Case Studies and Risk Management in Commodity Derivatives Trading

January 2011

Hilary Till
Research Associate, EDHEC-Risk Institute
and Principal, Premia Capital Management, LLC

EDHEC BUSINESS SCHOOL

Author's Note:
This is the pre-peer-reviewed version of the following article:
Till, H. (2008), "Case Studies and Risk Management Lessons in Commodity Derivatives Trading," a chapter in Risk Management in Commodity Markets: From Shipping to Agriculturals and Energy (Edited by H. Geman), Chichester (UK): John Wiley & Sons Ltd., pp. 255-291, which has been published in final form at: http://www.wiley.com/WileyCDA/WileyTitle/productCd-0470694254.html.

EDHEC is one of the top five business schools in France. Its reputation is built on the high quality of its faculty and the privileged relationship with professionals that the school has cultivated since its establishment in 1906. EDHEC Business School has decided to draw on its extensive knowledge of the professional environment and has therefore focused its research on themes that satisfy the needs of professionals.

EDHEC pursues an active research policy in the field of finance. EDHEC-Risk Institute carries out numerous research programmes in the areas of asset allocation and risk management in both the traditional and alternative investment universes.

Risk management in commodity futures trading takes two different forms, depending on whether trading is done for a commercial or a purely speculative enterprise.

In a commercial enterprise, the rationale for trading activity is usually to "optimise the value of physical assets;" and the returns and risks from this activity would be expected to be a small fraction of the enterprise's overall profits and losses. One would include BP's trading activity in this category, for example.

Commercial and investment banks also engage in commodity derivatives trading, historically to facilitate their overall business in financing natural-resource producers. This is arguably the case historically with Canadian commercial banks.

For commercial enterprises, the important aspects of risk management are in adhering to regulatory rules and laws, and in establishing strict operational policies and procedures over every facet of risk-taking activity.

For a purely speculative participant, the emphasis is almost entirely on market risk-management. The barriers-to-entry in futures trading are remarkably low: strictly speaking, a participant solely needs a quote device to track the markets and a Futures Commission Merchant (FCM) to execute and clear one's trades. Arguably, the tail risk on a futures trading position is ultimately the responsibility of an FCM.

It became ingrained in the minds of financial-market participants that should fixed-income or equity markets ever have extreme dislocations, they could ultimately rely on a "central-bank put" underwritten by either the Federal Reserve Board (Fed) or the European Central Bank. On December 12th, 2007, for example, the Fed unveiled the Term Auction Facility (TAF) to enable depository institutions in the U.S. (and indirectly in Europe) to acquire short-term funds against a wide variety of capital. Further on March 11th, 2008, the Fed created the Term Securities Lending Facility (TSLF) whereby primary dealers, including investment banks, could borrow Treasury securities against a wide variety of mortgage-related securities. With these and other actions, financial-market participants again assured at the time that the too-big-to-fail doctrine still held.

For commodity speculators, though, there is no TCAF ("Term Commodity Arbitrageur Facility"). Instead, commodity speculators are forced to rely on disciplined risk management. The financial writer, Ralph Vince, goes so far as to recommend that before studying the mathematics of money management, one should consider what would happen if the prospective trader suffered a cataclysmic loss:
"Take some time and try to imagine how you are going to feel in such a situation. Next, try to determine what you will do in such an instance. Now write down on a sheet of paper exactly what you will do, who you can call for legal help ... Do it now .... " (Vince 1992).]

Many experienced traders have noted how ephemeral trading strategies are, or at least, how all strategies have life-cycles: "Just when you think you found the key to the market, they change the locks", declared the late Gerald Loeb, who was a highly successful financier and founding partner of E.F. Hutton, as quoted in Cashin (2008).

As a matter of fact, Weisman *et al*. (2007) have quantified one of the consequences of Loeb's observation. The expected draw-down for a strategy is positively related to how consistently profitable a strategy is, *if a threshold of returns is constantly demanded*. In the words of Weisman *et al*., the markets have "periodic market efficiency," which is another way of saying all strategies have a limited lifespan. The "tail loss", when a strategy finally (and inevitably) outlives

its usefulness, can be found to be:
Loss = [(Demanded Returns) * Probability of the Strategy Succeeding / Probability of the Strategy Failing].

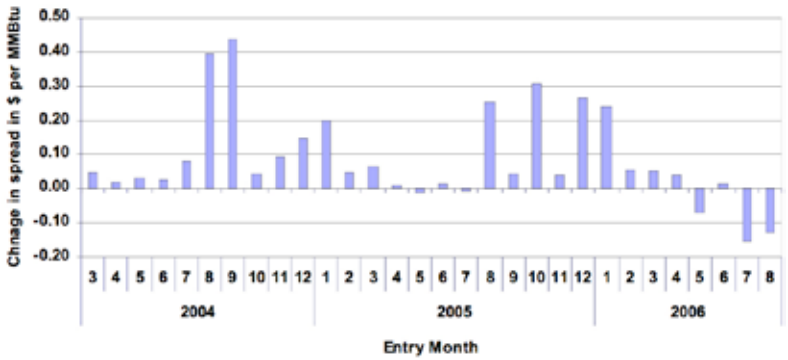
For strategies that target an absolute level of return, the natural consequences of this demand are that (1) losses are proportional to wins; and (2) losses are inversely proportional to their probability of occurrence, as explained by Weisman and his colleagues.

Ethical issues do not arise when Weisman *et al.*'s analysis is applied to proprietary trading firms since in this case it is the partners' capital at risk. The partners accept that draw-downs are endogenous to the trading strategy. As a result, they may not target absolute returns, knowing that trading strategies are fleeting. As Eagleeye (2007) wrote, "One can manage risk ... [but] one can't demand a threshold return from the market." Enduring proprietary trading firms instead typically target risk.

Now, there are severe consequences to Weisman's analysis for investors in hedge funds, who have historically based their investment decisions on past track records, which may not be predictive of future results; and who pay hedge-fund traders based on short-term results, with no claw-backs of fees if the strategy suffers disastrous results.

We can take an example from the natural gas futures markets to illustrate the negative consequences to Weisman's observation of the "dangerous attraction" to absolute-return targeting.

Figure 1 - Natural Gas Bear-Calendar Spread P/L, 1-Month Horizon, January 2004 through August 2006



Source of Data: Bloomberg.

Figure 1 illustrates how consistent a strategy of trading natural gas bear calendar spreads was in the spring of 2004 through the spring of 2006. A "calendar spread" consists of taking offsetting positions during the different delivery months of a particular futures contract. A "bear calendar spread" consists of taking a short position in a nearer-month futures contract while simultaneously taking a long position in a later-delivery contract of the same futures market.

By early summer 2006, the profitability of this strategy had declined by about half of the performance of the previous two years. If the commodity futures trader had responded by doubling up his or her position size (to try to maintain an absolute-return target), then in July and August of 2006, that trader would have sustained losses about twice the size of the trader's year-to-date profits. The significance of such a loss is that when a trader's risk-and-return results differ dramatically from client and/or prime-broker expectations, this can set off a "critical liquidation cycle" where client redemptions and/or additional demands for collateral from creditors cause a trader to liquidate positions in a distressed manner, which can then cause further losses that imperil a fund's survival, as both the fund's investors and creditors lose faith in the manager. This process is mathematically modelled in De Souza and Smirnov (2004) as being like a short barrier put option.

