A Long-Term Perspective on Commodity Futures Returns

A Review of the Historical Literature (I)
Term Structure as the Primary Driver of Returns (II)

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A Review of the Historical Literature (I)

Broadly speaking, there are seven strands of literature on commodity pricing theory, which we summarize as follows:

• The insurance role of commodity futures contracts, which emphasizes the role of the speculator;
• The theory of storage, which emphasizes the behavior of the inventory holder and commercial hedger;
• The net-hedging-pressure hypothesis, which encompasses the behavior of both classes of participants;
• The statistical behavior of commodity futures prices;
• The attempt to reconcile commodity futures returns with the CAPM;
• The role of commodities in a strategic asset allocation; and
• The importance of yields as a long-term driver of commodity returns.

We cover each strand of thought below.

1. Insurance Role of Commodity Futures Contracts

1.1 Keynes

The earliest literature on the subject always starts with Keynes. This polymath created a massive legacy of economic, financial, and political thought. He is now even being seen as the father of the global macro hedge fund style of investing; if that characterization is too strong, then he is at least thought to be the grandfather of this investment style, as shown by the renewed interest in Keynes exhibited in Drobny (2006) and Biggs (2006).

Keynes's writings on commodity futures trading still ring true to present-day commodity speculators, which is why he continues to be quoted, even though there have been tremendous advances in commodity futures pricing theory since his original writings. The following is but one example of his writing flair: "the violence of the fluctuations which normally affect the prices of many individual commodities shows what a great risk the short-period speculator in commodities runs, for which he requires to be remunerated on a corresponding scale" (1930). Keynes states that the inspiration for this statement is from a 1927 National Bureau of Economic Research book on the behavior of prices, but an alternative explanation can be found in Drobny (2006): "during the commodity slump of 1929, [Keynes's] ... personal account was completely wiped out by a margin call." That said, Drobny's account continues with a description of Keynes's later investment activities, which were largely successful.

Later writings that cite Keynes sometimes state his "normal backwardation" commodity hypothesis as one where (a) the spot price of a commodity normally exceeds its future price; and at other times, his hypothesis is stated as one where (b) the expected future spot price exceeds the current futures price.

Which characterization is correct? It turns out they both are. Keynes included both hypotheses in his writings.

One can state hypothesis (a) as $S > F$, where $S$ is the spot price of a commodity, and $F$ is the commodity's future price. Similarly, one can state hypothesis (b) as $\mathbb{E}[S] > F$, where $\mathbb{E}[.]$ is the expectation operator.

Briefly, an accurate characterization of Keynes' normal backwardation hypothesis is:
(a) If there are either inadequate or adequate inventories, then $S > F$;
(b) Otherwise, if there is an excess of inventories, then $S < F < \mathbb{E}[S]$. 

In each case, the producer will tolerate selling futures contracts at a discount to the spot price (or the expected future spot price) in order to lay off unpredictable price risk to speculators.

We will return to Keynes' hypotheses later in this paper.

1.2 Hicks

In 1939, the eminent economist, Hicks, further developed the hypothesis that commodity futures prices tend to be downwardly biased estimates of future spot prices. This is the Keynesian hypothesis (b), described above. Today, Hicks is more widely known for his “liquidity premium” hypothesis for bonds than for his writings on commodities.

A key element of Keynes's hypothesis is that it is producers who desire to use the futures markets to hedge unpredictable, volatile spot price risk. But what about consumers? Wouldn't they be long hedgers? If one has both long hedgers and short hedgers, why should the futures price be downwardly biased? These questions were answered in Hicks (1939). Briefly, Hicks's idea is that producers are in a more vulnerable position than consumers so will be under more pressure to hedge than consumers. This leads to a "congenital weakness" on the demand side of commodity futures markets, which is made up by speculators, who in turn require a risk premium for their services.

Hicks's contribution to fleshing out Keynes's hypothesis is sufficiently great that the insurance role of futures contracts is sometimes referred to as the Keynes-Hicks hypothesis. Because of their emphasis on the role of speculators, one could also refer to their hypothesis as “the supply of speculative services” hypothesis, drawing from Cootner (1967). The next strand of thought that we will cover instead emphasizes the role of hedgers, and is referred to as the “theory of storage.” Both of these theories will be partially reconciled in a later section on “net hedging pressure.”

But before moving on to the theory of storage, some clarification in concepts and terminology is necessary in order to avoid confusion as we proceed further into this article.

Regarding concepts, one should note that later writers extend Keynes' and Hicks's characterization of hedgers to include not only producers, but all commodity inventory holders, especially processors and merchants, as in Working (1948).

Regarding terminology, we should provide several definitions for the benefit of readers who are unfamiliar with commodity markets. In what follows, we will adopt the definition of backwardation that is in line with current market convention. When a commodity's immediately deliverable futures contract is at a premium to the next deferred delivery contract, we will refer to the commodity as being in backwardation. We will also refer to a commodity's immediately deliverable contract as the nearby contract, and the next deferred delivery contract as the second nearby. When the nearby contract is at a discount to the second nearby contract, we will refer to the commodity as being in contango. We also refer to the relationship between a commodity market’s nearby futures contract and its second nearby as its "term structure," in line with the conventions in the fixed-income markets. We will also be using the phrase, "futures curve shape." Futures traders frequently refer to the term structure of a futures contract as a curve: the futures prices for each maturity are on the y-axis while the maturity of each contract is plotted on the x-axis, which thereby traces out a “futures price curve.”

2. Theory of Storage

While Keynes and Hicks were the pioneers in the supply-of-speculative-services hypothesis, the pioneers in the development of the supply-of-storage theory were Kaldor, Working, Brennan, and Telser. Their contributions to the development of this theory are briefly discussed below, along with recent enhancements to this theory.
This school of thought emphasizes the behaviors and motivations of commercial-market participants. One could argue that because this theory does not emphasize the speculative role in the futures markets, the literature on commodity investing had not stressed this branch of commodity pricing theory until very recently.

2.1 Kaldor
A description of the theory of storage usually starts with Kaldor (1939). This economist reasoned that there are actually two types of yields for a commodity inventory holder. One is the cost of financing and storing inventories (or stocks); and the other is the benefit of being able to use the inventories the moment that they are commercially needed. The latter benefit became known as the "convenience yield" and is now a mainstay of commodity pricing theory.

Kaldor’s paper specifically included the following equation:

\[ F - S = \text{storage costs} + \text{interest costs} - \text{convenience benefit}; \text{ and therefore,} \]
\[ \text{Convenience benefit} = \text{storage costs} + \text{interest costs} + S - F. \]

Derivatives textbooks now present Kaldor’s famous equation using continuously compounded yields and rates, as is the present requirement in derivatives pricing theory and practice. See, for example, Hull (1989) and Geman (2005).

Also, sometimes the term, “convenience yield,” refers to the “convenience benefit” defined above; and sometimes the term is used to refer to a true yield: the convenience benefit divided by the spot price of the commodity.

Like Keynes’s original assertions, not all of the ideas in Kaldor (1939) have been directly accepted. Over the years, Keynes has remained relevant because his ideas have been continuously reinterpreted, for example, in Cootner (1960, 1967), Walton (1991), and in Gorton and Rouwenhorst (2006). Similarly with Kaldor. Kaldor’s ideas were successively reinterpreted in Working (1948, 1949), Brennan (1958), and Telser (1958, 1960), as well as by later authors, as witnessed in recent Journal of Futures Markets articles.

The following is one example of an idea in Kaldor (1939) that has not been emphasized in later work. Kaldor (1939) caveated his famous equation as not holding when hedgers are forward buyers. This caveat has thus far not been emphasized in commodity or derivatives textbooks, except for the special case of precious-metals futures contracts. We would predict that this caveat will now appear with more frequency, given the emergence of a new class of large-scale forward buyers: commodity investors.

2.2 Working
While Kaldor’s contribution was purely theoretical, Working’s contribution to the development of the theory of storage was painstaking (and immensely valuable) empirical research. Working’s early work was entirely concentrated in the wheat physical and futures markets. His goal was to “relate theory to the observable facts” (Working, 1948).

One of his challenges was to explain why any commercial entity would hold inventories when there were times that the returns from doing so appeared to be negative. This would occur when the wheat futures market was backwardated; in other words, when the spot price (S) of wheat was above the futures price (F). When the wheat market was backwardated, an inventory holder would be carrying his wheat stocks at S, and then sell them forward at F for what would seem to be a loss of S−F. Why would anyone want to do that?
Before continuing, we need to make another clarification in terminology. In agricultural futures markets, a market that has a backwardated futures curve is more frequently referred to as an inverse-carry market. Conversely, a market that has a futures curve that is in contango is more frequently referred to as a carry market. In the latter case, the futures market is providing a return for carrying inventories forward because the futures price is trading at a premium to the spot price.

In Working's 1948 article, "Theory of the Inverse Carrying Charge in Futures Markets," the researcher evaluates wheat prices since 1884. Working defines a carrying charge as the “difference at a given time between prices of a commodity for two different dates of delivery.” This is what we had previously referred to as the term structure of a futures contract.

By examining futures spreads versus prevailing inventories, Working found that "carrying charges behave like prices of storage as regards their relation to the quantity of stocks held in storage." Figure 1 reproduces his stylized chart.¹

**Figure 1**

![Typical Storage Supply Curve](image)

Source: Working (1948)

This basic relationship has been verified across commodities and across time by numerous authors. For example, we provide an updated chart of this relationship for the soybean futures market in Feldman and Till (2006).

Working emphasized that a commodity's futures market should not be considered distinct from its cash market; that the relation, S-F, should be considered an entity: the "market-determined price of storage." He regarded the Keynesian view of futures prices having a downward bias, due to commercial hedging pressure, as having some validity, but that this explanation had been overemphasized in explaining futures price relations.

Based on the statistical relationship between inventories and carrying charges, Working concluded (a) that inverse carrying charges are a reliable indicator of scarcity; and (b) that during times of scarcity, Kaldor's convenience yield becomes sufficiently large as to overwhelm the stocks' storage and financing costs, leading to a negative price of storage. In the latter case, the convenience yield could arise from merchandising profits, as noted in the following example: a merchant "must carry stocks beyond known immediate needs and take his return in general customer satisfaction." If the merchant did not carry sufficient inventories, he could jeopardize his relationships with customers in the event of a stock-out.

