

COMMODITY RISK MANAGEMENT

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Abstract

This article discusses the practical issues involved in applying a disciplined risk management methodology to commodity futures trading. Accordingly, the paper shows how to apply methodologies derived from both conventional asset management and hedge fund management to futures trading. The article also discusses some of the risk management issues that are unique to leveraged futures trading.

Keywords: Futures Trading, Risk Management, Commodity

1. INTRODUCTION

Commodity futures trading is such a niche discipline that discovering how to succeed using disciplined risk-management principles usually only occurs through hard-won experience. This article provides an alternative approach: one can instead study a logical structural framework, as set forth in this article.

In covering the topic of commodity risk management, this practitioner-oriented paper proceeds as follows. A number of trading strategies exist because the trader is being paid to bear risk: that is why they can continue to exist, even if well-known. But then in order for a trading program to be viable in the long-term, a trader must implement disciplined risk management procedures. The key parameters for a risk-management program include quantifying a client's risk tolerance and attempting to ensure that one does not exceed that tolerance as well as understanding the price behavior of commodity futures prices and their potential for explosive behavior. Both of these parameters are essential for the choice of leverage level and hedging strategy for a trading program. Next the paper covers two types of useful risk metrics for a trading program, which include Value-at-Risk and historical worst-case measures. The article then discusses how to avoid inadvertent concentration risk, namely by understanding the fundamental drivers of a strategy. The paper also advocates the use of (a) out-of-the-money options to hedge against identifiable extreme scenarios and (b) disciplined exit strategies for when trading strategies exceed worst-case outcomes. Finally, the paper enumerates what should be included in a trading program's risk-management reports.

2. RISK IS THE FLIPSIDE OF RETURN

In a number of derivatives trading strategies, an investor is paid to bear risks that others would prefer to lay off or not take on. What John Maynard Keynes (1935) wrote is just as true today: "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."

A number of derivatives trading strategies are well known and publicized, which does not prevent them from continuing to exist. For example, trades that have appeared in 1980's commodity brokerage recommendations and have been published in the *Journal of Futures Markets* and other empirically oriented journals are still valid in some form today.

In discussing consistently profitable grain futures trades, Cootner (1967) stated that the fact that they "persist in the face of such knowledge indicates that the risks involved in taking advantage of them outweigh the gain involved. This is further evidence that ... [commercial participants do] not act on the basis of expected values; that ... [these participants are] willing to pay premiums to avoid risk."

In a number of statistically significant futures trades, the investor who implements these trades assumes some specific event risk that others do not want to assume, which is why there is a return to efficiently bearing this risk in the first place.

3. THE MOST IMPORTANT ELEMENT OF AN INVESTMENT PROCESS

The key to a successful investment program is not in discovering proprietary investment strategies: a diligent literature search will turn up a great number of strategies, as noted above.

Instead, the most important element of an investment process may well be how one implements the program's portfolio construction and risk management methodologies so that one can have both smooth performance and stay in business during dramatic market moves. This point will be further elaborated on below.

4. PRODUCT DESIGN ISSUES

In derivatives trading, one has a lot of flexibility in designing an investment program. Futures trading requires a relatively small amount of margin. For example in some futures programs, one only needs

