimate of what investors would have actually earned. This is probably not a concern, or at least less of a concern, in commodities because commodity futures tend to get delisted not because the underlying commodity goes to zero but because there is no demand for a derivative on the underlying commodity. For example, there may be insufficient hedging interest or there may be a problem with the delivery mechanism. An early study by Bodie and Rosansky (1980) studied the returns of 23 commodity futures from 1950 to 1976. Of those 23, 5 are no longer listed (broilers, plywood, potatoes, wool, and eggs). Bodie and Rosansky report that four of those five had positive returns.

The futures data comes primarily from the Commodity Research Bureau (CRB). More recent data has been updated from the data set kept at the Cornerstone Quantitative Investment Group and that has been primarily

taken as reported by Bloomberg. In the more recent data we restrict the data to day sessions only. All data has been checked. The spot price data is also taken from the CRB with the exception of RBOB (gasoline) which is taken from the Department of Energy website. Additional information is presented in the data appendix to this chapter.

RETURNS

Computing investment returns from futures contracts is less straightforward than for other instruments. The reason is that futures are free. Unlike a stock or a bond, when a futures contract transaction takes place no money changes hands. The buyer and seller are agreeing to exchange the commodity at a time in the future at a price that is fixed now. (They are also agreeing to pay or receive money as the price changes day to day.) Margin must be posted, but this is generally small relative to the face value. For example, a WTI crude oil contract that trades on the NYMEX is for 1,000 barrels. If a barrel of oil costs $60.00, then the face value of one contract is $60,000. The initial margin that must be posted, however, is only $3,375 dollars, which is 5.6 percent of the contract value. So one could control 1,000 barrels of oil with only $3,375. This would be a highly levered position and a movement in the price of oil of $3.37 would wipe out the entire investment. Another way to approach the investment would be not to lever at all but to actually put up the $60,000. When this is done, the futures investment is said to be fully collateralized. The interest earned on the $60,000 is another source of investment return in addition to the change in price of the future contract. Putting up $60,000 is arbitrary, but people often find it intuitively appealing to have the cash investment equal to the face value of the futures contracts.

As an example, consider a cash investment in the S&P GSCI Index. Assuming XYZ Investment Bank was the manager, an investor would give XYZ, say, $1,000. XYZ would then buy the appropriate basket of futures contracts; they would post margin for the futures contracts, and they would invest the balance of the $1,000 in interest-bearing securities such as T-Bills. Most of the margin could also be posted as interest-bearing securities, so the investor would earn approximately the return on the futures position, plus interest on the $1,000, less any fees the investor might be charged.

In what follows we will compute returns as the percent change in the relevant future contract. We will fully collateralize (i.e., include T-Bill interest) or not, depending on the question at hand.

HAVE COMMODITY FUTURES EARNED POSITIVE RETURNS?

The answer to this question is "Yes." The results that show this are presented in Table 2.2. The returns in this table are presented with no interest included (i.e., they are not collateralized). This allows us to focus solely on the performance of commodities without mingling it with the performance of T-Bills. At this stage, we are interested in the simple issue of whether commodities by themselves tend to go up or not. Following Erb and Harvey (2006), we take the period since the introduction of the NYMEX crude oil contract as particularly important in the history of commodity

TABLE 2.2 Commodity Future Returns

Panel A: Full Sample: August 1959–March 2007

	Annualized Geometric Returns	Annualized Arithmetic Returns	Annualized Standard Deviation	Sharpe Ratio	t-Stat
Equal Weight Portfolio	*6.04%*	*7.00%*	*13.67%*	*0.51*	*3.54*
Crude Oil	9.26%	15.10%	32.95%	0.46	2.24
Gasoline	19.62%	28.98%	40.60%	0.71	3.36
Heating Oil	12.40%	19.09%	35.48%	0.54	2.80
Natural Gas	−6.73%	7.06%	53.46%	0.13	0.54
Canola	−2.01%	−0.43%	17.85%	−0.02	−0.10
Wheat	−4.55%	−2.10%	22.77%	−0.09	−0.64
Corn	−4.15%	−1.86%	22.26%	−0.08	−0.58
Soybeans	1.89%	5.12%	25.96%	0.20	1.36
Soybean Meal	5.27%	9.63%	30.15%	0.32	2.20
Soybean Oil	3.15%	7.40%	29.33%	0.25	1.74
Cotton	0.81%	3.18%	21.89%	0.15	0.99
Cocoa	−1.93%	2.70%	30.96%	0.09	0.60
Coffee	1.94%	9.56%	39.44%	0.24	1.37
Sugar	−6.84%	2.43%	45.10%	0.05	0.36
Lean Hogs	2.94%	6.79%	27.26%	0.25	1.52
Live Cattle	5.27%	6.94%	17.77%	0.39	2.53
Copper	9.01%	12.98%	27.17%	0.48	3.30
Gold	−2.18%	−0.41%	19.10%	−0.02	−0.12
Silver	−2.01%	2.86%	31.35%	0.09	0.58
Aluminum	0.16%	2.20%	20.39%	0.11	0.56
Zinc	4.82%	7.61%	23.16%	0.33	1.80
Nickel	10.27%	16.65%	35.90%	0.46	2.45