¹ - Gunzberg and Kaplan (2007) also provide a stylized version of this graph.
Later authors continued to flesh out the convenience-yield concept by emphasizing that in the case of commodities used in production processes, it is unacceptable to shut down a factory due to insufficient inventories. The convenience yield in this case arises from the value of keeping production processes going. In this case, there would again be a negative price of storage since the market provides an incentive to bring forward stocks for consumption, rather than to be left in storage.

In Working (1953), the author again returned to the theme that risk-avoidance as a motivation for hedgers is overemphasized. Instead, commercial hedging activity should be viewed as an essential aspect of merchandizing and processing operations, which are unambiguously risk-taking in nature. Working provides a concrete example of the behavior of a wheat merchant who is an expert on the spot-versus-futures-price relationship, which is also known as "the basis." Based on sufficiently predictable changes in the basis, the wheat merchant may buy spot wheat and sell wheat futures. Again, the merchant's motivation is not exactly to reduce risk by hedging; he is in fact speculating on the basis, as further explained in Cootner (1967). Working (1953) also describes the operation of a flour miller who sells flour forward and buys wheat futures, when this processing margin is favorable.

In summary, commercial hedging activity is more realistically described as either (a) speculating on the basis; or (b) locking in processing margins. This more realistic view of hedging, though, does not negate the Keynes-Hicks hypothesis, as will be discussed later in the "Net Hedging Pressure" section of this article.

2.3 Brennan and Telser

Building off of Kaldor's insights and Working's empirical work, Brennan and Telser both developed theoretical models for the commercial supply-of-commodity-storage in 1958.

In Brennan (1958), the author reasons that the marginal cost of commodity storage, \( c \), is equal to [i] \( o \), the marginal outlay on physical storage plus [ii] \( r \), a marginal risk-aversion factor minus [iii] \( y \), the marginal convenience yield of stocks. The outlay on physical storage includes storage space, insurance, and interest. This outlay can be expected to be reasonably constant until storage facilities reach full capacity, and then would increase as more costly secondary and tertiary storage is exhausted.

Note that Brennan had also added a risk-aversion factor to his model. From the standpoint of inventory holders, this factor would be expected to increase as inventories increase. This is because of the greater likelihood of loss due to the greater investment necessary to carry the stocks. This factor may seem confusing in light of the existence of futures contracts, which would presumably hedge this risk. But Brennan's article includes commodities that did not have futures contracts, in addition to ones that had contracts, so this factor does make sense in that light.

Brennan also broadened the convenience-yield concept. In addition to prior explanations of the convenience yield, he added that the "convenience yield is [also] attributed to the advantage [by producers] ... of being able to take advantage of a rise in demand and price without resorting to a revision in the production schedule. ... [Also,] a wholesaler can vary his sales in response to an increased flow of orders only if he has sufficient stocks on hand." As before, the convenience yield would be expected to increase as stocks decrease.

Significantly, Brennan applied his model to actual data. This contrasts with the previous work by Keynes, Hicks, and Kaldor, which, while path-breaking, did not include empirical confirmation.

Brennan treated the cost of storage as \( E[S] - S \) for commodities that did not have futures contracts; and as \( F - S \) for commodities that did have contracts. He estimated \( E[S] \) based off of the recent
trend in spot prices along with an adjustment for the commodity's typical seasonal price pattern plus a further adjustment factor for past prediction errors. For commodities that did have futures contracts, he treated $E[S]$ as being equal to $F$.

In theory, then:
\[ c = E[S] - S = o + r - y; \text{ and therefore,} \]
\[ E[S] - S - o = r - y. \]

Brennan referred to the quantity, $E[S] - S$, as a price spread; and we shall refer to the quantity, $E[S] - S - o$, as the outlay-adjusted price spread. Previously, we had defined the "convenience yield" as a true yield with the "convenience benefit" being divided by the spot price of the commodity. Here, we stick with Brennan's convention of expressing this factor as an absolute quantity (and not dividing this factor by the spot price).

Brennan specifically examined the relationship between the outlay-adjusted-price-spread and month-end inventories for five agricultural commodities, three of which did not have functioning futures markets. This contrasts with Working's papers up to that point, which focused solely on the wheat markets. Brennan's study covers the period, 1924 to 1938, for three commodities (eggs, butter, and cheese); and covers the period, 1924 to 1932, for two commodities (wheat and oats). For the latter commodities, Brennan omitted the later dates because of the "influence of government price-support and storage programs." Taking into consideration government programs continues to be a factor in most current studies on agricultural futures markets.

For each of the five commodities, the plot of the outlay-adjusted-price-spread variable versus inventories had the familiar shape of Working's price-of-storage graph that was previously shown in figure 1. At low inventories, the outlay-adjusted-price-spread was negative, which is consistent with the presence of positive convenience yields. In summary, Brennan's study provided more evidence of the general applicability of the supply-of-storage theory beyond Working's wheat markets.

Telser (1958) also studied the relationship of futures price spreads to inventories. His study included wheat and cotton and covered the period from 1926 to 1954. Like Brennan, Telser also found evidence of Working's familiar curvilinear pattern in his empirical study, which provided further confirmation of convenience yields at low inventory levels.

Telser also noted that the seasonal pattern in inventories determined the level of spreads (and therefore convenience yields) across futures contract maturities. As later authors (including us) confirmed, this is especially true of grain futures contracts where the patterns of stock building and decline follow the harvest schedule. Accordingly, convenience yields (and futures curve backwardation) tend to be the highest before harvests when stocks are at their low. This is also discussed, for example, in Sorensen (2002) and in Feldman and Till (2006).

In evaluating the relationship between convenience yield and inventories, Telser added that one should not be examining quantities of stocks per se, but instead should be evaluating inventories in terms of the amount of present consumption. In other words, instead of examining inventories in terms of physical quantities, one should evaluate them in time units. For example, if there are 100 units of a commodity in inventory, and the expected consumption is 50 units per month, then we would say that current inventories are equal to two months of forward supply. This enhancement has been used in later convenience-yield-related studies.

2.4 Recent Developments
The recent literature on the theory of storage and the motivations of producers has proceeded in two directions: (1) the theory of storage has been extended to non-agricultural futures markets;
and (2) option theory has been employed to explain futures spreads. We summarize some of the newer developments below.

**Extension to Other Markets**
Milonas and Henker (2001) confirmed that the theory of storage applies to the oil markets. Using price data from 1991 through 1996, the authors examined the WTI and Brent cash and futures markets. They found that “convenience yield is a negative function of stocks,” as predicted by the theory.

Heaney (2006) analyzed the London Metals Exchange (LME) copper, lead, and zinc markets over the period from 1964 to 2003. His analysis supported “the existence of convenience yields that are a decreasing, non-linear function of stocks.”

**Application of Option Theory**

**Futures Spreads Related to Volatility**
Litzenberger and Rabinowitz (1995) modeled oil reserves as a “call option whose exercise price corresponds to the extraction cost.” As uncertainty about the future price of oil increases, the (call option) value of reserves increases, motivating producers to leave oil in the ground. Therefore, as volatility increases, the spot price of oil needs to exceed its forward value oil by a sufficient margin in order to make it worthwhile for producers to extract oil in the near term rather than leave reserves in the ground. Amongst the empirical results supporting their model, the authors find that backwardation in the oil futures markets had been significantly related to implied volatility, calculated from at-the-money oil options, over the period from 1984 to 1992.

**Convenience Yields as Options**
Milonas and Thomadakis (1997) modeled convenience yields for four commodities as call options on stock-outs. In this framework, producers or merchandisers are willing to sell futures contracts at a discount to spot prices since they hold an option to sell their inventories at high prices if spot shortages develop in their commodity. The value of this option should increase as inventories decrease. The authors found empirical support for their model in the corn, soybeans, wheat, and copper markets over the period from 1966 to 1995.

Milonas and Thomadakis also found that “the probability and magnitude of a stock-out, the primary factor which gives rise to convenience yields, increase as the crop cycle advances [for corn, soybeans, and wheat].”

Zulauf et al. (2006) examine the soybean futures market, and model convenience yields as a “call option to sell stocks [during a rally] before the end of the storage period.”

The authors’ study covers the period from 1988 to 2004. The authors chose the soybean futures contract for their study because it is the only major U.S. crop that never had an acreage control program. The authors’ dataset does not start until 1988 because the 1986/1987 season was the last time public stocks of soybeans existed, and government-owned stocks can displace privately held ones.

Zulauf et al. found a highly significant relationship between their call option values and storage-cost-adjusted-futures-spreads. But they also note that their call option values did not entirely explain the value of futures spreads. This means that additional variables are needed to explain futures spreads in soybeans.

The authors also found a quadratic relationship between the stocks-to-use ratio (inventories divided by consumption) and implied volatility. The direct relationship between scarcity (low stocks to use) and implied volatility is widely understood. But the empirical result of implied volatility increasing
past certain thresholds values of the stock-to-use ratio is not as theoretically well developed, except if the threshold values indicate that storage is at capacity for the commodity. This empirical result recalls Brennan’s assertion that the marginal cost of storage, as reflected in futures price spreads, should incorporate a risk-aversion factor, past certain thresholds of inventories.

3. Net Hedging Pressure

3.1 Cootner

The first section of this historical review emphasized the role of speculators in futures markets, and the second section emphasized the role of commercial participants.

Is the supply-of-speculative-services hypothesis reconcilable with the supply-of-storage theory? The short answer is yes, and was provided in Cootner (1960, 1967). Cootner is more widely known for his contributions on the random-walk theory of stock prices. He was also one of Helmut Weymar’s PhD thesis advisers. Weymar, in turn, is now acknowledged as the father of the commodity stream of the global macro hedge fund style, according to Drobny (2006).

Telser (1958) had cast doubt on the Keynesian hypothesis of futures prices being downwardly biased because a trend in futures prices was not apparent in his specific dataset, using certain statistical methods.