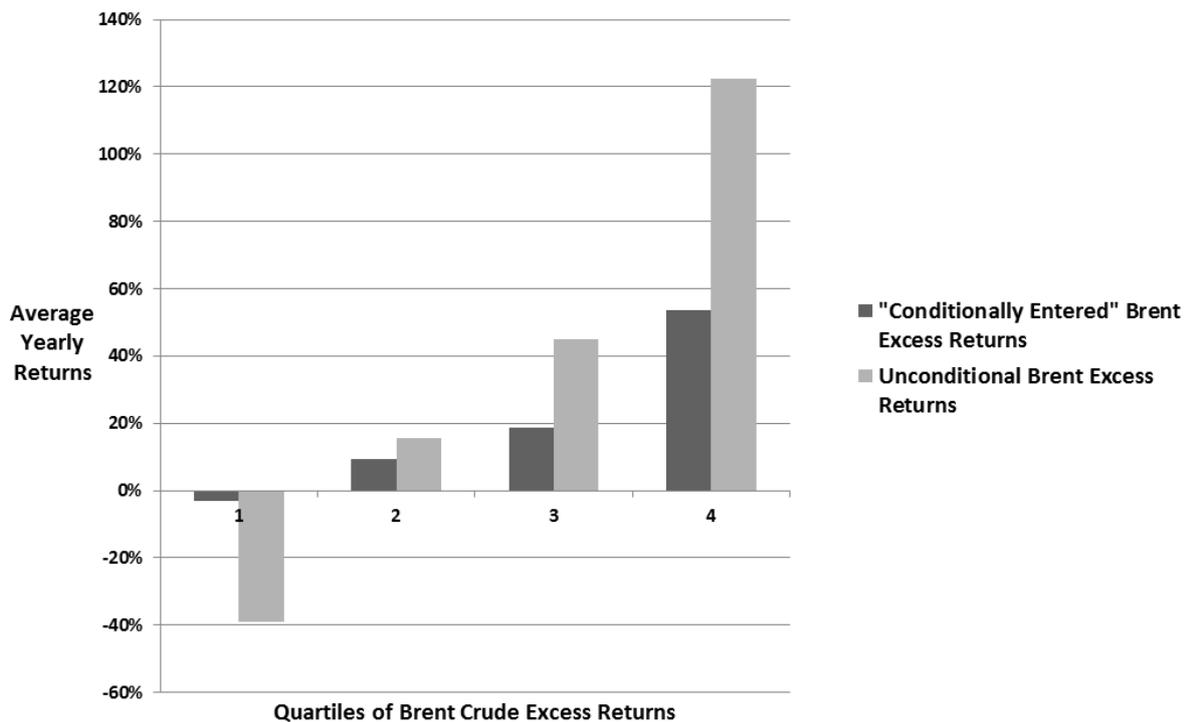
to set aside about \$7 for each \$100 of exposure. The result is that one can easily adjust one's leverage level to magnify gains (and of course, magnify losses, too.) Trade sizing is mainly a matter of how much risk one wants to assume. An investor is not very constrained by the amount of initial capital committed to trading. With the use of options, one can also be very particular about the risks that the investor wishes to hedge away by paying option premia.

What leverage level is chosen for a program and which risks are hedged are product design issues. One needs to determine: "How will the program be marketed, and what will the client's expectations be?" A number of top Commodity

Trading Advisors (CTA's) have had losses in excess of -30%, which seem to have been acceptable to their clients since these investment programs sometimes produce 100%+ annual returns. Investors know upfront the sort of swings in profits and losses to expect from such managers.

Further, investors in futures programs frequently expect a long-options-like payoff profile from such trading programs. Figure 1 provides an example of a crude oil futures trading strategy that, at least historically, has the desired long-options-like payoff profile (the "conditionally entered" Brent futures strategy) while passively investing in Brent oil futures contracts does not (the "unconditionally entered" Brent futures strategy.)

Figure 1. "Conditionally Entered" vs. "Unconditionally Entered" Brent Crude Oil Futures (Excess) Returns (End-January 1999 through End-December 2014)



Note: The calculations underlying this chart were performed by Joseph Eagleeye, Premia Research LLC
 Source: Till (2015), Slide 37

CTA investors also frequently expect futures trading programs to be equity diversifiers, so clients thereby expect that a trading program will not do too poorly in the face of a large equity decline.

The parameters of a program's risk management policy should directly flow from the return, risk, and correlation expectations of the program's client base. When attempting to adhere to these top-level parameters, the actual implementation of a program's risk management policy will rely heavily on the particular assumptions about the statistical properties of futures prices, as will be discussed later.