(*Continued*)

TABLE 2.2 (*Continued*)

Panel B: May 1983–March 2007					
	Annualized Geometric Returns	**Annualized Arithmetic Returns**	**Annualized Standard Deviation**	**Sharpe Ratio**	**t-Stat**
Equal Weight Portfolio	*4.80%*	*5.40%*	*10.64%*	*0.51*	*2.48*
Crude Oil	9.26%	15.10%	32.95%	0.46	2.24
Gasoline	19.62%	28.98%	40.60%	0.71	3.36
Heating Oil	13.62%	21.06%	37.18%	0.57	2.77
Natural Gas	−6.73%	7.06%	53.46%	0.13	0.54
Canola	−2.01%	−0.43%	17.85%	−0.02	−0.10
Wheat	−6.30%	−4.08%	21.70%	−0.19	−0.92
Corn	-6.16%	−3.68%	23.26%	−0.16	−0.77
Soybeans	−1.14%	1.26%	22.05%	0.06	0.28
Soybean Meal	2.57%	5.38%	23.53%	0.23	1.12
Soybean Oil	−1.35%	1.87%	25.79%	0.07	0.35
Cotton	−0.97%	1.63%	23.02%	0.07	0.35
Cocoa	−7.44%	−3.76%	28.38%	−0.13	−0.65
Coffee	−6.35%	0.43%	38.56%	0.01	0.05
Sugar	−5.41%	1.66%	39.42%	0.04	0.21
Lean Hogs	2.33%	5.61%	25.21%	0.22	1.09
Live Cattle	5.30%	6.39%	14.36%	0.44	2.18
Copper	9.08%	12.86%	26.94%	0.48	2.34
Gold	−3.16%	−2.26%	13.73%	−0.16	−0.80
Silver	−5.30%	−2.37%	24.71%	−0.10	−0.47
Aluminum	1.80%	3.87%	20.37%	0.19	0.93
Zinc	5.94%	8.64%	22.82%	0.38	1.85
Nickel	13.54%	20.69%	37.59%	0.55	2.69

Note: Returns are uncollateralized.

investing. The NYMEX WTI crude oil contract is arguably the most important commodity contract listed today, and it makes up a large part of the S&P GSCI Index, the most widely followed commodity index. In our sample, the first oil return is in May of 1983, so we divide the sample here. In addition to the 22 contracts examined individually, we create a simple portfolio in which all contracts that have returns for a given month are included with an equal weight.[b] As shown in Table 2.1, the earliest contracts in the sample are the CBOT grains, and the most recent is NYMEX natural gas.

[b] This implies monthly rebalancing.

Both annualized geometric and arithmetic returns are considered. Geometric returns represent compounded investor returns that encapsulate the overall return performance in a single number. Arithmetic returns are just the series of simple returns, but they are easier to analyze statistically given that a series is needed in order to compute something like a standard error. One very useful property of a geometric return is that if it is positive the investor made money.[c] Geometric returns are always less than (or equal to) arithmetic returns.

For the full sample, annualized geometric return is 6.04 percent and the annualized arithmetic return is 7.00 percent (again, no interest has been included). The returns are lower in the more recent subsample. Since May of 1983 the annual compounded return is 4.80 percent. As measured by t-statistics these returns are statistically significant, with a t-statistic of 3.54 on the equally weighted portfolio for the whole period and a t-statistic of 2.48 for the more recent period. The Sharpe ratios over the two periods are both roughly 0.5. The smaller return since May of 1983 was matched by a fall in volatility.

These returns also beat inflation, as measured by the consumer price index (CPI). This is presented in Table 2.3. For the full sample the compounded real return was 1.87 percent. The real return was also positive in each of the subperiods. It was 2.04 percent prior to May 1983 and 1.71 percent since then. Thus returns are also lower in real terms in the more recent period.

TABLE 2.3 Real Commodity Future Returns

Date Range	Equal Weight Portfolio	CPI	Real Return
Panel A Monthly Real Returns (Arithmetic Returns)			
8/31/59–3/31/07	0.57%	0.34%	0.22%
8/31/59–4/30/83	0.69%	0.43%	0.26%
5/31/83–3/31/07	0.44%	0.26%	0.18%
Panel B Annualized Geometric Returns (Geometric Returns)			
8/31/59–3/31/07	6.04%	4.18%	1.87%
8/31/59–4/30/83	7.31%	5.27%	2.04%
5/31/83–3/31/07	4.80%	3.09%	1.71%

[c] Unfortunately, this is not necessarily true of arithmetic returns. If an investment goes up 75%, up 75%, and then down 100%, the arithmetic return would be (75% + 75% – 100%)/3 = 17%, but the investor would have lost all of his money.