In a 1960 article, “Returns to Speculators: Telser Versus Keynes,” Cootner explained how the Keynesian hypothesis could be usefully reinterpreted. First, Cootner noted that hedgers can be long as well as short. Second, for agricultural commodities, there are only certain times of the year when short hedging is done on a large scale, and that is at harvest time. It is at that point that commercials would be hedging stocks, which would correspondingly depress the commodity’s futures price. It is also at this point that hedgers would need speculators to take on long positions in the commodity’s futures markets. As crops are consumed, then commercials would lift their hedges, and prices would rise, which would thereby reward the speculators. Using wheat futures data from 1921 to 1951, Cootner found the trend in wheat futures prices was consistent with this story. (One caveat is that Cootner actually used only a subset of this data. He included only those years in which the Wholesale Price Index was stable, so that any trends would not be due to general inflation.)

Cootner also used a measure of wheat inventories as a proxy for the amount of hedging that would need to occur in the futures markets as commercials hedged their stocks. Cootner’s data showed that the peaks and troughs in speculative positions generally mirrored the peaks and troughs in wheat stocks. And he found that prices generally rose after the peak in inventories (i.e., the peak in harvesting); and declined in the pre-harvest period.

In summary, Cootner’s hypothesis was that speculators (can) earn a return for their services, but only by being long at the peak of short hedging pressure; and by being short at the peak of long commercial hedging pressure. In the case of wheat futures contracts, the amount and direction of hedging pressure varies seasonally.

In a reply to Cootner’s article, Telser (1960) questioned Cootner’s use of a measure of inventories to proxy net hedging commitments. Telser’s own analysis showed that the correlation between the two was far from close. He also found that trends in the prices of two commodities (corn and cotton) were only slightly inversely correlated with the trends in each commodity’s net hedging commitments, which thereby provided scant support for Cootner’s hypothesis.

Ultimately, the question of whether the net-hedging-pressure hypothesis is correct or not is an empirical question. Based on studies from the past 40 years, it appears that Cootner was in fact correct. The following section draws mainly from Till and Eagleeye (2006) in discussing some
recent studies. But first we should resolve how the net-hedging-pressure hypothesis can be reconciled with the theory of storage, especially considering Working’s studies. If there is a convenience yield from holding hedged inventories, then inventory holders, whether they are producers, merchants, or merchandisers, should be tolerant of paying a premium (or “giving up some edge”) to speculators for taking on their futures hedges. This would also mean that the demand (and profits) for speculative services would be most insistent when commercials have inventories to hedge, which may not be year-round.

Cootner (1967) explained this concept in another way. "Hedging, unlike arbitrage, is not riskless. What it accomplishes is not the elimination of risk, but its specialization: its decomposition into its components. ... we would expect merchants with a presumed comparative advantage in basis speculation (i.e., in predicting demand for stocks), to specialize in that field and to buy from others the specialty of speculation on absolute price."

Cootner (1967) further explained why commercials would not take advantage of predictable changes in futures prices that are keyed off peaks and troughs of inventories: “For hedgers to profit from the bias requires that they be long when they already hold maximum inventories and short when they have minimum inventories.”

Cootner (1967) summarizes the results of studies that both he and others carried out, which use data that goes as far back as 1921 and as recently as through 1966, to support the net-hedging-pressure hypothesis.

Cootner's (historically) profitable strategies were keyed off the following factors: (1) peaks and troughs in visible grain supplies, (2) peaks and troughs in hedging positions from data provided by the Commodity Exchange Authority, a predecessor organization to the Commodity Futures Trading Commission (CFTC), and (3) fixed calendar dates that line up on average with factors (1) and/or (2). In Till and Eagleeye (2004), we discuss how one of Cootner’s calendar spreads has continued to work almost 40 years after his study was published.

Before continuing, an additional clarification in terminology is in order. A calendar spread consists of taking offsetting positions during the different delivery months of a particular futures contract.

In reading the debate between Cootner and Telser, one realizes that, in their time, it was in question whether there was or should be a return to speculators. There was a prevailing notion that speculators participated because of their love of gambling (or “the love of the game”). So one aspect of empirically verifying the net-hedging-pressure school of thought is to check whether, in general, speculators are profitable, and correspondingly, whether hedgers are not. (Again, saying that hedgers lose money does not mean that they are losing money once one takes into consideration their wider business operations, as exhaustively argued by Working.)

3.2 Recent Empirical Work

Maddala and Yoo (1990) examined both futures prices and Commitment of Trader (COT) data from 1976 to 1984. The COT data is provided by the CFTC and classifies futures open interest, according to commitments made by hedgers and commitments made by speculators. The futures markets that they studied included wheat, corn, oats, soybeans, soybean oil, and soybean meal (as well as some financial futures markets.) The researchers calculated the monthly rate of return to both larger hedgers and large speculators as a whole. They found that "large hedgers consistently lose money on ... average ... [while] large speculators consistently make money on ... average."
While Maddala and Yoo framed their study in terms of whether speculators as a group are profitable, later researchers examined whether net hedging pressure caused discernible trends in futures prices. As will be discussed, these studies have thus far confirmed Cootner's original 1960 hypothesis.

To be clear, we should formally define "net hedging pressure." Using COT data, “Net hedging pressure is defined as the number of short hedge positions minus the long positions divided by total hedge positions,” as explained by Dincerler et al. (2005).

Bessembinder (1992) looked into the question of whether futures returns depend on the sign of net hedging pressure, as calculated from COT data. His study covered the period from 1967 (or the origination of a particular contract's futures trading) to 1989, and included 22 futures contracts. His study included financial, foreign currency, agricultural, and metals futures contracts.

Bessembinder concluded that "substantial evidence indicates that the mean returns of nonfinancial futures differ from zero when conditioned on the sign of net hedging." The evidence was strongest for agricultural and currency futures contracts. To restate Bessembinder's findings, if one's decision rule for futures trading is to be on the opposite side of how commercial hedgers are positioned, this decision rule generally yields profitable trades.

De Roon et al. (2000) confirmed Bessembinder's results on a dataset that includes 20 financial and commodity futures contracts over the period from 1986 to 1994. Interestingly they also found evidence of cross-hedging pressure: hedging pressure on one commodity has historically affected price returns on related commodities. Obviously, commodity investors and speculators would want to know if the predictability due to net hedging pressure might be exploitable.

Helpfully, De Roon et al. (2004) examined trading strategies that were keyed off of net hedging demand. The authors find that the strategies were only exploitable through futures calendar spreads rather than through outright futures contracts. Their study included 23 financial and commodity futures contracts over the period from 1986 to 2000.

Again, to be clear, in the terminology of a trader, an individual futures contract is known as an “outright futures contract,” in order to distinguish between holding an individual futures contract from holding a spread position of two offsetting contracts.

That the statistically detectable net-hedge-pressure effect can be taken advantage of only through spreads is a key result of the De Roon et al. (2004) article. If the net-hedge-pressure effect exists, but is slight compared to other market factors, then an investor would need to isolate the effect through spreads, and thereby hedge out the first-order risk of this strategy. Perhaps Cootner's hypothesis on the net-hedging-pressure effect also needs to be reinterpreted or restated: speculators do (and can) provide outright risk protection to commercial hedgers, but then the speculators have to hedge their own futures positions with related futures contracts, creating a basis (or hedged) position that, in turn, is reasonably (stable and) predictable.

Dincerler et al. (2005) examined whether trends in inventory changes in natural gas, crude, copper, and gold can lead to predictability patterns of economic significance. Their strategy is to enter into long positions if a commodity's inventories are withdrawn, and enter into a short position otherwise. As a commodity’s inventories are withdrawn, presumably commercial hedgers would be lifting their hedges, putting upward pressure on the commodity's price. Correspondingly, as inventories increase, presumably commercial hedgers would be selling futures contracts against these holdings, to minimize their outright price risk, which would thereby put downward pressure on the commodity's futures contract.

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2 - De Roon (2007) provides a theoretical discussion of an updated version of this study.
Their dataset covers the period from 1995 to 2004. Their strategy yields its best results in natural gas and copper when employed in the third nearest to maturity contract. The results for crude oil are positive, but not statistically significant. For gold, the strategy yields results of close to zero.

Dincerler et al.’s study recalls the Cootner study of keying off of visible supplies in wheat as a proxy for hedging pressure. Like the De Roon et al. (2004) study, the Dincerler et al. (2005) study raises questions of how best to exploit the net-hedging-pressure effect. If commercial-market participants are exerting the greatest hedging pressure in deferred-month contracts, then a strategy based on this effect should be concentrated in those deferred-delivery contracts.

Other recent studies have also documented price-pressure effects due to commercial hedging in “processing-margin spreads.” Examples of processing-margin spreads include the gasoline crack spread, which is the differential between gasoline futures prices and crude oil futures prices, and the soybean crush spread, which is the differential between soybean product prices and soybean futures prices. We have already referred to the processing margin of flour-versus-wheat from Working’s research.

As Till and Eagleeye (2006) had discussed, there are times when commercial entities lock in processing margins via the futures markets, which appear to exert one-sided pressure on these spreads. Again, on average it appears that a commodity speculator can earn a return by taking the other side of these transactions. Girma and Paulson (1998) provide empirical evidence of this price-pressure effect for a number of petroleum futures spreads. For heating oil vs. crude oil futures spreads, the horizon of Girma and Paulson’s study is over the period, April 1983 through December 1994. For gasoline vs. crude oil futures spreads, the study is over the period, December 1984 through December 1994. Girma and Paulson write that “the gasoline crack spread seasonality seems to parallel the seasonality of the gasoline inventory levels”. And the heating oil crack spread reaches peaks and troughs that parallel the heating oil inventory cycle. In other words, petroleum-complex crack spreads appear to have periodicities at approximately seasonal frequencies. This would make sense to Cootner since the commercial hedging pressure on prices should wax and wane, according to builds and draws in petroleum-complex inventories.