5. VIABILITY OF A FUTURES PROGRAM

As noted earlier, a number of statistically significant trading opportunities exist because of the possibility of rare, but nonetheless large, losses. One can build a business or investment program around these

positive expected value opportunities, but the particular leverage level and hedging strategy chosen determines the ongoing viability of the program. For example, the basic strategies employed by the following institutions were backed by historical experience:

- The U.S. savings and loan industry's strategy in the 1980's in exploiting a persistently steep yield curve had been historically valid;
- Metallgesellschaft's strategy in 1993 in exploiting the persistently backwardated shape of several energy futures contracts had also been historically profitable;
- Long Term Capital Management's strategy in 1998 in profiting from convergence trades in the fixed-income markets was statistically appropriate;
- Amaranth Advisors LLC's strategy in 2006 of being positioned for extreme weather events had historically provided a long-options-like payoff

profile for investors in its natural gas futures program.

All the above strategies are statistically valid, but, nonetheless, resulted in billions of dollars of losses. Obviously, the leverage level and hedging strategies chosen by these institutions, in retrospect, were flawed.

6. STANDARD RISK MANAGEMENT METHODOLOGY

The way that risk management is applied at conventional asset managers is typically as follows:

- Translate the client's guidelines into return and risk targets with respect to an index or benchmark;
- Determine the active bets away from a program's benchmark;
- Make assumptions about the expected returns, volatility, and correlation of the active bets;
- Construct the client's portfolio so that the client's return and risk targets will be achieved if one's statistical assumptions are correct;
- Continually monitor the portfolio's actual return and risk performance for adherence to the established targets.

Litterman (1996) noted that "[t]he art of successful portfolio management is not only to be able to identify opportunities, but also to balance them against the risks that they create in the context of the overall portfolio." Risk management is therefore designed into the investment process. The conventional asset manager approach to risk management is a useful first step in designing a risk management program for leveraged futures trading. As will be discussed, one still needs to add several layers of risk management to this approach because of the unique statistical properties of commodity futures contracts and because of the different way futures products are marketed.

A futures product typically does not have a benchmark so the conventional asset manager approach of translating a client's guidelines into risk and return targets with respect to an index does not directly apply. Instead, one needs to determine what the acceptable total-return-to-total-risk trade-off is for a client. Given the ability to leverage, a number of CTA's offer 1-times, 2-times, and 3-times versions of the same program. In other words, a client can directly choose the leverage level for their investment based on their ability to tolerate losses of a given magnitude.

The second step in a conventional asset manager approach to risk management consists of making assumptions about expected returns, risks, and correlations of active bets. It is at this point that the unique behavior of commodity prices creates extra steps in a risk management program.

7. UNDERSTANDING PRICE BEHAVIOR

Research from the 1970's showed that diversified portfolios of equities have returns that appear to be symmetrically distributed. It is a different matter for commodity prices.

Deaton and Laroque (1992) noted the following about the empirical behavior of the prices of a number of commodities:

- "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;

- There is "substantial kurtosis with tails much thicker than those of the normal distribution."

Commodity prices tend to exhibit positive skewness for the following reason. During times of ample supplies, there are two variables that can adjust to equilibrate supply and demand: more inventories can be held *and* the price can decrease. But, if there are inadequate inventories, *only* the price can respond to equilibrate supply and demand, given that in the short run, new supplies of physical commodities cannot be instantly mined, grown, and/or drilled.

7.1. Value-at-Risk

If a portfolio of instruments is normally distributed, one can come up with the 95% confidence interval for the portfolio's change in monthly value by multiplying the portfolio's recent monthly volatility by two (or 1.96, to be exact.) The portfolio's volatility is calculated from the recent volatilities and correlations of the portfolio's instruments. This is the standard Value-at-Risk approach. Now, this approach alone is obviously inadequate for a commodity portfolio, which consists of instruments that have a tendency towards extreme positive skewness.

While this measure is useful, it has to be used jointly with other measures and actions. The measure is useful since one wants to ensure that under normal conditions, a commodity position has not been sized too large that one cannot sustain the random fluctuations in profits and losses that would be expected to occur, even without a dramatic event occurring. Sizing a trade based on its volatility is especially important the longer the frequency of predictability is. For example, if a trade's predictability is at quarterly intervals, the trade has to be sized to withstand the daily fluctuations in profits and losses.