Keeping Weisman's and De Souza and Smirnov's analyses in mind, perhaps one should accept that individual trading strategies may not be enduring, but perhaps a trader's risk-management methodology can be enduring, instead.

A number of studies have indirectly verified this latter point. The fund-of-hedge-funds investor, David Gordon, found that while pre-investment returns for managers had no predictive value, as discussed in Gordon (2003a), it was different for risk:

"*Historical standard deviation tends to be somewhat helpful in predicting future risk. The correlation between pre-investment standard deviation ... [versus] downside deviation and maximum drawdown during the subsequent period of investment is [statistically] significant.*" (Gordon 2003b).

Further, Kat and Menexe (2003) found that the historical value of a hedge-fund manager's track record is precisely in its risk characteristics; they found that the standard deviation of a manager's returns (and the manager's correlation to the stock market) was what persisted across time, but not manager performance itself.

Interestingly, for institutionally-scaled hedge funds, the publicly available information on these funds is precisely in the quality of their risk-management-and-monitoring infrastructure. This was the message from the extensive Moody's operational reports on Chicago-based Citadel Investments and London-based Brevan Howard, which were both $15 billion-plus hedge-fund institutions, as at the date of this article. These reports were made available on Moody's website in 2007 for accredited investors, and are listed in this article's references section under Gains (2007) and Lahav (2007).

So perhaps it is not controversial, after all, to state that risk management is the most important aspect of a futures trading operation. In this article, we will discuss the risk-management lessons from a number of recent trading debacles with the hope that the reader will thereby be able to avoid such mishaps in their own professional lives.

In the following, we will briefly discuss the apparent risk-management lapses at three large institutions involved in commodity derivatives trading; these lapses were mainly operational in nature rather than market-risk problems per se. This section will then be followed by a discussion of the market-risk lessons garnered from trading debacles that have occurred from 2005 through the spring of 2008.

Institutional Risk Management

Regulatory and Legal Risk

In 2007, BP ran afoul of market-conduct laws and rules, as enforced by the Commodity Futures Trading Commission (CFTC) and the U.S. Department of Justice (DOJ), for trading activities of the previous five years. In one particular case, the civil and criminal fines far exceeded the market-risk of the activities, illustrating where the risk-management priorities need to be for large participants in the commodity markets.

There is a strict body of law prohibiting market manipulation by commodity traders, especially when retail customers are put at risk. According to the CFTC (2006a, 2006b, 2007b), during the spring of 2004, traders at BP Products North America cornered the February 2004 physical propane market at a particular delivery location in Texas. This delivery location ultimately serves customers throughout the Midwest and Northeast via pipeline. The largest users of propane in

the U.S. are from the residential and commercial heating sector as well as from the petrochemical industry, which uses propane for creating plastics.

A 28th June 2006 CFTC complaint specifically cites recorded telephone conversations where a senior BP trader discusses whether BP could "control ... [a particular propane] market at will". To find out whether they could accomplish a corner, "BP employees purchased enormous quantities of propane to establish a dominant and controlling long position" in physical propane, notes the CFTC (2006a). The CFTC complaint also notes how senior management at BP consented to the strategy. For example, in the CFTC (2006b) complaint, the compliance manager at the BP business unit responsible for propane trading is quoted as approving the propane-purchasing strategy, but told the traders "to refrain from using certain words in conjunction with ... the strategy, including the word 'squeeze.'"

From a careful reading of the CFTC complaint, the actual trade construction of BP's speculative trading strategy appears to be one of being long propane for physical delivery by the end of February 2004 while also being short propane for physical delivery by the end of March 2004. BP had also attempted a similar strategy, in what appears to be a smaller scale in April 2003, again according to the CFTC complaint.

According to an internal BP document that is posted to the CFTC website, BP actually lost $10 million from their speculative propane strategy. The BP traders were only able to sell a relatively small fraction of their February 2004 position at the elevated price levels that prevailed at the end of February, meaning that they had to close out their remaining February longs at much lower prices prevailing in March 2004.

Because of this trading loss, the BP trading bench had put together a Powerpoint presentation, "NGL Feb Value Trade[:] Lessons Learned." This presentation is publicly available on the CFTC's website as Exhibit F of the 28 June 2006 complaint; each page of the presentation is stamped, "BP Confidential." Based on past historical relationships, the propane traders had expected their trading strategy's performance to be in the range of -$5 million to +$15 million. The document detailed the controls that were in place, and those which needed to be put in place going forward, to avert unexpected trading losses in the future. The report documents the Market Value-at-Risk limits, limits on calendar spreads and plans for improved communications across BP trading units for better information-sharing. Figure 2 summarises the key compliance risks from the internal BP presentation.

Figure 2 - Compliance: Key Risks As Excerpted from Internal BP Presentation: "NGL Feb Value Trade Lessons Learned"

- Regulatory - No violations under current framework, but could increase the risk of regulatory intervention;
- Legal/credit – No specific legal concerns identified, but could increase the risk of an "aggrieved short" failing to make payment or filing a claim for damages;
- Reputational – Primary risk.

Source: Exhibit F of CFTC (2006b).

Amongst the "actions going forward" are a request for the trading unit to have training in compliance and regulatory matters.

On 25 October 2007, the CFTC announced the entry of a consent order in the United States District Court in Northern Illinois, which settled civil charges against BP. "In a related filing, the Criminal Division, Fraud Section of the United States Department of Justice also announced the simultaneous filing of an information and entry into a deferred prosecution agreement with BP America Inc. based upon the same underlying conduct," stated CFTC (2007b). The total monetary

sanction against BP was approximately $303 million, "the largest manipulation settlement in CFTC history," according to the CFTC (2007b), which included both civil and criminal penalties. The order found that BP employees had "violated the Commodity Exchange Act's prohibitions against manipulating the price of a commodity and cornering a commodity market."

The key risk-management lesson from this debacle is to have a clear-cut compliance and ethics program, not just for the trading staff but also for senior management, given how the regulatory and legal risks can outweigh market risks when engaged in large-scale commodities trading. In fact, the 25 October 2007 consent order required BP to "establish a compliance and ethics program, and install a monitor to oversee BP's trading activities in the commodity markets."

On the same date, the CFTC also announced an additional settlement against an *individual* BP trader. In this case, the CFTC found that a BP gasoline trader had attempted "to manipulate the price spread between the November and December 2002 unleaded gasoline futures contract traded on the New York Mercantile Exchange ... on October 31, 2002, the last day of trading for the November 2002 unleaded gasoline futures contract," according to CFTC (2007c).

The order found that even though BP had 52 more gasoline contracts than were stated as commercially needed, the individual gasoline trader had "bought an additional 720 November 2002 unleaded gasoline contracts throughout the course of the day on October 31, 2002" in order to influence the spread between the November and December contracts.

The individual trader was personally fined $400,000 and was prohibited from any employment activity that required registration with the CFTC.

Again, in this case, the key risk-management lesson is operational. One would conclude that a large-scale trading operation should have systems in place, which monitor position sizes versus limits, particularly on the last trading date for a physically-settled contract.

As will be discussed later in this article, U.S. regulators are now more active in fining traders *personally* rather than just fining their place of employment. This would lead one to the conclusion that prospective traders entering into large-scale derivatives trading operations should be as (or more) knowledgeable about regulatory rules and laws, as they are with sophisticated market risk-management techniques.