Another processing margin is the hog-versus-corn-and-soymeal feeding spread, which is analyzed by Liu (2005). Using data from 1985 to 2001, Liu finds that this spread has also fluctuated on a seasonal basis. Whereas the Girma and Paulson study created trading strategies around keying off of times of past peaks and troughs in the spreads, the Liu study successfully keyed its entry and exit rules off of levels of the spreads that strongly departed from past average levels.

In concluding this section, we note that we accept both the theory of storage and the net-hedging-pressure hypothesis. Both of these concepts, while related, have different applications in investing and trading. After covering more ground, we will show that the implications of the theory of storage are important for long-horizon investing while the implications of the net-hedging-pressure effect are important for short-horizon trading.

4. Statistical Behavior of Commodity Prices
Another area of fertile research has been in the econometric modeling of commodity price behavior. We will be using one of the long-term statistical properties of commodities in the empirical analysis that is discussed in part II of this article.

Here we briefly discuss three examples of recent work.
Deaton and Laroque (1992) examined the annual prices of thirteen primary commodities over the period, 1900-1987. They provided the following general picture regarding the commodities that they studied:

- "Commodity prices are extremely volatile;"
- There exist "rare but violent explosions in prices;"
- In normal times, there is a “high degree of price autocorrelation;"
- "In spite of volatility, prices tend to revert to their mean or to a … trend" level;
- "There is substantial positive skewness" in the price distributions; and
- There is "substantial kurtosis with tails much thicker than those of the normal distribution."

Sorensen (2002) analyzes agricultural price behavior from 1972 to 1997. He formally models the prices of soybean, corn, and wheat as the sum of following factors: (a) permanent trend shifts, (b) seasonality, and (c) mean reversion. Permanent trend shifts can be the result of either inflation or permanent changes in supply or demand. The researcher estimates mean-reversion parameters for each commodity: their half-lives range from 0.9 years for wheat to 0.7 years for soybeans. For those unfamiliar with this terminology, “The half-lives express the time it takes before a given shock to … [a price] process is expected to have leveled off by half of the shock,” explains Sorensen.

In order to make Sorensen’s mean-reversion results more intuitive, figure 2 shows how long it takes for each commodity’s price shock to decay, using the researcher’s parameters. Note that the shocks to agricultural prices in his dataset substantially subsided within 5 years (on average.)

Figure 2

NB: This graphical representation does not take into consideration the uncertainty around the fitted mean-reversion parameters. See Sorensen (2002) for the standard errors around the author’s mean-reversion parameter estimates.

Geman (2005) states that “commodity prices neither grow nor decline on average; they tend to mean-revert to a level which may be viewed as the marginal cost of production. This has
been evidenced a number of times in the literature … [for both] agricultural … and … energy commodities. Hence, mean-reversion is one of the main properties that has been systematically incorporated in the literature on commodity price modeling.” That said, Geman sounds a note of caution regarding crude oil, noting that modeling may now need to take into consideration a trend to a higher level of crude prices around which prices would then fluctuate. This latter point is discussed further in Till (2006) based on Grantham (2005).

5. CAPM-Related Approaches

Starting from the early 1970’s there were a number of attempts to reconcile commodity futures returns with the Capital Asset Pricing Model (CAPM), starting with Dusak (1973), which is discussed further in Feldman and Till (2006). CAPM “predicts that risk premia will be proportional to the covariance of the futures returns with the return on the market portfolio of all (tradeable) assets.” Until recently, this model has not been an empirically successful line of research,3 perhaps for the following two reasons. First, "the CAPM … in general implies that all individuals hold a small amount of all marketable assets for diversification reasons. [And at least in the past] … few noncommercial investors take positions in commodities.”, reasoned Hirshleifer (1988).

A second reason was noted in Erb and Harvey (2006). "The CAPM is supposed to explain the expected returns of capital assets, but commodity futures are not capital assets. ... If commodity futures are not included in the market portfolio, why would the CAPM explain commodity futures returns?"4

One early successful CAPM-influenced model was Hirshleifer's (1988). Hirshleifer combined both the CAPM and the net-hedging-pressure hypothesis. He explained that returns from commodity futures trading cannot solely be related to stock-market risk if there are significant impediments to futures trading, preventing common participation in these markets, which was the case when he wrote his article. That said, one might expect that the CAPM’s application to explaining and/or predicting commodity futures returns will become more accepted because of the recent development of efficient vehicles for commodity investing, including mutual funds and exchange-traded funds. These vehicles are now enabling investors to access commodity exposure easily and cheaply, which is a very recent historical development.

6. Commodities in Strategic Asset Allocation

6.1 Pioneering Work

Greer

Before the late 1970’s, commodities were only seen as hedging instruments for commercials and/or trading vehicles for speculators. This changed in 1978 with Greer's pioneering article in the Journal of Portfolio Management, which advocated commodities as a strategic investment for institutions. Twenty-five years later, Greer helped lead the effort to provide investors with efficient access to the commodity markets.

Greer's original article discussed how the perceived riskiness of commodity futures had been at least partly due to the financial risk assumed when trading on margin. Instead, if an investor fully collateralizes his or her futures position, then the riskiness of this strategy becomes materially lower.

At this point, we need another terminology pause. A collateralized commodity futures position is unleveraged. That is, for every desired $1 in commodity futures exposure, an investor sets aside $1 in money-market funds (or other fixed-income instruments), making the futures program fully...
collateralized. When calculating the returns to a collateralized commodity futures program, one typically includes the collateral returns as well.

Using a dataset from 1960 to 1974, Greer (1978) showed how an unleveraged index of commodity futures had higher returns and a lower maximum drawdown than an index of equities. He further showed how a rebalanced portfolio of stocks and commodities would have provided a steadier and higher rate of return than a stock-only portfolio.

In updated work, Greer (2000) explained the components of historical commodity index returns, including the rebalancing yield. Greer (2000)'s index was value-weighted. He explained one advantage of this weighting scheme: "This value-weighted construction simply means that each commodity will be given a fixed percentage of the value of the portfolio. As prices fluctuate, the index reflects the idea of selling the futures that go up and buying those that go down to maintain this constant balance. Unless there is an economic reason to expect futures prices to trend indefinitely up or down, then this construction should provide incremental return to the extent that the various futures in the index are uncorrelated." And indeed, from 1970 through 1999, the value-weighted commodity index considered in Greer's article had meaningful returns due to rebalancing alone that ranged from 0.56% to 6.25% per year.

The collateral returns in Greer's study were meaningful as well. Between 1970 through 1999, the T-bill returns ranged from 3.02% to 14.09%.

An interesting element of this work is the inclusion of reliable return sources that are unrelated to the properties of individual commodity futures contracts. The evaluation of commodity index returns includes not just trends in spot commodity prices and the term-structure of futures contracts, but also other sources of return: the collateral return and the rebalancing (or diversification) return. We will return to the discussion of the importance of the rebalancing return when we cover Erb and Harvey (2006)'s work later in this section.

Bodie and Rosansky
Bodie and Rosansky (1980) found that an equally weighted basket of commodity futures historically had equity-like returns, once one included collateral returns. The mean annual loss on their portfolio was also substantially lower than with a basket of equities. Their dataset was from 1950 to 1976.

GSCI
The next jump forward in commodity investment research wasn’t until about 10 years later with the publication of research related to the Goldman Sachs Commodity Index (GSCI). Although the bellwether Commodity Research Bureau (CRB) index had been developed in 1956, it was primarily used as a gauge for how spot commodity prices were performing, and not as an investment vehicle. As a matter of fact, it wasn’t until 1997 that the total returns for investing in the CRB index, which includes both collateral returns and the impact of rolling from one futures contract to the next, were calculated. This latter point is discussed in Santoli (1997), NYFE (1997), and Murphy (2000).

6.2 Walton
At the time the GSCI was launched, Walton (1991) put forth the case for investing in backwardated commodity futures contracts, adopting a Keynesian view on the commodity markets. At the time, Walton was with Goldman Sachs, but later became a member of the Bank of England’s Monetary Policy Committee.
Walton explained that:
“In general, backwardation will be greatest in markets where commodity prices are very volatile, producers are very sensitive to commodity price fluctuations, and when it is costly to have large holdings of inventories, (e.g., oil, ... [base metals, and livestock]). If any of these conditions fail to hold, the excess return will diminish. For this reason, backwardation is usually greatest in markets in which commodities are consumed as they are produced and holdings of stocks are small because they are expensive to store or unsuitable for storage. These commodity markets are then more prone to supply disruptions, and as a result, there is frequently a premium in the spot market for physical possession.”

It was with this theoretical backdrop that the GSCI was launched. The GSCI is a production-weighted index that in turn is largely weighted in commodities that have been historically backwardated.

The rest of this section on GSCI-related studies draws largely on Till and Eagleeye (2004).

Empirical studies undertaken in the 1990’s consistently showed that GSCI-based commodity futures investments generally had positive returns and negative correlations to equity investments. Therefore, portfolio optimization studies consistently called for (large) allocations to commodities.

6.3 Harvard Management Company Case Study
For example, a 1992 Harvard Business School case study on Harvard Management Company exhibited an “efficient frontier of optimal portfolios” which was produced by a “computer-based algorithm.” The portfolio optimizer sorted through prospective positions in foreign stocks, U.S. bonds, commodity-related assets, U.S. stocks, venture capital, and real estate. The optimizer was allowed leverage of up to 50%. The results of this analysis were unconventional to say the least. Depending on the allowed portfolio risk level, the optimizer called for allocations to commodity investments ranging from 5.8% to 32.0%.

6.4 World Bank Study
Later, Satyanarayan and Varangis (1994) of the World Bank examined what efficient frontier is produced when adding commodity assets to international portfolios. Their study covered the period from December 1984 to June 1992. They used the Goldman Sachs Commodity Index (GSCI) as their proxy for investments in commodity assets. The researchers were surprised:

“to see how heavily the GSCI is represented in the international portfolio. The minimum-risk international portfolio, for instance, implies a 42% investment in the GSCI. This proportion decreases at higher required rates of return but it would seem that at most reasonable levels of risk, the optimal proportion of commodity market investments in the international portfolio would still be at least 30%.”