In one extreme example, Lettau and Ludvigson (2001) have found that equities are predictable at business cycle frequencies. But that means that one cannot have a leveraged investment process to take advantage of this predictability.

7.2. Scenario testing

Using long-term data, an investor should directly examine the worst performance of a commodity strategy under similar circumstances in the past. In practice, such a measure will sometimes be larger than a Value-at-Risk measure based on recent volatility.

One should examine the worst performance of a futures trade over the entire time horizon of the trade rather than looking at what its worst performance was over a period of say, three days. Markets are "learning systems." During a price shock, if a similar event occurred in the past, market participants know what the magnitude of the price

move was during the past event. So an entire, dramatic price move may occur in a shortened timeframe as compared to the past.

In practice, if a market only has limited historical data, it would be prudent to scale down the size of a position in such a market since one may not be able to get a complete idea of the range of possible outcomes.

If one is relying on historical data to find pockets of predictability in the futures markets, then examining worst-case outcomes can also serve another purpose. If the loss on a particular commodity futures strategy exceeds the historical worst case, this can be an indication of a new regime that is not reflected in the data. This would trigger an exit from a systematic trade since one no longer has a handle on the worst-case scenario.

An example of a fundamental structural change occurring in a commodity market was provided by Fusaro (2005). He reveals that in the summer of 2005, "the big Wall Street houses and some other hedge funds lost many ... hundreds of millions [of dollars] on gasoline/heating oil spreads. They could not imagine that heating oil would go higher than gasoline in June. It just never happened before."

The conclusion from this discussion is that a commodity program will not experience the full brunt of a structural break if one exits a trading strategy after experiencing losses that are greater than have been the case in the past, as noted in Till (2006).

7.3. Deep out-of-the-money options

In a systematic investment program based on historical data, one can make determinations about the expected return of an investment. One result is that an investor can decide to give up a small fraction of this expected return in order to hedge against catastrophic risk. An investor can do so with deep out-of-the-money options.

This choice is especially advisable for commodity futures positions that require physical delivery at maturity. This means that contracts can be periodically squeezed to quite unpredictably high levels.

7.4. Exit strategy

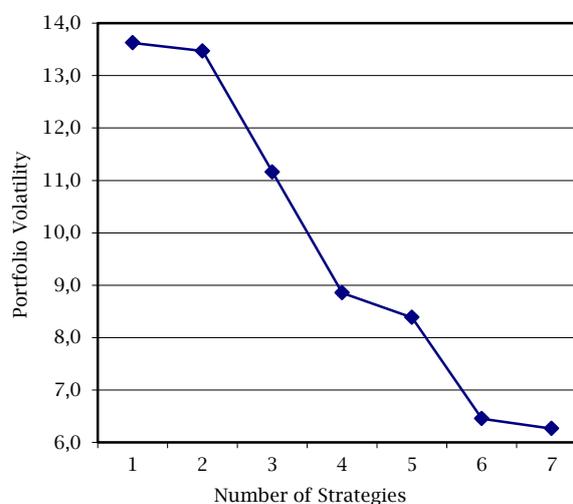
Although strictly speaking not a risk management issue, one should employ an exit strategy that recognizes the mean-reverting properties of commodities. This means examining historical data to determine the typical size of moves during supply/demand imbalances.

7.5. Diversification and concentration risk

As discussed in Till (2001), a commodity investment manager can potentially set up dampened risk portfolios of commodity investments, which are very nearly uncorrelated with each other. For example, Figure 2 shows the annualized portfolio volatility versus the number of commodity strategies for a portfolio from June of 2000. Based on three months of price data, these strategies had correlations amongst each other of between -20% and +20%. The figure demonstrates the beneficial effect of

incrementally adding unrelated trades on portfolio volatility.

Figure 2. Portfolio Volatility vs. Number of Strategies



Note: Copyright © Institutional Investor, Inc.
Source: Till (2000), Figure 5

Now for all types of leveraged investing, a key risk management concern is inadvertent concentration risk. So for example, equity option market-makers will try to ensure that their book of trades does not have inadvertent style and industry concentrations.