Valuation Risk[1]

Bank of Montreal was temporarily in the headlines in 2007 for an energy trading debacle. This case received a lot of attention in the specialty commodity press in the spring of 2007, but then quickly faded from the headlines, as the subprime-credit-related crisis picked up steam in the early summer of 2007.

At the end of April 2007, the Bank of Montreal, which is also known as BMO, announced trading losses of about C$400 million: these losses were later revised upwards to C$680 million. This sum was higher than the bank's revenue from trading during the previous year, according to *The Desk* (2007b). Unfortunately, BMO's auditors had found that the bank's over-the-counter (OTC) natural-gas book had been seriously "mismarked."

The bank's auditors reported that they had never seen such a large discrepancy between the marks that were used, and market value, according to Mavin (2007). Another way of framing the significance of BMO's natural-gas trading loss was that in its filings with the U.S. Securities and Exchange Commission (SEC), BMO had stated that its average one-day Value-at-Risk in its commodity book was only C$8.8 million during the quarter that ended on 31 January 2007 (See Figure 3).

1 - This section is based on Till (2008a).

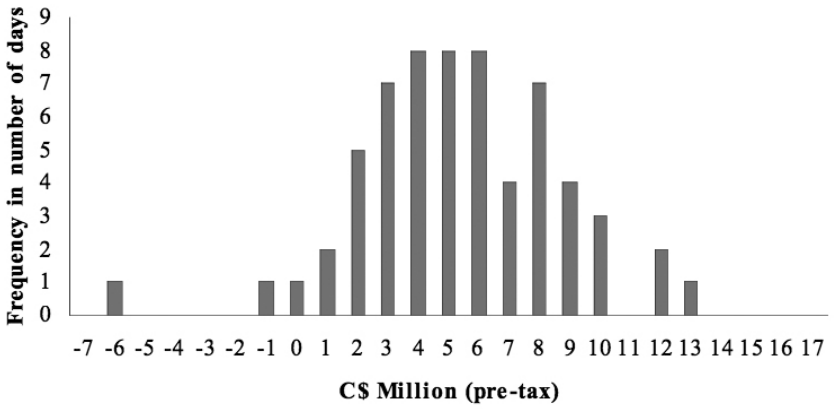
Figure 3 - Total Tradng and Underwriting MVE Summary ($ millions)*

(Pre-tax Canadian equivalent)	For the quarter ended January 31, 2007 Quarter-end	Average	High	Low	As at October 31, 2006 Quarter-end
Commodities Risk	(16.8)	(8.8)	(16.8)	(4.6)	(8.4)
Equity Risk	(8.6)	(7.5)	(10.8)	(5.1)	(9.8)
Foreign exchange Risk	(1.0)	(2.7)	(5.6)	(0.8)	(3.3)
Interest rate Risk (Mark-to-Market)	(7.6)	(5.3)	(10.2)	(2.7)	(7.1)
Correlation	11.1	8.7	11.9	5.1	10.4
Comprehensive Risk	(22.9)	(15.6)	(22.9)	(11.3)	(18.2)
Interest rate Risk (accrual)	(24.7)	(16.1)	(25.0)	(10.3)	(12.0)
Issuer Risk	(3.6)	(4.5)	(5.7)	(3.5)	(5.8)
Total MVE	(51.2)	(36.2)	(51.2)	(28.1)	(36.0)

*Explanatory Notes:
- MVE means "Market Value Exposure"
- MVE is an one -day measure using a 99% confidence interval. Losses are in brak ets and benefits are presented as positive numbers.
Source: Bank of Montreal (2007a).

Figure 4 excerpts from a presentation by BMO's chief risk officer that has been available on the Bank of Montreal's website. This presentation is listed in this article's references section under McGlashan (2007).

Figure 4 - Histogram of Trading P/L As Excerpted from BMO Financial Group's Presentation: "Q1 2007 Risk Review"
Frequency Distribution of Daily P&L For Trading and Underwriting at the BAnk of Montreal (November 1, 2006 to January 31, 2007)



Source: McGlashan (2007).

Figure 4 shows a relatively modest frequency distribution of daily trading profits-and-losses (p/l) for the bank. Clearly, the quantitative method of summarising BMO's trading risk had fallen short.

A key reason why there has not been more communication from BMO on this unexpected loss, as at the plate of this article, is because the bank has had to focus on a number of inquiries from securities, commodities, banking and law enforcement authorities, according to an SEC filing by the bank. The bank "is cooperating with all of these authorities", noted Bank of Montreal (2007b).

Based on publicly available reports, can we say anything about how BMO's trading loss amounted to about 100 times its average VaR reported for fiscal year 2006? One cannot say anythingconclusively since litigation involving the bank's outsized trading loss was still ongoing, as at the date of this article, but a number of press reports and lawsuit allegations provide some indication of what may have gone wrong. Because a number of the facts and allegations in this case are quite incendiary, this section of the article will carefully document the source of each statement.

• Apparently, in the over-the-counter natural gas markets, it "is highly prevalent ... [for] the front office/trading ... [staff to] mark curves for a) implied volatility and b) illiquid basis locations", noted a chief risk officer in *The Desk* (2007d).

• "The Deloitte report [on BMO's OTC energy valuation] ... indicated that some of the prices used in BMO's mismarked book of trades were provided by Valhalla-NY-based Optionable, Inc.," reported Mavin (2007).

• Optionable is "a brokerage [that] specialized in OTC derivatives for long maturities," stated Blanco and Mark (2007). The firm is a public company with its stock trading on an OTC Bulletin Board, which trades under the ticker, OPBL.

• BMO was Optionable's largest customer for a long time, according to *The Desk* (2007c).

• And correspondingly, Optionable was BMO's principal options broker, again according to *The Desk* (2007a).

• " .... Optionable made private offers of stocks or warrants to traders in exchange for volume guarantees," reported The Desk (2007a).

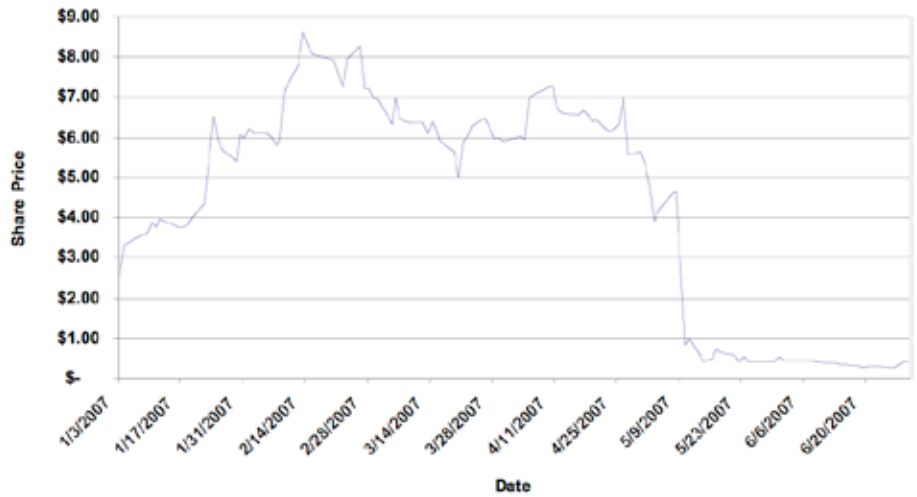
• The lead natural gas options trader at BMO, who was regarded as the "biggest national-gas options trader in the market, had a close personal relationship with the senior management of Optionable," wrote Mavin (2007).