The World Bank researchers found that:
“... the efficient frontier with commodity assets lies everywhere higher than the [international] portfolio without commodity assets, implying that for the same levels of return (risk), the portfolio with commodity assets provides lesser (higher) risk (return).”

6.5 Froot
Froot (1995) clarified that in order for a commodity index to hedge not only bond investments, but also equity investments, then the index has to be oil-dominated, based on his historical analysis which was primarily over the period from 1970 to 1993. The energy sector has always received the highest weighting within the GSCI.

5 - More recently, Miller (2005) discussed how crude-oil investments also serve as a natural hedge for traditional hedge fund portfolios.
6.6 Recent Work

More recent work on commodity investing has delved further into the following topics: (a) the component elements of commodity futures returns; (b) the desirability of commodity investing even when it might be a poor standalone investment; (c) the sustainability of future commodity returns; and (d) the development of new commodity indices.

Appendix A provides an explanation of the performance attribution concepts, which are commonly used in commodity futures investing. An understanding of these concepts is necessary to best appreciate the recent research into commodity investing.

**Anson**

Anson (1998) discussed the component parts of the returns in a commodity futures investment in terms of the spot return, roll yield, and collateral return, as has been the convention, until recently, in discussing commodity futures programs. Anson found that it was the spot return, which provided the investment's diversification benefit, while it was the roll yield and collateral return that provided most of the commodity investment's total return. Anson's study covered the period from 1985 to 1997.

**Beenen**

Beenen (2005) clarified the goals of institutional investment in commodities within an asset-liability framework. Institutional investors cannot solely examine the asset side of their ledger; instead, their goal is for the future expected returns of their assets to match off against the future expected liabilities for their institution. A further constraint is not to require "unreasonably high contributions from the plan's sponsors" to meet this goal.

Beenen's study assumed that "commodities would have a return just below that of fixed income and a volatility higher than equities and private equities." Further, he acknowledged that "over the long term[,] price movements have contributed little to the return, as commodities prices tend to mean revert to inflation/cost of production."

Even given these unattractive assumptions for commodities, Beenen's study still resulted in meaningful allocations to commodities, given their diversification potential when combined with a pension plan's fixed income, equities, and real-estate investments. The total risk of the diversified plan would then be sufficiently reduced with the addition of commodities that the required contributions from the plan's sponsors could also be reduced.

2006 witnessed three new studies on commodity-index investments, each of which will be briefly discussed below.

**Gorton and Rouwenhorst**

As discussed in Till (2006), Gorton and Rouwenhorst (2006) create a monthly time series, from 1959 through 2004, of an equally weighted index of commodity futures. Their index was rebalanced monthly. They find that their fully collateralized commodity futures program historically had about the same return and Sharpe ratio as U.S. equities. The Sharpe ratio is calculated as an investment's excess returns over Treasury bills, divided by the investment's standard deviation.

Figure 3 summarizes the historical excess returns of their commodity futures index versus the returns of stocks and bonds. Stocks are represented by the S&P 500 index, and bonds are represented by the Ibbotson U.S. corporate bond index. Again, "excess returns" means that these are the returns over an investment in risk-less Treasury bills.
They also find that commodity futures returns were negatively correlated with equity and bond returns. Commodity futures returns were also positively correlated with inflation. Notably, these relationships were strongest at five-year holding periods.

**Erb and Harvey**

Erb and Harvey (2006) examine the returns of sixteen commodity futures contracts over the period, 1982 to 2004. The average correlation of individual commodities with one another were quite low: only about 9%. The average standard deviation of the commodities that they study was 25%. As noted by Greer (2000), it turns out that combining lowly correlated, highly volatile instruments can result in additional *index-level* returns.

Erb and Harvey show mathematically that “when asset variances are high and correlations are low,” the diversification return from rebalancing can be high. For example, “for an equally weighted portfolio of 30 securities with average individual security standard deviations of 30 percent a year and average security correlations ranging from 0.0 to 0.3, the diversification return [alone] ranges from 3.05 percent to 4.35 percent.” This return is separate from any returns due to each individual commodity within the index.

Note that by specifying that the portfolio is equally weighted, this implicitly means one will be actively rebalancing the portfolio to maintain its equal weights across instruments. The returns from rebalancing a commodity portfolio could have been quite meaningful (historically) because of their constituent's low mutual correlation and high volatility. This return-enhancing effect has not been obvious to equity-index investors because of the typically high mutual correlations of equities.

That said, Erb and Harvey note their research on weighting schemes is indeed also applicable to equity investments. “The difference in return between the market cap-weighted Wilshire 5000 Index and the monthly rebalanced and equally weighted Wilshire 5000 provides a concrete example .... From December 1970 through May 2004, the market cap-weighted Wilshire 5000 had a compound annualized return of 11.4 percent and the equally weighted Wilshire 5000 had a return of 20.3 percent. In this case, the return of the equally weighted equity portfolio was almost twice as high as the return of the aggregate stock market.”

**Ibbotson Associates**

Idzorek (2006) notes how “it is widely agreed upon that the strategic asset allocation is the most important decision in the investment process, and for diversified portfolios, the dominant determinant of performance." Based on an examination of asset class data from 1970 to 2004, Idzorek calculates how the efficient frontier for a diversified portfolio would have been improved with the inclusion of commodity futures contracts. He finds that "over the common standard deviation range of approximately 2.4% to 19.8%, the average improvement in historical return at each of the risk levels was approximately 133 basis points, with a maximum of 188 basis points."
New Indices
Besides the GSCI and CRB, as of 2005, the other prominent commodity indexes are the Dow Jones AIG Commodity Index (DJAIGCI), the Rogers International Commodity Index (RICI), and the Deutsche Bank Liquid Commodity Index (DBLCI).

We provide a very brief summary on each index’s construction methodology below. See Akey (2007), which in turn draws from Akey (2005), for a comprehensive summary on each of these indices.

The DJAIGCI limits weightings for each commodity sector to 33% and rebalances annually. The sector weighting limits are in contrast to the GSCI, which presently is weighted 74% in energies. The DJAIGCI was launched in 1999.

Both the GSCI and DJAIGCI include only futures that trade on U.S. and U.K. exchanges.

In contrast, the RICI includes non-US and non-UK futures contracts and rebalances monthly. This index was designed in 1998 by James B. Rogers, the popular writer and former business partner of George Soros.

The DBLCI and other extensions of this index restrict investment to the most liquid of futures contracts. The DBLCI has six contracts in the energy, grains, and metals sector, and is weighted 55% in the energy sector. It rebalances yearly. Lewis (2005) notes how roll returns are directly related to convenience yields, as discussed above. Referring to the theory of storage, Lewis examines the average days-of-inventory for each commodity to determine which commodities have (and may continue to have) high convenience yields, and therefore high roll returns. The explicit intention with the design of the DBLCI is to maximize positive roll yields (backwardation), and minimize negative roll yields (contango). The index designers attempt to achieve this goal by placing the exposure of the typically backwardated commodities in the front-month contracts and rolling frequently (monthly), and placing the exposure of the commodities typically in contango in the deferred contracts and rolling infrequently (yearly). The DBLCI was launched in 2003.

7. Yields as a Driver of Return
Interestingly, most textbook definitions of the convenience yield state that it is only the physical holder of the commodity who earns this yield. The yield comes from the benefit of physical possession, which provides all sorts of optionality, mainly in being able to take advantage of the possibility of ensuing spot shortages.

7.1 Kaldor
That said, Kaldor did say in his original 1939 article that inventory holders lose the convenience yield if they hedge their physical inventories. This assertion has by and large been ignored by later authors, so there has been a lack of clarity regarding this concept from its very birth.

7.2 Analogy to Equity Futures and the Dividend Yield
More recent authors have compared the convenience yield to the equity dividend yield, noting that dividends go solely to the equity-holder.

But when we examine the futures arbitrage relationship for equity-index futures, we realize that the owner of a long futures contract does benefit from the dividend yield.

The following is the formula for equity index futures. \( F \) is the futures price, maturing at time \( t \). \( S \) is the current value of the equity index. \( r \) is the cost of financing the equity position; and \( r^* \) is the dividend yield.
\[ F(t) = S \times (1 + (r - r^*)t), \] or Stock index level + Cost of Financing the Basket of Stocks - Dividends

An equity futures contract is economically equivalent to a financed position in the index's basket of stocks, so its pricing exactly reflects that. At the futures contract's maturity, one's profits (or losses) are the change in the index level minus the cost of financing the position plus the equity index's dividends.

This simple arbitrage equation also in effect exists for commodity futures contracts. In this case, the profits (or losses) are the change in the commodity's price minus the physical outlay costs (described previously) plus the convenience yield. In this context, the convenience yield operates in the same way as the equity futures contract's dividend yield in the futures arbitrage equation.

### 7.3 Analogy to Bond Forwards

As a further analogy, we can also draw on the pricing of bond forward prices. The forward price will equal the price of the bond plus the short-term financing cost minus the bond's coupon. In a steep yield curve, where long-term rates (and therefore the bond's coupon) are higher than short-term financing costs, the bond's forward price will be under the "cash" bond's price; the bond forwards will be "backwarded." (It is not market convention to refer to fixed-income relationships in terms of backwardation or contango, but it makes sense to do so here in order to illustrate the analogies between fixed-income derivatives and commodity derivatives.)

### 7.4 Nash's Intuition

Nash (2001) attempted to describe commodity futures price relations in an intuitive fashion. He noted that when owning a commodity, something has to been done with it. "For example, a refiner buys crude oil, turns it into gasoline, and sells the gasoline. An investor buys the commodity and stores it, or lends it back to the market [where something useful is done with the commodity.] If the commodity is stored, it will typically cost a storage fee. If the commodity is lent, the market will pay a lending fee. ... Most commodities do not have physical lending markets (metals being the exception), but do have actively traded forward markets." Nash's lending fee is the same as the convenience yield less storage costs. The forward price of a commodity represents the current price of a commodity plus the dollar borrowing costs (which is incurred in order to purchase the commodity) minus the lending fee (which is paid by commodity borrowers who do something useful with the commodity.)