In leveraged commodity futures investing, one must be careful with commodity correlation properties. Humphreys and Shimko (1997) discuss how correlations amongst commodity markets can be highly seasonal. Their specific example discusses the correlation of natural gas in different regions, which depends on whether it is summer or winter.

In addition, seemingly unrelated commodity markets can become temporarily highly correlated. This becomes a problem if commodity managers are designing their portfolios so that only a certain amount of risk is allocated per strategy. The portfolio manager may be inadvertently doubling up on risk if two strategies are unexpectedly correlated.

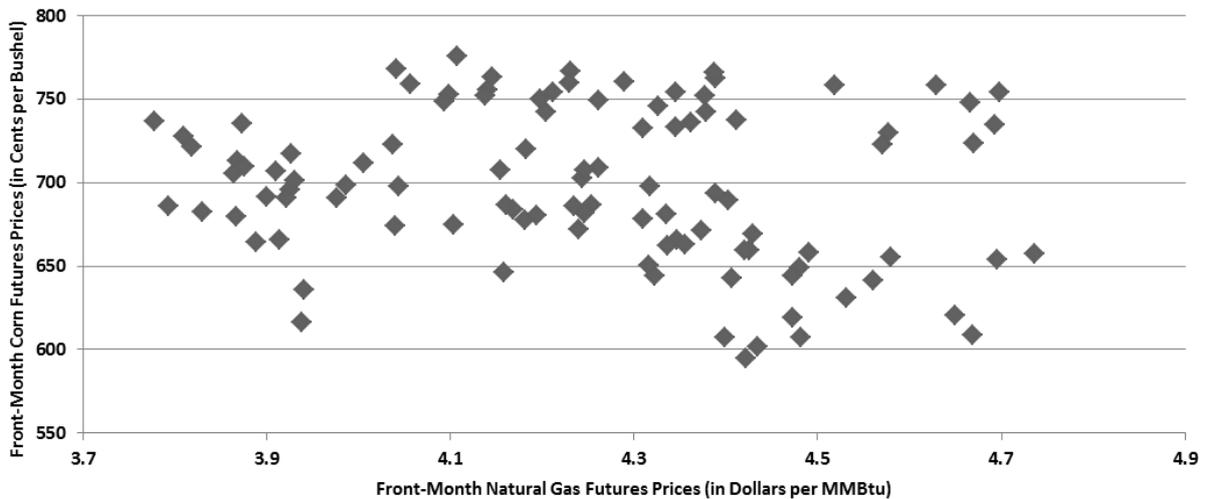
7.6. Understanding the fundamental drivers of a strategy

The antidote for this problem is two-fold. One is to understand what the key factors are which drive a strategy's performance, and the other is to use short-term recent data in calculating correlations. If two trades have common drivers, then it can be assumed that their respective performances will be similar. Recent data can frequently capture the time-varying nature of correlations that long-term data average out.

7.6.1. Corn and natural gas example

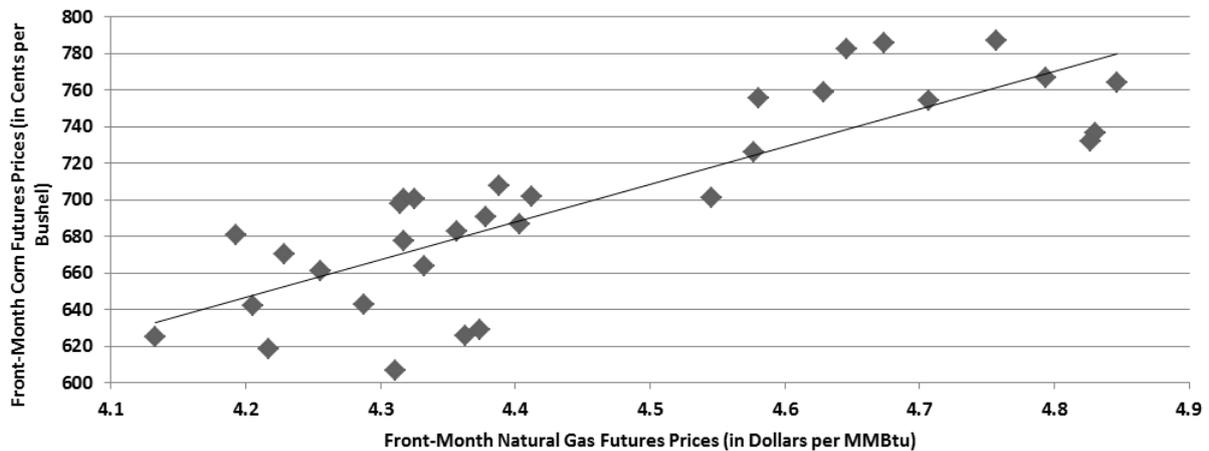
The following graphs in Figures 3 and 4 provide an example from 2011 that show how seemingly unrelated markets can become temporarily very related.