• BMO may have been directly connected to over 80% of Optionable's revenues, according to a lawsuit filed in the U.S. District Court of Southern New York (2007).

• The Optionable CEO's past included being sentenced to 30 months for a felony conviction on credit card fraud in 1997, and six months for income tax evasion in 1993, reported Leising (2007a).

• As shown in Figure 5, Optionable's share price precipitously declined after the revelations of BMO's unexpected losses and associated fraud allegations. As Richard Oldfield said in his book on investing, Simple But Not Easy, "Ethics is not just a county to the east of London.[2] Markets are particularly intolerant of seriously unethical behavior by management, and the revelation of scandal is something which can be relied upon to cause a collapse in share price."

Figure 5 - Optionable (OPBL) Share price



"Optionable, Inc., doing business as OPEX, operates a real-time electronic trade matching and brokerage system. The company provides trading and brokerage services to brokerage firms, financial institutions, energy traders, and hedge funds nationwide."
Source of Data: Bloomberg

2 - Explanation of Richard Oldfield's quote: Essex is a county in the East of England.

Blanco and Mark (2007) conclude the following about the BMO fiasco:
• "Insufficient checks and balances in the mark-to-market process" appear to be the main reason for this debacle.

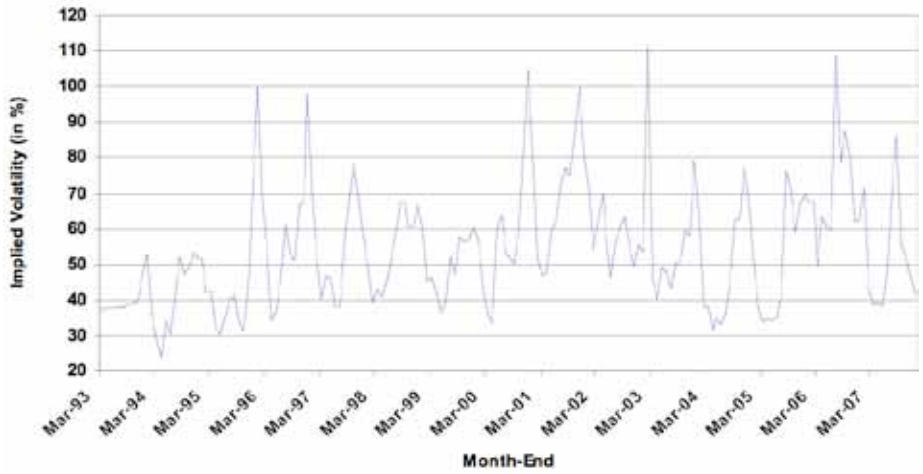
• A contributing factor may have been "deficiencies in the bank's pricing and risk models in terms of incorporating the impact of implied volatility changes."

• "The bank started experiencing heavy losses as implied volatilities came down in the first months of 2007."

• BMO's "chief risk officer noticed [then] that the risk models had some deficiencies in measuring the risk of *long positions in [deep] out-of-the-money ... natural gas OTC options*."

Figure 6 illustrates the dramatic swings in implied volatility that are inherent to the natural-gas options market.

Figure 6 - Natural Gas Implied Volatility (March 1993 to December 2007) Monthly Data Implied from Call Prices



Source of Data: Bloomberg.

According to *The Desk* (2007c), the lessons thus far for energy-trading participants are as follows:
• "... [A]lways get your marks from ... [large,] legitimate, established brokers, publishers, or exchanges."

• "... [M]ake sure that one's code-of-conduct document for traders is ... [sufficient,] and that ... [all traders] have signed it."

• Include in the code-of-conduct document what sort of broker "perks" are unacceptable for traders, and "let nothing be left to common sense."

• Ensure that one's trading activity is diversified across more than one broker.

Again, like the two BP case studies, we have to conclude that for large-scale commodity-trading efforts the complexity may not be in market-risk monitoring, but in relatively-simply described operational controls, which must be rigorously applied throughout a large organization.

Position Limits

On 28 February 2008, the FCM, MF Global, Inc., revealed an unexpectedly large $141.5 million loss from a wheat-futures trading position taken by one of its registered representatives in Memphis, Tennessee for the representative's proprietary (own) account. The MF representative had amassed more than 15,000 futures contracts covering 75 million bushels of wheat on the Chicago Board of Trade, between midnight and 6 a.m. on 27 February, reported Smith and Scheer (2008).

According to Cameron and Lucchetti (2008), "the futures brokerage blamed the loss on a failure in its systems." Apparently, the clearing firm did not have automatic limits in the sizing of futures trades executed electronically, when the operator was a registered representative of the firm.

Dowd (2007) wrote about the potential downside of electronic trading:
"*The downside of all this speed is that it can now take milliseconds for an 'out trade' to go horribly wrong. We often hear the 'fat-finger' trade cited as one of the drawbacks of electronic trading. (The term fat finger is trading jargon to describe electronic trades that were entered incorrectly.) For example, there is the story of the trader who spilled his coffee on the keyboard and mistakenly sold 10,000 Japanese Government Bond futures.*"

As a consequence of the wheat loss, MF Global's CEO stated that "the company would introduce limits on positions taken by all customers and traders," reported Cameron and Lucchetti (2008).

The FCM also took other remedial actions to restore customer and shareholder confidence in its risk-management infrastructure. According to MF Global (2008), the firm increased "the number of on-site risk specialists in every company center around the world, assigning additional staff to duty in each center overnight and ensuring that all centers operating in daytime hours back up nighttime centers." The firm also commenced the search for a "new chief risk officer to be in charge of all risk areas of the company and to report directly to MF Global's CEO."

As of late April 2008, the marketplace affirmed these risk-management improvements by MF Global, as shown by the FCM's share-price recovering by a substantial margin from its mid-March-2008 low.

In this case, a corollary to Oldfield's previously-cited maxim held: because the firm's financial loss had not been due to an ethical lapse by the company's management, MF Global was successful in retaining the market's confidence.

Summary of Risk Management Lessons for Large Institutions

None of the three case studies described above involve complex mathematical issues, nor can they be briefly summarised as fundamental control problems. That said, this statement is admittedly not fair to individuals at large organisations, who operate in extremely complex social environments. Frequently, for individuals working at large companies, one can liken employment to a sumo-wresting match. From the outside, it does not look like anything much is getting done, but just staying in the ring is actually the accomplishment.

The real conclusion from this section might be an insight from a textbook, which is not considered a risk-management primer: "Good to Great". In the main, a large organisation can only do well when it implements a handful of simple concepts, which it consistently applies in scale and across time, by individuals who all share common business values. In the case of large commodity derivatives trading companies, an emphasis on:
(1) complying with regulatory rules and laws;

(2) valuing instruments based on pricing sources genuinely independent of the trading team; and

(3) imposing strict position limits in all electronic trading systems;

are clearly core principles that all stakeholders in institutionally-sized commodity trading firms should embrace.