When the lending fee is high relative to dollar borrowing costs, a commodity's futures contract is in backwardation. When the lending fee is low relative to dollar borrowing costs, a commodity futures contract is in contango.

Nash's explanations provide us with some intuition for understanding why the owner of a long commodity futures contract does benefit from the convenience yield.

Nash empirically demonstrated how over long periods of time, the accumulation of these financed lending fees has determined the returns from investing in individual commodity futures contracts. He showed that from 1983 to 2000, the annualized (total) returns (including interest income) from investing in 13 commodities were very linearly related to the percentage of time each commodity was in backwardation. His results are reproduced in figure 4.
In an update to this work, Nash and Shrayer (2005) showed that from 1983 to 2004 the annualized (total) returns (including interest income) from investing in 21 individual commodities were also very linearly related to the average percentage of backwardation for each commodity. These results are reproduced in figure 5.

Nash’s average percentage-of-backwardation is linearly related to roll return and convenience yield.\footnote{Using the definitions and conventions described in Appendix C, Nash’s average percentage-of-backwardation is calculated as \( \frac{F_1(t) - F_2(t)}{F_2(t)} \), which in turn is equal to:
\[ (\text{Convenience Yield - Outlay Yield}) \times \frac{F_2(t)}{F_1(t)} + \text{Roll Return} \times \frac{F_2(t)}{F_1(t)} \times \frac{1}{1 + \text{Excess Return}} \].}
Both Erb and Harvey (2006) and Gunzberg and Kaplan (2007) confirmed these results. Also, in an illustration of how some of the commodity-futures performance-attribution concepts are not yet standardized, Erb and Harvey’s definition of roll return is the same as Nash and Shrayer’s average percentage-of-backwardation definition.

Erb and Harvey found that their calculated roll returns “explained 91.6% of the long-run cross-sectional variation of commodity futures returns over the period, [1982 to 2004, for 12 commodities.]” They were careful in how they framed the predictive value of these results: “when substantial differences in roll returns among various commodities futures persist for a long time, investing in commodity futures with relatively high roll returns may be rewarding” (italics added).

The message from both Nash’s and Erb and Harvey’s work is clear. Over long periods of time (or at least during the past 20 years), whether a commodity was in structural backwardation or not largely determined its returns. And a commodity futures contract could have been only structurally backwardated if its convenience yield stayed sufficiently high during the 20-year-plus interval of both studies.

Perhaps for students of commodity pricing theory, this will not be a surprising result. Since the expectation (in the main) is that spot commodity prices mean-revert to the commodity’s cost-of-production over the long-run, spot commodity prices cannot be the driver of return: instead, the roll yield has to be the driver of individual commodity futures returns over a long enough horizon. Further, it might not be a surprise for Sorensen to see these results hold for the agricultural futures markets, given that his statistical study showed that shocks to soybean, wheat, and corn prices substantially subsided within about five years on average, which means, again, that changes in spot commodity prices cannot be the driver of long-run returns.

The logical investment consequences of backwardation as a driver of (long-term) returns have been explored in a number of recent papers. Over long time horizons, De Roon et al. (2004), Gorton and Rouwenhorst (G-R) (2006), and Erb and Harvey (E-R) (2006) each documented the historical profitability of strategies whereby an investor would go long a basket of typically backwardated futures contracts and short a basket of futures contracts which were typically in contango. The De Roon et al. study tabulated average returns over a period of 14 years; the G-R study’s returns were over a period of 45 years; and the E-R study was over a period of 12 years.

The finding that a yield variable is the dominant driver of long-run returns is not unique to commodities. Cochrane (1999a, 1999b) discusses how the evolution of yield variables is key to the long-run returns in equities, bonds, and foreign exchange.

De Roon et al. (2004)’s paper raises interesting possibilities in viewing markets in this holistic way since their long/short baskets of futures contracts not only include commodities but also financial futures contracts.

Perhaps it should not be surprising that a framework for understanding long-run “traditional” market returns should also be applicable to commodities. After all, Erb and Harvey found that the importance of an index’s rebalancing scheme also applied to equities and not just commodities.

7.5 Cochrane

In 1999, Cochrane reviewed a substantial body of recent empirical financial research across asset classes. He stated that, "We ... [now] recognize that stock and bond returns have a substantial predictable component at long horizons."
As for equities, he states, "Low prices – relative to dividends, book value earnings, sales, or other divisors – predict higher subsequent returns." When one regresses equity returns versus equity dividend yields, over the period, 1947 to 1996, the relationship only becomes meaningful at 5-year time horizons.

To be more precise, the independent variable in Cochrane's article was actually the inverse of the dividend yield: the price/dividend ratio. The R-squareds for regressing the excess returns of a basket of equities versus this ratio were 17% at a 1-year timeframe, 26% at a 2-year horizon, 38% at a 3-year horizon, and finally, 59% at a 5-year horizon.

"As the R-squared values [for this regression] ... show, these are long-horizon effects: annual returns are only slightly predictable and month-to-month returns are still strikingly unpredictable, but returns at five-year horizons seem very predictable. ... The results at different time horizons are reflections of a single underlying phenomenon. If daily returns are very slightly predictable by a slow-moving variable, that predictability adds up over long horizons."

In summarizing work across asset classes, Cochrane states, “The value, yield curve, and foreign-exchange strategies I survey ... also exhibit features of catastrophe insurance. Value stocks [which have low prices, and therefore likely high dividend yields] may earn high returns because distressed stocks will all go bankrupt in a financial panic. Buying bonds of countries with high interest rates [or yields] leaves one open to the small chance of a large devaluation, and such devaluation is especially likely to happen in a global financial panic. Similarly, buying long-term bonds in the depth of a recession when the yield curve is upward sloping may expose one to a small risk of a large inflation" (italics added).

Keynes would be happy with applying the above interpretation to commodity-curve backwardation, and Nash might also argue that his lending-fee hypothesis fits in with Cochrane's comprehensive view of asset classes. Under the Nash interpretation, inventory holders are able to lay off the (devastatingly volatile) spot price risk to the holder of long futures contracts, but inventory holders still get the (industrial) benefit of physical possession of the commodity, for which they pay a lending fee. Nash's interpretation is a nice blend of the theory of storage and the Keynesian insurance hypothesis.

Nash's interpretation can be reconciled with the work of previous authors who modeled the convenience yield (or the financed lending fee) as an option on stock-outs. Wouldn't commercial entities pay a higher lending fee for the physical use of a commodity if stock-outs were more likely?

8. Conclusion
In this chapter, we reviewed 75 years of literature on the commodity futures markets. We discussed various theories on what motivates participants in the futures markets, including hedgers, speculators, and now investors.

Based on our review of the historical literature, it appears that there are different types of return opportunities available in the futures markets, which have varying time horizons.

The reasonably short-time horizon effects are due to seasonal hedging pressure and are best explained by Cootner's work. The price-pressure effects due to seasonal hedging pressure may be slight enough that they can be detected only through trends in futures spreads, which is a key result of De Roon et al. (2004)'s work.
There also appear to be reliable long-horizon effects on outright futures contracts. These appear to be best explained by a reinterpreted version of both the theory of storage and the Keynesian insurance hypothesis, as was done by Nash (2001).

In the next chapter, we discuss how term structure should be the primary driver of (historical) long-term commodity futures returns.

9. Endnote
The literature review in this chapter benefited from detailed suggestions from Thomas Schneeweis, editor of the *Journal of Alternative Investments*, during the review of Feldman and Till (2006).

10. Appendix A
Performance Attribution in Commodity Futures Investments
An investor never (or rarely) holds a futures contract through the contract's maturity since the intention of the investor is to obtain exposure to changes in the commodity futures' price without ultimately taking delivery of the actual commodity. Therefore, in order to avoid taking delivery of barrels of oil or bushels of wheat, the investor will eventually close out (or sell) the futures contract he or she is holding, and initiate a new long position in a futures contract that has a later maturity date. This process is known as "rolling the futures contracts forward."

As touched upon in our introduction, "calculating commodity returns is more difficult than it seems," as was also noted by Shimko and Masters (1994).

The returns from passively buying futures contracts and then continuously rolling them forward to deferred-delivery futures contracts are known as "futures-only returns."

The futures-only returns are also known as "excess returns" since they are the excess returns of the futures program over the collateral returns, which are usually calculated as Treasury bill (T-bill) returns.

When the futures-only (or excess) returns are combined with collateral returns, the result is the program's "total returns;" or Total Returns = Excess Returns + Collateral Returns.

It is now convention to separate out the futures-only returns into the spot (price) return and "roll yield." The spot price return is the "component of return that arises from changes in nearby prices." Roll yield (or return) is the "component of return that arises from rolling a long position through time in a sloping forward curve environment," as explained by Shimko and Masters.

In summary, Excess Returns = Spot Returns + Roll Returns.

Sometimes "roll returns" are also referred as the "roll yields." We will use both terms interchangeably below.

Note that the convention of separating out futures-only returns into spot return and roll return is solely for performance-attribution purposes. One cannot invest and receive the spot return separate from the roll return; and correspondingly, one cannot invest solely to receive the roll return, but not the spot return.

We realize that these concepts may be somewhat arcane without concrete examples. In these examples, we will for the most part use an arithmetic (as opposed to geometric) approach to make
the exposition as easy to follow as possible. Part II’s study, though, uses a geometric approach. This topic is also briefly covered in Lewis (2007).

Let’s say the convention is to calculate the commodity futures returns based off of investing $100 in the nearby (closest-to-maturity) futures contract. Figure 1 will help us work through a simplified example.

### Futures Performance Attribution Example

<table>
<thead>
<tr>
<th>First Nearby Price</th>
<th>Second Nearby Price</th>
<th>August 1st</th>
<th>September 1st</th>
</tr>
</thead>
<tbody>
<tr>
<td>$100 F1 (t)</td>
<td>$90 F2 (t)</td>
<td>$120 F2 (t+1)</td>
<td>$100 F3 (t+1)</td>
</tr>
</tbody>
</table>

In this example, the first nearby contract is about to mature, so the investor who only wants price exposure, and not physical delivery of the commodity, decides to invest in the second nearby by “buying” one contract. With futures contracts, an investor does not actually pay the “price” of the commodity. Except for setting aside a de minimis margin, the investor only pays or receives cash based on daily changes in the price of the futures contract that he (or she) is long. In our case, the investor does not want to be leveraged, so that investor will set aside $100 in (not-too-risky) fixed-income securities.