Turning to the individual compounded commodity returns, over the entire period 14 of the 22 commodities had positive returns. From May 1983 onward, 10 of the 22 had positive returns. Not all contracts existed prior to May 1983 and some that did had short histories, so we do not report separate results for that period. Over the full period, grains (with the exception of the soy complex) and precious metals are negative. The other contracts with negative returns are natural gas, cocoa, and sugar. In the more recent period the same commodities yield negative returns along with soybeans, soymeal, cotton, and coffee. The best performing commodity future was unleaded gasoline, which earned a compounded annual return of 19.62 percent since it entered the sample in February 1985. The other two petroleum commodities, crude oil and heating oil, also produced positive returns.

It is interesting to compare the returns earned from commodity futures to the percent change in price of the spot commodities. This will bring into relief any differences there may be between the change in physical commodity prices and the change in commodity future prices. As a reminder, investors' exposure to the commodity markets is by way of commodity futures, not the physical commodity. This disconnect is potentially important inasmuch as the shape of the futures curve can have significant implications for returns. This effect of the future curve on returns is developed in detail in Chapter 20, "Some Building Blocks of a Commodity Trading System." However, to introduce some of the concepts now: The spot price is the price of a commodity now, the future price is the price at which a commodity will be exchanged at a fixed date in the future. If the spot price is above the future price the market is said to be backwardated. If the spot price is below the future price the market is said to be in a state of contango (or a normal market for grains). In a backwardated market, a long position in the future can earn a positive return even if the spot price does not change, because the future price will creep up the curve as it converges upward to the spot price. The reverse is true in a contangoed market.

The commodity spot price data is taken primarily from the CRB. More information is given in the data appendix to this chapter. Displayed in Table 2.4 are the futures returns, as previously discussed, showing the monthly arithmetic percent change in the spot price and the difference between the two. For each commodity the spot price and the future price are aligned to cover the period over which both exist, so some of the future returns may differ from what was presented previously. As before, an equally weighted portfolio is created consisting of the commodities that had returns for a given month. Results are presented for the entire sample, which begins as early as August 1959 for the CBOT grain contracts.

On average, commodity spot *returns* are higher than commodity future returns. The annual compounded *return* for the physical commodity portfolio is 7.77 percent compared with 5.53 percent for the portfolio of futures, a

TABLE 2.4 Comparison of Spot Change with Future Returns (Annualized Geometric Returns)

Commodity	Future Return [A]	Spot Return [B]	Future – Spot [A] – [B]
WTI Crude	9.26%	3.23%	6.03%
Unleaded Gas/RBOB	19.62%	4.12%	15.50%
Heating Oil	12.40%	3.40%	8.99%
Natural Gas	−0.47%	12.90%	−13.36%
Canola	−2.01%	0.79%	−2.79%
Wheat	−4.55%	1.57%	−6.12%
Corn	−4.15%	2.21%	−6.36%
Soybeans	1.89%	2.50%	−0.61%
Soybean Meal	5.27%	2.66%	2.61%
Soybean Oil	3.15%	2.56%	0.60%
Cotton	−0.21%	1.04%	−1.25%
Cocoa	−1.93%	2.06%	−3.99%
Coffee	1.94%	1.74%	0.21%
Sugar	−6.84%	3.38%	−10.22%
Live Cattle	5.27%	3.05%	2.22%
Lean Hogs	2.94%	2.00%	0.94%
Gold	−2.18%	4.01%	−6.19%
Silver	−2.01%	6.03%	−8.04%
Copper	5.13%	5.21%	−0.08%
Aluminum	1.46%	2.41%	−0.95%
Zinc	6.97%	7.10%	−0.13%
Nickel	18.17%	13.46%	4.71%
Equal Weight Portfolio	**5.53%**	**7.77%**	**−2.24%**

Notes: Futures and spot prices are aligned over same time period for each commodity, so future returns may differ from previous tables if the cash has a shorter time period. The period spans August 1959 through March 2007.

difference of −2.24 percent. This suggests that, overall, the positive returns of commodity futures are not due to curve effects. If anything, the curve effects lowered the return of the commodity future portfolio.

Examining the individual commodities, in 8 cases the future outperformed the spot, and in 14 cases the spot outperformed the future. As a group, petroleum-based futures all outperformed spot prices. This is because these markets have typically been backwardated (the spot price above the future contract price). In the majority of the remaining markets, the spot price outperformed the future. This is consistent with the standard theory that the owner of a future must *pay* the carrying costs. These theories are discussed more fully in Chapter 20, "Some Building Blocks of a Commodity Trading System."