Proprietary-Trading Risk Management

In contrast with a proprietary trading firm, one is not dealing with the complex external world of clients, distribution agents and enhanced regulatory scrutiny, so complexity in the trading process is much more acceptable (and possible). In addition, there is no agency-versus-principal problem of struggling to come up with the right incentives so that agents handle client or shareholder obligations responsibly. At a proprietary trading firm, the principals have their own capital at risk so a complex system of controls and incentives becomes a moot point: the possibility of facing personal bankruptcy is usually a sufficient disciplining mechanism in carrying out business operations responsibly.

Quite simply, a proprietary trading firm exploits some empirical regularity in the futures markets. They are two main risks to this business model. A strategy might have arisen because there was enormous commercial demand for some exposure and there was not sufficient speculative capital to offset this demand, creating abnormal economic profits for speculators. The risk is then that what had once been a one-sided flow becomes a two-sided flow as more speculators enter a "too-good-to-be-true" strategy.

Another risk for proprietary traders is that there are structural breaks. A signature example is that prior to the current business cycle, the U.S. could safely be said to be the dominant participant in a number of commodity markets, especially on the demand side. This created numerous empirical regularities, particularly in the energy and grain futures markets. This is now a questionable proposition in the face of the historic Chinese industrial revolution. Another way of saying this is that strategies, which relied on the continuation of the U.S. as the dominant factor in commodity demand, may no longer work.

These two risks can best be explained by understanding that the fundamental nature of speculative commodity trading is "flow trading." Kins explained this in Akey *et al*. (2006). The following excerpts from Kins' text:

- "Many traders in sizeable organizations benefit from extensive information flow, and many of these traders do not even realize the degree of their dependence on such information.

- "Once removed from the deep information channels, many formerly successful traders may become incapable of trading profitably".

- "In other instances, the ... effects of reduced information flow are more difficult to detect. In these scenarios, it appears at first that a trader is unaffected by his or her new situation and is able to perform as well as he or she had historically".

- "After a period of time, [however,] ... the trader's performance dissipates dramatically".

- "This phenomenon is often caused by the fact that when an individual leaves an institution, they may be able to maintain several key relationships with former colleagues, clients, or counterparties who are still in a position to provide valuable information flow for some while. As time passes, however, this information flow ...often ... dwindle[s], ... thereby leaving these traders unable to perform as they had historically".

- "In order to avoid such a situation, flow traders either need to find new return drivers or become large enough so that they can obtain similar information themselves before their relationships expire".

Kins' observations help us to understand how temporary any individual trader's capacity to be profitable can be, once they leave the employment of institutionally-sized firms.

Hedge Fund Risk Management

Hedge funds are a hybrid of an institutional asset-management firm and a proprietary trading company. Whether a hedge fund is more like an institutional firm versus a proprietary trading firm depends on how much of the principals' wealth is at risk. Historically, hedge funds were operated by traders who were successful in their own right, and then consented to allow a limited number of investors into their fund. This made them like proprietary trading firms until relatively recently. But with firms such as JP Morgan, Morgan Stanley, the Man Group and Goldman Sachs buying (or taking stakes in) hedge-fund firms, and with sovereign wealth funds becoming large-scale investors in hedge funds, this historical description may no longer be accurate. For a number of large-scale hedge funds, we have to think of them more like institutional firms where the operational issues are what are paramount in risk management.

In support of this latter assertion, Christory, Daul and Giraud (2006) cite a 2003 study by Giraud, which found that:

"*in the case of blowups, operational risk greatly exceeds the risk related to the investment strategy, with more than half of hedge fund collapses directly related to a failure of one or several operational processes.*"

Also, arguably once a hedge fund becomes sufficiently large, the only opportunities that exist in the required scale are either traditional or alternative betas (which are also known as risk premia), so the complexity in risk management is typically not in market-risk management since it is the fund's clients who are assuming the market risk.

Fund-of-Hedge-Funds Diversification

A key way that commodity investors can choose to diversify the idiosyncratic operational risk of individual commodity hedge funds is through a natural-resources fund-of-funds, as explained in Akey *et al.* (2006). Because the opportunity set for commodity investments is so diverse, a fund-of-funds can potentially dampen the sharp peaks-and-troughs of individual managers, as discussed in Akey (2005, 2007). Even with this in mind, each individual manager should take steps to keep their market risk within well-understood bounds, which is covered in the next section.

Market Risk Management

No matter what the scale of an individual trading operation is, the management of market risk is still necessary (but not sufficient, as the previous case studies showed). The five basic elements of commodity risk management are as follows:

- Trade Construction;
- Sizing;
- Exit Strategy;
- Scenario Analyses; and
- Choice of Leverage Level.

We will take the reader through recent trading mishaps and show how losses might have been reduced with a more judicious application of these elements of risk management.

Trade Construction

Futures traders typically aim for a long-option-like payoff profile. Grant (2004) notes, for example, that global macro traders typically have an additional objective besides a return threshold. He provides a benchmark objective for the "performance ratio," which is the ratio of average daily gains divided by average daily losses. Based on Grant's experience, a performance objective "in the range of 125% is entirely achievable ... [although some traders can exceed that], consistently achieving 200%+ in this regard."

That said, some opportunities in the commodity futures markets have short-option-like payoff profiles. One example is weather-fear premia strategies. In these trades, which can be found in the grain, tropical and natural gas futures markets, a future price is systematically priced too high relative to where it eventually matures. This occurs before a time of unpredictable weather such as the Brazilian winter or summer-time in the U.S. Midwest and Northeast. In the case of the Brazilian winter, an extreme frost can damage Brazil's coffee trees. In the case of the U.S. summer-time, an exceptional heat-wave can impair corn pollination prospects as well as stress the delivery of adequate natural gas supplies for peak air-conditioning demand.

Over long periods of time, it has been profitable to short these commodity markets during the time of maximum weather uncertainty. But during rare instances, these strategies can have very large losses, which create classic short-option-like profiles.

If one includes short-option-like strategies in a futures program, then the sizing of these trades needs to be reduced compared to the sizing of trades with long-option-like profiles in order to preserve the program's overall long optionality.

Bear calendar spreads in physically-settled commodity futures markets typically have short-options-like payoff profiles. In times of scarcity for a commodity, market participants will pay extremely high prices for the immediately deliverable contract, meaning that a rally will only substantially benefit the front-month price rather than later-month maturities. In extreme cases of scarcity, the front-month contract's price can become disconnected from the values of the rest of the commodity's futures curve. If a trader is short the front-month contract and long a later-month maturity, then that trader is at risk to this scenario. In other words, a bear-calendar spread puts one at risk to extreme losses. Therefore, if one is aiming to have a sustainable trading career, then one should devote limited risk capital to trades that have this type of construction.

Collins (2007) noted how during 2006, wheat futures traders at the Chicago Board of Trade had assumed there was "free money" in establishing bear-calendar spreads prior to commodity-index roll dates. Unlike an equity index, one unique aspect of a commodity futures index is that its precise rules need to specify on what dates each of its contracts have to be rolled before the maturity of each contract. These rules are known as "roll rules." The rules specify when a particular index constituent should be sold and a further-maturity contract should be bought. In advance of such a procedure, wheat speculators had historically sold the front-month while buying the next-month contract, establishing a bear-calendar spread. They would then unwind this position during index roll dates. Collins (2007) wrote that this strategy suffered during the fall of 2006 "when a [wheat] supply disruption in Australia caused sharp reversals in wheat spreads[;] ... certain calendar wheat spreads moved [substantially against the speculative spreaders] ... in a week."