Figure 3. Front-Month Corn Futures Prices versus Front-Month Natural Gas Futures Prices (1/3/11 to 6/1/11)



Source: The Bloomberg

Figure 4. Front-Month Corn Futures Prices versus Front-Month Natural Gas Futures Prices (6/1/11 to 7/15/11)



Source: The Bloomberg

Normally, natural gas and corn prices are unrelated. But during the summer, they can become highly correlated, as shown in Figure 4. Depending on the values of key fundamental drivers, two prospective trades in the summer are to be short these two commodities. Now, the empirical evidence seems to show that these two trades may be the same trade. So, if one puts both of these trades in their portfolio, one would be inadvertently doubling up on risk. How could these two seemingly different trades be, in fact, the same trade?

To answer this question, one needs to understand why these two trades tend to work. These two trades are part of a class of trades called, “Weather Fear Premium” trades. In this class of trades, as explained in Di Tomasso and Till (2000): “A futures price will sometimes embed a fear premium due to upcoming, meaningful weather events. One cannot predict the weather, but one can predict how people will systematically respond to upcoming weather uncertainty. In this class of trades, a futures price is systematically too high, reflecting the uncertainty of an upcoming weather event. We say the price is too high when an analysis of historical data shows that one can make statistically significant profits from being short the

commodity futures contract during the relevant time period. And further that the systematic profits from the strategy are sufficiently high that they compensate for the infrequent large losses that occur when the feared, extreme weather event does in fact occur.”

Till (2000) gave several examples of this strategy, including ones from the corn and natural gas markets, as discussed below.

7.6.2. Corn

“Its key pollination period is about the middle of July. If there is adverse weather during this time, new-crop corn yields will be adversely affected. This means that the new-crop supply would be substantially lessened, dramatically increasing prices. A systematic trade is to short corn futures from June through July. There is systematically too high a premium embedded in corn futures contracts during the pre-pollination time period.”