On August 1st, the investor enters into a long position in the second nearby. The “price” is $90. On September 1st, the second nearby becomes the first-nearby contract because the “old” first-nearby contract matured in August.

On September 1st, the investor closes out (or sells) his position. His profits are $120 - $90 = $30. Simultaneously, the investor enters into a long position in the new second-nearby contract; he is rolling his position forward. As of September 1st, since this is a new position, which we assume is entered into at that day’s settlement price, the cash outlay is zero since his initial price is the same as the settlement price. At this point, then, the investor’s sole returns are due to the initial position entered on August 1st and closed out on September 1st.

Let’s calculate the returns for the investor’s futures trading.

His futures-only returns (which do not include the returns from his $100 invested in say, T-bills) are $30/$100 = 30%; or \[ \frac{(F2 (t+1) - F2 (t))}{F1 (t)} \].

How much of this performance is due to the spot return, and how is due to roll yield?

The rolling front-month contract price change was $120 - $100 = $20. This provides a spot return of $20/$100 = 20%; or \[ \frac{(F2 (t+1) - F1 (t))}{F1 (t)} \].

The roll yield is the difference between the futures-only (excess return) and the spot return, which is \( \frac{($30 - $20)}{$100} = 10\% \).

Note that we could have directly calculated the roll yield from the shape of the futures curve as of August 1st: \( \frac{($100 - $90)}{$100} = 10\% \); or \[ \frac{F1 (t) - F2 (t)}{F1 (t)} \].

Note also that the above method of performance attribution starts to make clear the connection between the roll yield and convenience yield.

Let’s treat the first-nearby price as the spot price of the commodity. Many researchers frequently do so because the nearby-futures contract will soon mature into the spot commodity; that is, the
holder of the contract will take physical delivery of the commodity (if the position is not closed out). As a result, the first-nearby price tends to be tightly connected with the spot (cash) price of the commodity.

If we treat the first-nearby price as the spot commodity price, then the \( \left\{ \frac{\text{first-nearby price minus the second-nearby price}}{\text{first-nearby price}} \right\} \) is also \( \left\{ \frac{\text{Brennan's price spread} * -1}{\text{first-nearby price}} \right\} \), which in turn is equal to the convenience yield minus the cost of storing the commodity as well as financing it; or

\[
\left\{ \frac{F_1(t) - F_2(t)}{F_1(t)} \right\} = \text{Roll Return} = \text{Convenience Yield} - \text{Storage Cost} - \text{Interest Cost};
\]

this equation will be qualified below.

Let's refer to \( \text{Storage Cost} + \text{Interest Cost} \) as Outlay Cost, so:

\[
\text{Roll Return} = \text{Convenience Yield} - \text{Outlay Cost};
\]

this equation will also be qualified below.

Note that in this context, we are referring to true yields, so for example, the outlay cost is actually outlay as a percentage of the price of the commodity. So as to avoid confusion, let's refer to this term as the outlay yield to indicate that we have divided the outlay costs by the price of the commodity:

\[
\text{Roll Return} = \text{Convenience Yield} - \text{Outlay Yield};
\]

this whole exercise will turn out to be an approximation as explained below.

Now, note that we began this section with the following qualification: "Let's say the convention is to calculate the commodity futures returns based off of investing $100 in the nearby (closest-to-maturity) futures contract." In fact, what is detailed above is not the convention, but we wanted to make clear the connection between roll yield and convenience yield before muddying the waters with yet more clarifications. As explained by Shimko and Masters (1994), the convention in calculating excess returns is to treat the futures investment as being fully collateralized based on the second nearby price; in our example, the denominator for calculating excess returns should have been \( F_2(t) \) instead of \( F_1(t) \).

Convention in Calculating Excess Returns: \( \text{Excess Returns} = \frac{F_2(t+1) - F_2(t)}{F_2(t)}. \)

Convention in Calculating Roll Returns:

\[
\text{Roll Returns} = \text{Excess Returns} - \text{Spot Returns} = \left\{ \frac{F_2(t+1) - F_2(t)}{F_2(t)} \right\} - \left\{ \frac{F_2(t+1) - F_1(t)}{F_1(t)} \right\}.
\]

When one uses the performance-attribute conventions for calculating the excess return and roll return, the relationship between roll return (or roll yield) and convenience yield becomes:

\[
\text{Roll Return} = \text{Excess Return} - \text{Spot Return} = \left\{ \text{Convenience Yield} - \text{Outlay Yield} \right\} * [1 + \text{Excess Return}];
\]

this is the precise relationship between conventionally-defined roll returns and convenience yield.

Even with this clarification, it is obvious that roll returns are highly related to convenience yields, and will be positive if the convenience yield outweighs the physical outlay costs of storing and financing commodity inventories.

Just to make the discussion of calculating returns from investing in commodity futures complete, we note another caveat in calculating the "total returns" of the investment. As noted previously,
total returns are the futures-only returns plus the collateral returns. In calculating total returns, one needs to take into consideration the interaction effect between the futures-only returns and the collateral return, according to the GSCI Manual (2006). The calculation of the GSCI Total Return index assumes that an investor increases their futures positions over time in line with the increase in their investment from the collateral (interest) return.

Another point to make is that while mathematically, roll yield and convenience yield are very related, they arose from different traditions. Convenience yields arose from an economic explanation (of commercial inventory-holding behavior) while roll returns arose from performance-attribution concepts (that were borrowed from fixed-income investing.)

As was explained in the “Yields as a Driver of Return” section of this chapter, there are good reasons to borrow concepts from the fixed-income world in examining long-term returns in the commodity futures markets.

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Author's Note: A version of this article was originally published in Chapter 4 of the book, Intelligent Commodity Investing (London: Risk Books, 2007), http://www.riskbooks.com/intelligentcommodity
One issue with the long-term findings that an individual commodity futures contract’s returns are (or have been) linearly related to its roll yield is that the roll yield for a commodity is not constant. For example, Schneeweis and Spurgin (1997) note that there is a lack of evidence of a consistent convenience yield for oil.

This state of affairs is similar to equities where the dividend yield over time is not stable either.

In Part I of this article, we cited work by Nash (2001) and Cochrane (1999b). Nash shows that the factor that explains the long-term difference in returns across individual futures contracts is roll yield. He does not apply a Cochrane analysis of examining an individual futures contract and seeing how roll yields explain its returns across time. That said, we do not claim that this is a shortcoming of his work. If roll yield’s predictability only adds up over long time horizons, then one is restricted to applying this analysis to futures contracts that have existed for a very long time, which are basically the agricultural futures markets.

Given the generally observed mean-reverting nature of spot commodity prices, it should naturally follow that across time, roll yields (and therefore, backwardation) have to be the dominant explanatory variable for individual futures contract returns over long enough time horizons, and therefore Cochrane’s framework should also apply to the commodity futures markets. In this chapter, we summarize the findings of the Feldman and Till (2006) study, which applies this natural conclusion to the agricultural futures markets since these markets have continuous data since the late 1940’s.

We also examine how long the time horizon needs to be before roll yields (and backwardation) are the dominant explanatory variable for investment returns in soybean, corn, and wheat futures contracts.

1. Test on the Agricultural Futures Markets

Figures 1 through 3 show the historical evolution of front-month futures prices for soybeans, corn, and wheat. These graphs are updated through June 2006, and start in January of 1949.

Figure 1:

Source of Data: CSI and CRB
As an aside, in viewing the crop futures price charts, we see the emergence of substantial instability in prices during the fall of 1971, which is coincident with the collapse of the post-World War II Bretton Woods framework of fixed-currency regimes. Drobny (2006) writes that "Keynes’ distaste for floating currencies (ironically his original vehicle of choice for speculating) eventually led him to participate in the construction of a global fixed currency regime at Bretton Woods in 1945." The regime collapsed in the fall of 1971 with a subsequent decline in the U.S. dollar. In viewing the post-1971 crop price patterns, it may be hard to argue that weather got any more volatile in disrupting crops, so it would be logical to conclude that it was the instability in the value of the dollar that led to the increase in price volatility in crops. In viewing this chart, we can also understand "Keynes' distaste for floating currencies." We can also see why institutional investors have an interest in investing in stores-of-value, given the fallout from the fall 1971 shock.

The reason for putting in this aside is that, in our analysis, we did not inflation-adjust the futures prices because, for a dollar-based investor, futures returns due to general inflationary increases are just as valid as those due to roll yield.
2. Summary of Results
Once we had created a 55-year excess-return series for soybeans, corn, and wheat futures contracts, including separating out the spot (price) return from the roll return, we examined whether indeed the explanatory power of roll yield increased as we lengthened the investment horizon, as with Cochrane’s dividend-yield study. This dividend-yield study is described in Part I of this article. To be complete, we also examined excess returns versus percentage-of-time-in-backwardation and average-percentage-of-backwardation as in Nash (2001) and Nash and Shrayer (2005).

Results for the joint analysis of all crops demonstrate that the percentage of excess-return variation explained by all of these factors increases greatly, if unevenly, with the length of the investment horizon. With a one-year time horizon, percentage-time-in-backwardation explains 19% of total excess-return variance, average backwardation explains 24% of total excess-return variance, and roll return explains 25% of total excess-return variance. At five years, the percentages of explained variance are 64%, 64% and 67%, respectively.

We are the first researchers that we are aware of to analyze commodity futures return data in this manner.

We provide two illustrative graphs, which show how well roll yield (and backwardation) explain excess returns when analyzed over 5-year time horizons from 1950 to 2004.

Figure 4 shows average excess returns versus roll yield for all three agricultural futures contracts.