Collins (2007) reported that "the use of bear calendars this way [can be compared] to an options writing strategy, which can offer consistent profits until one huge spike in volatility can wipe out months of profits and more."

Sizing

Natural gas seems to be at the centre of a lot of trading debacles. Natural-gas derivatives trading

has offered hedge funds a potentially alluring combination of scalability and volatility, and also at times, pockets of predictability. This faith has continued unabated. For example, even in the aftermath of Amaranth sustaining the largest hedge-fund loss thus far in history, one of its natural-gas traders based in London was soon able to obtain a $1-million signing bonus when joining another large-scale global macro hedge fund, according to Harris (2006).

By the spring of 2007, Amaranth's former head natural-gas trader had apparently obtained close to $1 billion in investor commitments for a new hedge fund headquartered in Calgary, Alberta, reported Herbst-Bayliss (2007). A July 2007 U.S. regulatory action against the head trader himself (and not just against his former employer, Amaranth) appeared to put an end to these particular plans.

There are two main publicly known hedge-fund natural-gas trading mishaps: that of MotherRock and Amaranth in 2006. More recently in February 2008, the Houston-based energy hedge-fund, Saracen, was reported to have had difficulties with natural-gas trading positions, too. That said, in each of these cases, the losses in the U.S. and European banking system are so massive that the losses by these hedge funds seem very small in the rear-view mirror. According to Tett (2008), the Western banking system may eventually suffer $500 billion or more in write-downs during the "credit crunch."

But then again, even if a firm's losses are small compared to what the global banking system is capable of losing, this is not much comfort for a firm's principals or its clients.

The key to understanding the 2006-2008 natural-gas trading losses seems to be one of sizing. The commodity markets do not have natural two-sided flow. For experienced traders in the fixed income, equity and currency markets, this point may not be obvious. The commodity markets have "nodal liquidity." If a commercial market participant needs to initiate or lift hedges, there will be flow, but such transactions do not occur on demand. Before a trader initiates a position, particularly one that is large compared to the size of the market-place, one needs a clear understanding of what flow or catalyst will allow the trader out of a position.

A commodity-market observer can readily identify when a massively-sized distressed liquidation is occurring, particularly in a spread market. If there is no economic or weather news regarding a market, and a spread relationship changes by many standard deviations relative to recent history, this is a clear signal that a market participant is unwinding a position in a distressed fashion.

Therefore, a key risk-management objective in (speculative) commodity futures trading is to keep sizing within a relatively small fraction of daily trading volume and open interest.

The following is a discussion of three commodity hedge-fund case studies, based on publicly available information, which may admittedly be incomplete.

MotherRock

According to Leising (2006), MotherRock was a hedge fund that was founded in December 2004, which "invest[ed] in [natural] gas futures, seeking to exploit price differences based on the delivery month of the contracts." As of early 2006, the fund "had more than $400 million in customer funds." The New-York-based fund also traded option contracts on natural gas, according to MarketWatch (2006). As of the end of June 2006, the fund had about $280 million in assets under management, reported Goldstein *et al.* (2006).

On August 3rd, 2006, Leising and Burton (2006) broke the story that MotherRock was "preparing to shut down because of 'terrible performance,'" based on a letter to the fund's investors from the hedge fund's founder. According to Boyd (2006), by mid-September 2006 "investors in ... MotherRock ... lost their last chance to recover any of their stake in the ill-fated operation."

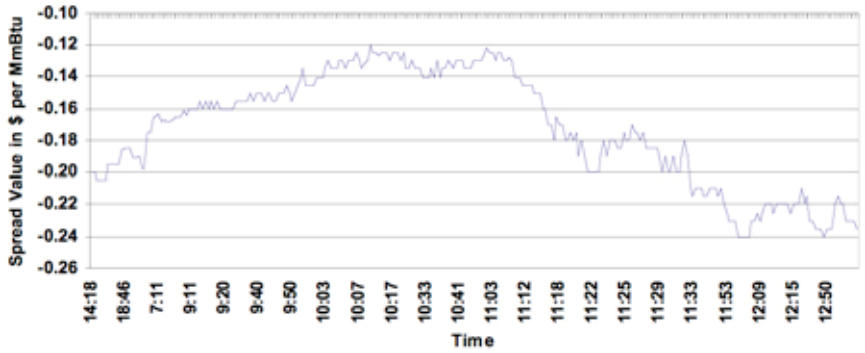
Further, according to MarketWatch (2006), MotherRock had left its clearing firm, ABN Amro, with up to $100-million in losses. This is an illustration of how an FCM can ultimately be responsible for the tail risk of a customer's strategies. MotherRock's clients apparently had no further liability for their losses beyond their investment.

The summary thus far contains information that became known *after* MotherRock's founder announced the fund's plans to shut down. Market participants, though, were already alerted to a distressed liquidation on August 2nd, 2006, the day before MotherRock's announcement.

A near-month calendar spread in natural gas experienced a 4.5 standard-deviation move intraday before the spread market normalised by the close of trading on August 2nd, 2006.

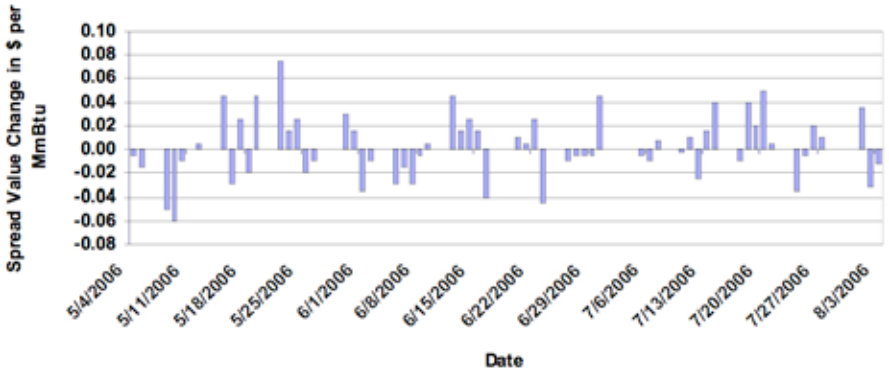
Figure 7 illustrates the intraday and three-month behavior of the September-vs.-October Natural Gas (NG U-V) spread.

Figure 7 - Natural Gas September-October Spread: Overnight Trading on 8/1/06 and Intraday Trading on 8/2/06



The intraday peak-to-trough move in the NG U-V spread was 12c on 8/2/06.
Trading in the NG U-V spread was discontinuous, so there are gaps in the graph when the spread did not trade.

Figure 8 - Daily Changes in Natural Gas September-October Spread from 5/3/06 to 8/3/06



As of 8/1/06, the daily standard deviation of the NG U-V spread had been 2.67c based on the previous three months of data. Therefore, the spread's intraday move, which is illustrated in Panel A, was 4.5 (= 12/2.67) standard deviations (based on the last three months of daily data.)
Source: Till (2006b).

We might assume that MotherRock had on a position that was correlated to being short the NG U-V (September-October) spread. Why make this assumption? The brief intense rally in this spread on August 2nd, 2006 is consistent with the temporary effects of a forced liquidation, involving a position related to this spread.

As it turned out, the scale of MotherRock's losses, which may have been up to $300 million, was small compared to Amaranth's experience the following month. According to Boyd (2006), Amaranth "was a buyer of many of the positions [of MotherRock.]."