7.6.3. Natural gas

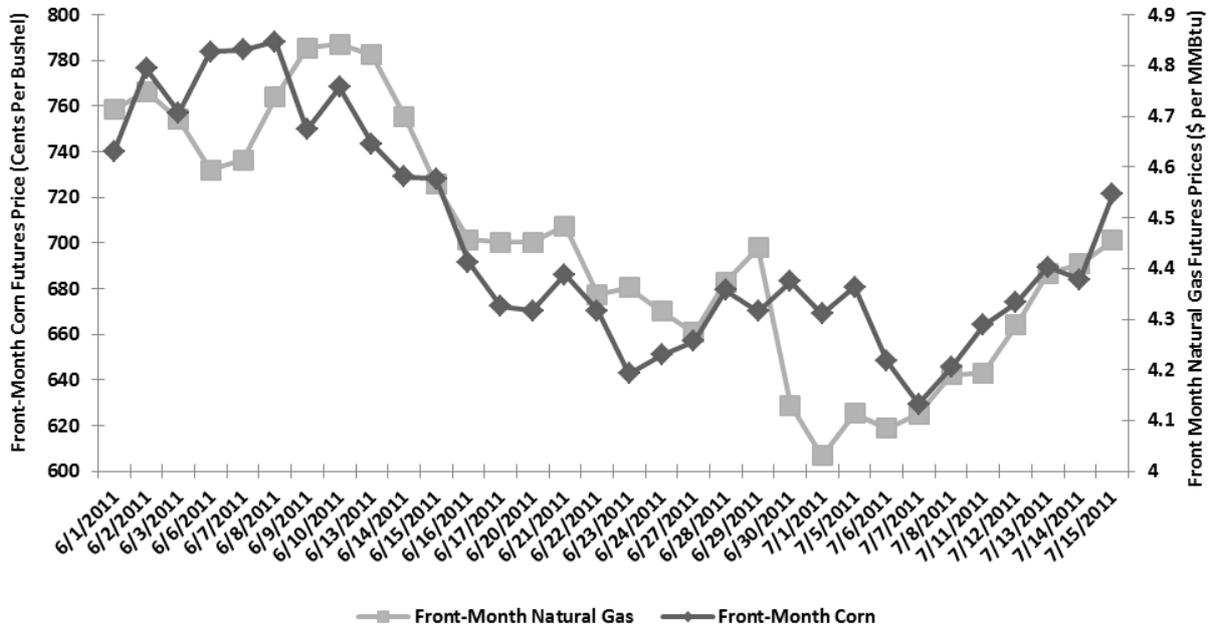
“In July, there is fear of adverse hot weather in the US Northeast and Midwest. Air conditioning demand

can skyrocket then. From June to mid-July, a systematic trade is to short natural gas futures contracts at the height of a potential weather scare.”

Both the July corn and natural gas trades are therefore heavily dependent on the outcome of weather in the U.S. Midwest. Figure 5 further

illustrates how both corn and natural gas had common reactions to the possibility of extreme heat in 2011: their prices frequently waxed and waned at similar times during the summer, as would be expected from the discussion above.

Figure 5. Front-Month Corn Futures Prices and Front-Month Natural Gas Futures Prices (6/1/11 to 7/15/11)



Source: The Bloomberg

Our conclusion is that in order to avoid inadvertent correlations, it is not enough to measure historical correlations. Instead, an investor needs to have an economic understanding for why a trade works in order to best be able to appreciate whether an additional trade will act as a portfolio diversifier.

7.7. Extraordinary stress testing

As discussed above, risk management policies flow from product design decisions. Futures products are typically marketed as equity investment diversifiers. Therefore, one job of risk management is to attempt to ensure that a futures investment will not be correlated to the equity market during periods of dramatic equity losses. This is not an issue for say, an equity mutual fund. During a time of stress in the equity markets, clients would expect that their equity fund would perform poorly.

This extra risk management step is unique to alternative investments, again, because of the way they are marketed. For example, funds of hedge funds are also marketed as equity diversifiers, so this is also a particular area of concern for such funds. Since fund of funds typically include a lot of arbitrage strategies, which in turn rely on the ability to leverage, fund of funds are at risk to liquidity shocks. And the equity markets typically also do poorly during liquidity shocks.

One potential solution is to include an interest-rate overlay in such funds. The interest-rate overlay consists of going long Eurodollar (short-term U.S. interest rate) futures, which do well when short-term interest rates are cut. The Federal Reserve Board’s

(Fed’s) response to liquidity shocks has typically been to cut short-term interest rates so a Eurodollar overlay could plausibly offset losses in portfolios consisting of arbitrage strategies.

This type of macro hedging is very applicable to commodity and financial futures investments as well. A number of commodity futures strategies have a long commodity bias since they rely on taking on inventory risk that commercial participants wish to lay off. One consequence is that these strategies are at risk to sharp shocks to business confidence. And during sharp shocks to business confidence as occurred in the aftermath of September 11th 2001, the stock market performs quite poorly.

A number of financial futures strategies involve taking long positions in relatively illiquid markets and taking short positions in liquid markets during predictable times of increases in market liquidity. One consequence is that these strategies are at risk to liquidity shocks as occurred in the fall of 1998 during the LTCM/Russian default crisis.