Figure 4:

Source of Empirical Analysis: Barry Feldman

1 - In Feldman and Tiv (2006), we used geometrically-derived roll returns:
Roll Return = (1 + Excess Return) / (1 + Spot Return) – 1.
The relationship between the arithmetically-derived roll returns, which are described in appendix C of part I of this article, and geometrically-derived roll returns is as follows:
Geometrically-Derived Roll Return = Arithmetically-Derived Roll Return / (1 + Spot Return).
Figure 5 shows annualized returns as a function of average-time-in-backwardation.

![Five-Year Annualized Excess Return as a Function of Five-Year Time-in-Backwardation 1950 to 2004](image)

This graph is based on Feldman and Till (2006), Chart 1.

Magers (2007) provides a related graph of the five-year annualized excess returns versus average level of backwardation.

In each graph, the outlier observations of extreme returns relative to backwardation and roll yield are from the 1970-to-1974 period, which incorporates the collapse of the Bretton Woods system and the consequent decline in the value of the U.S. dollar.

But other than the 1970-to-1974 period, it is apparent that the driver of 5-year returns has been roll yield.

We conclude that Cochrane's framework for understanding long-term predictabilities in asset classes can also be applied to soybean, corn, and wheat futures contracts. Our results show the cumulative effects on futures returns of the slight short-term predictability of a slow-moving variable, which we have alternatively referred to as the roll yield or the average percentage-of-backwardation, both of which are highly related to the classically-defined convenience yield.

3. Relevance of our Results to Investment Decisions

As discussed in part I of this article, perhaps students of commodity pricing theory would not be surprised by our results. If spot commodity prices generally mean-revert over long horizons, then spot prices cannot (usually) be the driver of return over long-term horizons.

There are two issues in deciding how to use our results for investment decisions. The first question is, if one relies on term structure for deciding whether to enter long or short positions in a futures markets, what sort of interim losses would the investor need to bear in carrying out this strategy over 5-year time horizons?

The second question gets at the heart of all investment decisions. The first question assumed that one could accurately predict what the structural shape of the futures curve would be for 5 years, and then on that basis, decide whether to take a long or short position in that market. Can one predict what the shape of a futures curve will be at 5-year horizons?
We will address the first question before moving on to the more difficult second question. We can examine the riskiness of curve shape as a timing indicator using empirical data. Figure 6 summarizes the maximum peak-to-trough drawdowns over 5-year periods from 1950 to 2004 using month-end data. The return calculations are for excess returns (and do not include the returns that an investor would receive for fully collateralizing his position with fixed-income instruments.)

Figure 6:

**Panel A**

**Soybeans:**
Enter long position if one knew in advance that the average curve shape would be in backwardation.
Enter short position if one knew in advance that the average curve shape would be in contango. Calculated from monthly data.

<table>
<thead>
<tr>
<th>Time Horizon</th>
<th>Peak-to-Trough Maximum Drawdown</th>
</tr>
</thead>
<tbody>
<tr>
<td>1950-54</td>
<td>-13%</td>
</tr>
<tr>
<td>1955-59</td>
<td>-26%</td>
</tr>
<tr>
<td>1960-64</td>
<td>-22%</td>
</tr>
<tr>
<td>1965-69</td>
<td>-21%</td>
</tr>
<tr>
<td>1970-74</td>
<td>-35%</td>
</tr>
<tr>
<td>1975-79</td>
<td>-40%</td>
</tr>
<tr>
<td>1980-84</td>
<td>-41%</td>
</tr>
<tr>
<td>1985-89</td>
<td>-53%</td>
</tr>
<tr>
<td>1990-94</td>
<td>-22%</td>
</tr>
<tr>
<td>1995-99</td>
<td>-42%</td>
</tr>
<tr>
<td>2000-04</td>
<td>-37%</td>
</tr>
</tbody>
</table>

**Panel B**

**Corn:**
Enter long position if one knew in advance that the average curve shape would be in backwardation.
Enter short position if one knew in advance that the average curve shape would be in contango. Calculated from monthly data.

<table>
<thead>
<tr>
<th>Time Horizon</th>
<th>Peak-to-Trough Maximum Drawdown</th>
</tr>
</thead>
<tbody>
<tr>
<td>1950-54</td>
<td>-22%</td>
</tr>
<tr>
<td>1955-59</td>
<td>-17%</td>
</tr>
<tr>
<td>1960-64</td>
<td>-18%</td>
</tr>
<tr>
<td>1965-69</td>
<td>-17%</td>
</tr>
<tr>
<td>1970-74</td>
<td>-84%</td>
</tr>
<tr>
<td>1975-79</td>
<td>-27%</td>
</tr>
<tr>
<td>1980-84</td>
<td>-41%</td>
</tr>
<tr>
<td>1985-89</td>
<td>-57%</td>
</tr>
<tr>
<td>1990-94</td>
<td>-31%</td>
</tr>
<tr>
<td>1995-99</td>
<td>-50%</td>
</tr>
<tr>
<td>2000-04</td>
<td>-40%</td>
</tr>
</tbody>
</table>

**Panel C**

**Wheat:**
Enter long position if one knew in advance that the average curve shape would be in backwardation.
Enter short position if one knew in advance that the average curve shape would be in contango. Calculated from monthly data.

<table>
<thead>
<tr>
<th>Time Horizon</th>
<th>Peak-to-Trough Maximum Drawdown</th>
</tr>
</thead>
<tbody>
<tr>
<td>1950-54</td>
<td>-25%</td>
</tr>
<tr>
<td>1955-59</td>
<td>-13%</td>
</tr>
<tr>
<td>1960-64</td>
<td>-19%</td>
</tr>
<tr>
<td>1965-69</td>
<td>-23%</td>
</tr>
<tr>
<td>1970-74</td>
<td>-34%</td>
</tr>
<tr>
<td>1975-79</td>
<td>-57%</td>
</tr>
<tr>
<td>1980-84</td>
<td>-22%</td>
</tr>
<tr>
<td>1985-89</td>
<td>-17%</td>
</tr>
<tr>
<td>1990-94</td>
<td>-36%</td>
</tr>
<tr>
<td>1995-99</td>
<td>-47%</td>
</tr>
<tr>
<td>2000-04</td>
<td>-31%</td>
</tr>
</tbody>
</table>


The drawdown tables inform us of the following. By solely viewing aggregated returns at 5-year timeframes, one misses a great deal of the drama of actually holding onto to the position during that timeframe. While curve shape may be the driver of returns over 5-year time horizons when examined over a 55-year period, one may also say that there is a great deal of variability within those 5-year timeframes as figure 6 demonstrates.
Perhaps these results should not be surprising. We already had discussed how dividend yields were an effective predictor of returns for equities over long-time horizons. But does anybody invest in equities solely based on dividend yields as a timing indicator?

Perhaps Keynes would look at our long-horizon results in commodities, and say, “[The] long run is a misleading guide to current affairs. In the long run we are all dead.”

Leaving aside that quip, let’s examine the second question, which is the more difficult one of the two. Can we actually predict what the term structure of a futures contract will be?

Here, we have to rely on theory. In part I of this article, we cited a number of studies that validated the theory of storage, which explains how a futures curve shape is related to a commodity’s inventory situation. The lower the inventories relative to consumption, the more likely the futures curve will be in backwardation. Supporting the theory of storage, we also found in Feldman and Till (2006) that since 1950 overall trends in backwardation have paralleled inventory trends in soybean futures contracts.

The roll yields for soybean futures contracts were quite high in the earliest part of our sample. In Feldman and Till (2006), we discussed the circumstances in which soybean futures contracts had high roll yields (and therefore, high convenience yields) early in our sample. According to Hieronymous (1949), in his time, “Soybeans are a relatively new crop, and farmers have not yet built storage space for them. In the past farmers have extensively stored corn and oats. These are both feed crops and are needed on the farms throughout the year. … Such a need is not present in the case of soybeans. … In the long run storage will take place where it can be done most economically. … The storage space for soybeans is owned by processors and is located at processing plants. This represents sunk capital and has no feasible alternate use. No other storage can be built cheaply enough to replace it.” In other words, there was inadequate storage space for soybeans, which heightened the risk of soybean shortages late in the crop cycle. This in turn would be expected to lead to the high average backwardation that was observed in the earliest part of our sample for soybeans (and for soybeans alone.)

The historical analysis of soybeans in Feldman and Till (2006) does not prove the theory of storage, but this study’s results are consistent with the theory-of-storage’s predictions.

When one examines the information in figure 4, it is obvious that roll yields have changed over time for each commodity, especially soybeans, so that analyzing past roll yields to make future predictions may not be helpful.

Relying on the theory of storage, we would conclude that an investor needs to predict the persistence of low inventories relative to demand for a commodity in order to expect a structurally positive roll yield. But even if an investor is capable of doing so, our historical drawdown analysis provides ample caution on how noisy a signal term-structure can be in making investment decisions.

As a final note to this section, we qualified our investment conclusion above by stating that “if spot prices generally mean-revert over long horizons, then spot prices cannot (usually) be the driver of return over long-term horizons.” An examination of the 1970-to-1974 period shows that this is a proper caveat. A rare trend shift upward in spot prices can also be a meaningful source of returns, separate from the term structure for a futures contract.
4. Conclusion
In this chapter, we added to the historical literature on commodity futures returns by showing that over the past 55 years the returns from investing in three agricultural futures contracts can largely be explained by their prevailing term structure, which shifted over time.

Nash (2001) and later authors showed that roll yields had been the dominant driver of commodity futures returns across commodity futures contracts. We extended this framework by showing that roll yields have also been the driver of returns across time in the case of three agricultural futures contracts: soybeans, corn, and wheat, again over very long time horizons.

5. Endnotes
The original analytical work in this chapter is by Barry Feldman, Senior Research Analyst at the Russell Investment Group and founder of Prism Analytics.

Some of the ideas on the determinants of commodity futures returns were jointly developed with Joseph Eagleeye, co-founder of Premia Capital Management, LLC.

This chapter is based on Feldman and Till (2006). That article, in turn, benefited substantially from detailed comments and suggestions from Thomas Schneeweis, editor of the Journal of Alternative Investments.

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