Amaranth[3]

Amaranth Advisors, LLC was a multi-strategy hedge fund, which was founded in 2000 and was headquartered in Greenwich, Connecticut. The founder's original expertise was in convertible bonds. The fund later became involved in merger arbitrage, long-short equity, leveraged loans, blank-check companies, and in energy trading. As of June 30th of 2006, energy trades accounted for about half of the fund's capital and generated about 75 percent of its profits, according to Burton and Leising (2006).

Davis (2006) has provided the best overview thus far on Amaranth's energy trading. The following account largely draws from her article.

Davis reported that Amaranth's head energy trader sometimes held "open positions to buy or sell tens of billions of dollars of commodities." Amaranth's energy trading operation was based in Calgary, Alberta. "[Amaranth's head energy trader] saw that a surplus of [natural] gas ... [in the] summer [in the U.S.] could lead to low prices, but he also made bets that would pay off if, say, a hurricane or cold winter sharply reduced supplies by the end of winter. He was also willing to buy gas in even further-away years, as part of complex strategies."

"Buying what is known as 'winter' gas years into the future is a risky proposition because that market has many fewer traders than do contracts for months close at hand."

"Unlike oil, [natural] gas can't readily be moved about the globe to fill local shortages or relieve local supplies."

"[Natural gas] traders ... make complex wagers on gas at multiple points in the future, betting, say, that it will be cheap in the summer if there is a lot of supply, but expensive by a certain point in the winter. [Amaranth's head trader would] closely watch how weather affects prices and whether conditions will lead to more, or less, gas in a finite number of underground storage caverns."

Amaranth's structural position-taking may have assisted energy companies in their need to hedge their far-forward production, including through 2010.

"[Amaranth's energy book] was up for the year roughly $2 billion by April [2006], scoring a return of 11% to 13% that month alone, say investors in the Amaranth fund. Then ... [the energy strategies] ... had a loss of nearly $1 billion in May [2006] when prices of gas for delivery far in the future suddenly collapsed, investors add. [The energy traders] won back the $1 billion over the summer ..."

As of August 31st, 2006, the fund had about $9.2 billion in assets under management.

On Monday, September 18th, 2006, market participants were made aware of Amaranth's distress. The founder had issued a letter to investors, informing them that the fund had lost an estimated 50% of their assets since its end-August value. Additionally, the fund had lost -$560 million on Thursday, September 14th, 2006 alone, according to *Reuters* (2006).

According to Davis *et al.* (2007), the fund had scrambled to transfer its positions to third-party financial institutions during the weekend of September 16th and 17th. Merrill Lynch had agreed to take on 25% of the fund's natural gas positions for a payment of about $250 million. The fund then lost a further $800 million through Tuesday, September 19th, 2006, due to the natural-gas market moving severely against its positions. On Wednesday, September 20th, 2006, the fund succeeded in transferring its remaining energy positions to Citadel Investment Group and to its clearing broker, JP Morgan Chase, at a -$2.15 billion discount to their September 19th, 2006

3 - This section is partially excerpted from Till (2008c).

mark-to-market value. Apparently, the two firms equally shared the risk of Amaranth's positions. On Thursday, September 21st, 2006, the natural gas curve stabilized.

The hedge-fund's losses ultimately totaled $6.6 billion, according to O'Reilly (2007).

On June 25th, 2007, the U.S. Senate Permanent Subcommittee on Investigations (PSI) released a report on the Amaranth debacle, entitled, "Excessive Speculation in the Natural Gas Market."

The 135-page report (and its further 345 pages of appendices) provided a wealth of detail on the Amaranth case. In carrying out their forensic analysis, the Senate subcommittee examined several million individual trades. The subcommittee obtained this information by subpoenaing records from the New York Mercantile Exchange (NYMEX), the Intercontinental Exchange (ICE), Amaranth, and other traders.

Amaranth's spread trading strategy involved taking long positions in winter contract deliveries and short positions in non-winter contract deliveries. These positions would have benefited from potential weather events such as hurricanes and cold-shocks from 2006 through 2010. Although one can justify the economic rationale for Amaranth's strategy, both trade-sizing *and* value matter even more so.

The U.S. Senate PSI found that in late July 2006, Amaranth's natural-gas positions for delivery in January 2007 represented, "a volume of natural gas that equaled the entire amount of natural gas eventually used in that month by U.S. residential consumers nationwide."

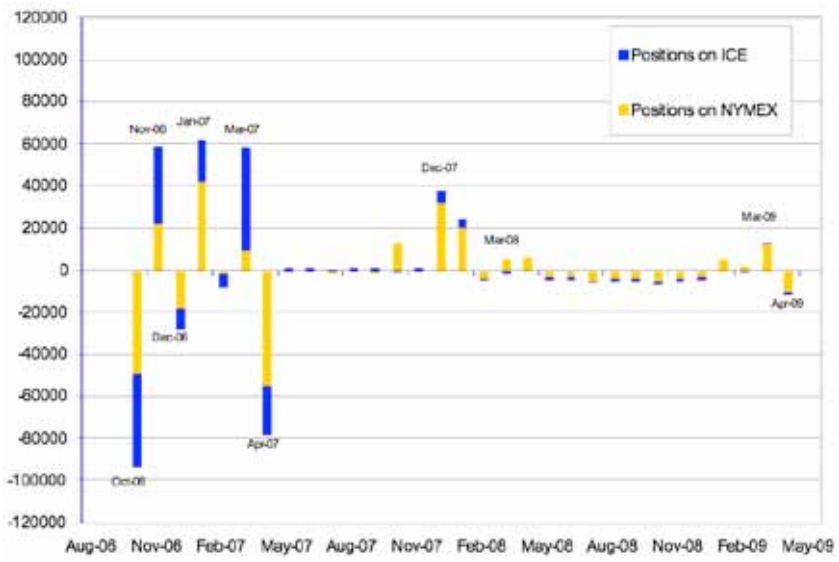
Drawing from the U.S. Senate's report, Figure 8 summarizes the scale of Amaranth's natural-gas trading activity. Figure 9 draws from the report's appendix to show the positioning of the fund through May 2009, as of the end of August 2006. The U.S. Senate report does not include similar charts for the fund's positions past the May 2009 maturity date. The report also does not include the fund's miscellaneous commodity investments.

Figure 8 - Scale of Amaranth's Natural Gas Trading: Excerpted from U.S. Senate Report of June 25th, 2007

At times Amaranth controlled up to 40% of all the open interest on NYMEX for the winter months (October 2006 through March 2007).	pp. 51-52
In late July 2006, Amaranth held a total of more than 80,000 NYMEX and ICE contracts for January 2007, representing a volume of natural gas that equaled the entire amount of natural gas eventually used in that month by U.S. residential consumers nationwide.	p. 52
On July 31st, 2006, Amaranth's trading in the March and April 2007 contracts represented almost 70% of the total NYMEX trading volume in each of these contracts on that date.	p. 52
Amaranth held large positions in winter and summer months spanning the five-year period from 2006-2010.	p. 52
For example, Amaranth held 60% of the outstanding contracts (open interest) in all NYMEX natural gas futures contracts for 2010.	p. 52
On 7/24/06, Amaranth's futures position as a % of NYMEX futures open interest in the December 2007 contract was 81%.	p. 94
On 8/28/06, Amaranth accounted for over 40% of the total volume on the ICE, and over 25% of the entire volume of exchange-traded futures and swaps on NYMEX and on ICE on that date.	p. 101
NYMEX: New York Mercantile Exchange ICE: Intercontinental Exchange	

Source: Excerpted from Staff Report (2007). The right-hand column shows on what page of the Staff Report that each point is derived from.