As noted before, the Fed has responded to financial shocks by cutting interest rates, which has resulted in the stock market stabilizing. As long as this type of policy continues, one way to hedge a portfolio that has exposure to shocks to business confidence or shocks to the availability of credit is to include a fixed-income hedge. The hedge could take the form of either a Eurodollar futures contract overlay or purchases of out-of-the-money fixed-income calls.

Obviously one would prefer to layer on natural hedges, which themselves have positive expected value. This is sometimes possible in a diversified

futures program. For example, in the fall there tends to be a number of statistically significant commodity trades that have a long bias. Also, at the same time there are a number of statistically significant long fixed income trades. By carefully combining these trades, the fixed-income trades operate as a natural hedge to the event risk taken on with the long commodity trades.

The hedge fund world also provides other risk management solutions that are applicable to futures programs. One concern for a fund-of-funds is that its group of funds is inadvertently exposed to some event risk like an emerging markets shock. This issue is compounded by the fact that a hedge fund investor is frequently not allowed to see what a hedge fund is investing in because this is considered proprietary information by a hedge fund.

One risk management software provider has solved this problem by confidentially collecting hedge fund portfolios and directly determining their sensitivity to past financial shocks. For example, if one held a particular fund-of-funds portfolio during October 1987, one could see how that portfolio would have performed during the stock market crash. This scenario test gives an indication of sensitivity to a stock market crash.

For a commodity and financial futures portfolio, it is prudent to examine how the portfolio would have performed during various well-defined stock market declines, given that such investments are marketed as equity portfolio diversifiers. Also, various crises have shown that the only thing that goes up during such times is correlation! If a portfolio shows sensitivity to certain extreme events when the stock market has declined, this does not necessarily mean that the portfolio should be sized differently or constructed differently. It may mean that a macro portfolio hedge would be in order such as purchasing out-of-the-money Eurodollar call options, as noted above.

8. RISK MANAGEMENT REPORTS

On a per-strategy basis, it is useful to examine each strategy's:

- Value-at-Risk based on recent volatilities and correlations;
- Worst-case loss during normal times;
- Worst-case loss during well-defined eventful periods;
- Incremental contribution to Portfolio Value-at-Risk;
- Incremental contribution to Worst-Case Portfolio Event Risk.

The latter two measures give an indication if the strategy is a risk reducer or risk enhancer.

On a portfolio-wide basis, it is useful to examine the portfolio's:

- Value-at-Risk based on recent volatilities and correlations;
- Worst-case loss during normal times;
- Worst-case loss during well-defined eventful periods.

Each measure should be compared to some limit, which has been determined based on the design of the futures product. So for example, if clients expect the program to lose no more than say 7% from peak-to-trough, then the three portfolio

measures should be constrained to not exceed 7%. If the product should not perform too poorly during financial shocks, then the worst-case loss during well-defined eventful periods should be constrained to a relatively small number. If that worst-case loss exceeds the limit, then one can devise macro portfolio hedges accordingly.

Now obviously the danger with these recommended approaches is that one is relying on historical data for guidance since completely unprecedented events do happen. That is why one should exit any futures trades in which the losses exceed those known in history since one is then in uncharted territory.

9. CONCLUSION

There are a number of derivatives strategies, which earn returns due to assuming risk positions in a risk-adverse financial world. The returns are not necessarily due to inefficiencies in the marketplace.

There is a very important active component to a futures program that earns a return due to bearing risk. It is the investment program's risk management methodology and policy. An investment manager must decide how much to leverage the strategy and whether to give up any returns by hedging out some strategy's extreme risks. That manager must also continually monitor the risk exposures in his or her portfolio and make sure that those exposures adhere to pre-defined limits.

In designing a risk management framework, a leveraged futures trader can use as a starting point the framework provided by conventional asset managers and also by fund of hedge fund managers.

We conclude by noting that how investors design and carry out their risk management policies is key to an investment program's viability, especially in leveraged commodity futures trading.

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