Figure 9 - Amaranth's forward Curve on Agust 31 2006
Natural Gas Contracts on Nymex and Ice



Source: Based on Staff Report (2007), Appendix V, p. 38.

Amaranth's position sizes were obviously too large for a financial entity that had no physical energy assets. If a financial firm cannot make or take physical delivery of a commodity, then that firm's exit strategy is very constrained. Also, the fund had entered into these vast positions at exceedingly wide levels for these spreads.

Using the Senate report's documented positions for Amaranth as of August 31st, 2006, we find that two spreads were 93% correlated to Amaranth's natural-gas book:

The November 2006 vs. October 2006 (NGX-V6) spread; and the
The March 2007 vs. April 2007 (NGH-J7) spread.

In our analysis, we examined the past spread values for the November-versus-October-2006 spread and the March-versus-April-2007 spread in order to understand the riskiness of Amaranth's documented August 31st 2006 portfolio.

If these two spreads had reverted to levels that had prevailed at the end-of-August during the previous six years, one could have seen that up to -36% could have been lost under *normal* conditions. This is illustrated in Figure 10.

Figure 10 - Scenario Analysis of Amaranth's Key Risk Positions As of 8/31/06

Scenario Analysis if Winter vs. Non-Winter Spreads Reverted to Past Spread Relationships

Number of Contracts	Spread Symbol	Natural Gas Spread	8/31/06 Level
(105,620)	NGV-X	October-November	-2.18
59,543	NGH-J	March-April	2.14

Date	NGV-X	NGH-J	Losses due to V-X	Losses due to H-J	Total Losses	Portfolio Loss
8/31/2000	-0.058	0.26	$ (2,241,256,400)	$ (1,119,408,400)	$ (3,360,664,800)	*-36.5%*
8/31/2001	-0.33	0.09	$ (1,953,970,000)	$ (1,220,631,500)	$ (3,174,601,500)	*-34.5%*
8/31/2002	-0.33	0.113	$ (1,953,970,000)	$ (1,206,936,610)	$ (3,160,906,610)	*-34.4%*
8/31/2003	-0.25	0.44	$ (2,038,466,000)	$ (1,012,231,000)	$ (3,050,697,000)	*-33.2%*
8/30/2004	-0.643	0.57	$ (1,623,379,400)	$ (934,825,100)	$ (2,558,204,500)	*-27.8%*
8/31/2005	-0.185	2.24	$ (2,107,119,000)	$ 59,543,000	$ (2,047,576,000)	*-22.3%*

Source: Till (2008c). Copyright © Institutional Investor Journals.

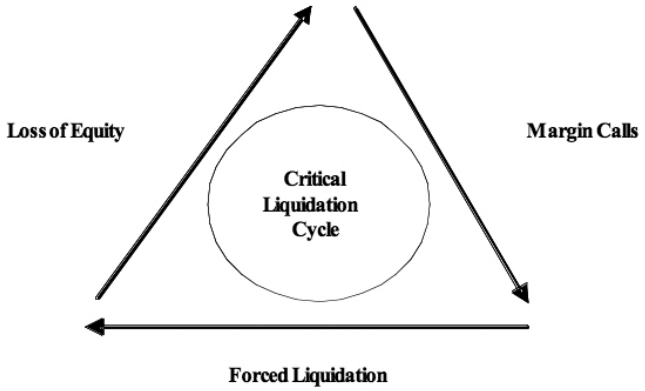
This was two weeks before the fund's implosion.

One caveat with this analysis is that it is based solely on the positions that were documented in the June 25th U.S. Senate report's graphical appendix. This analysis may therefore be incomplete,

to the extent that Amaranth held other sizeable positions not documented in the Senate report, or if the Senate report oversimplified Amaranth's natural-gas position-taking, which included options.

By the middle of September 2006, the fund had lost more than $2 billion month-to-date. It was at this point that the critical-liquidation-cycle was initiated for the fund, as illustrated in Figure 11. Figure 11's framework appears to be quite appropriate for the Amaranth case.

Figure 11 - The Critical Liquidation Cycle



Source: De Souza and Smirnov (2004). Copyright (c) Institutional Investor Journals.

In the case of Amaranth, there was no natural (financial) counterparty who could entirely take on their positions during a very short space of time when the fund became distressed in mid-September 2006. The natural counterparties to Amaranth's trades were the physical-market participants who had either locked in the value of forward production or storage. The physical-market participants would likely have had physical assets against their derivatives positions so would have had little pressing economic need to unwind these trades at Amaranth's convenience.

We can infer how long it may have taken to unwind the Amaranth positions by seeing if there were any footprints in natural-gas price patterns from, 20 September, 2006 onwards.[4]

Figure 12 shows the evolution of natural-gas spreads in which the long legs are the winter contracts, and the short legs are summer and spring contracts, which in turn are collectively correlated to Amaranth's actual positions. This graph is from September 1st, 2006 through December 31st, 2006.

From this graph, we see that the spreads recovered in late September during the immediate aftermath of the portfolio transfer, indicating a (temporary) absence of liquidation pressure. At the end of September 2006, Citadel assumed the entire Amaranth portfolio, taking on JP Morgan's half of Amaranth's positions, by paying JP Morgan $725 million; Citadel also received all the remaining concessionary payments from Amaranth, according to Baer (2006).

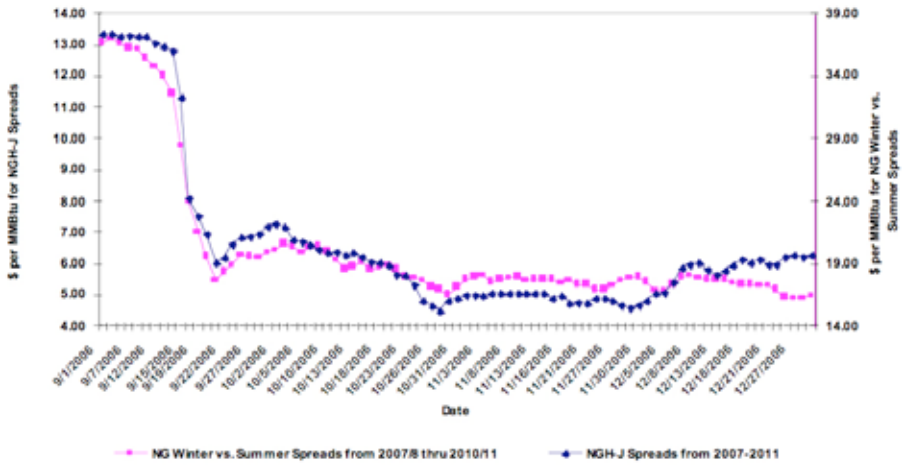
Again examining Figure 12, we note that the natural-gas spreads smoothly declined throughout October, and in the main bottomed out by the end of October.

At the end of November 2006, there were widespread public reports about the contents of Citadel's bond prospectus, which provided some commentary on the timing of the unwind of Amaranth's trades. According to Baer (2006), the Citadel document said that the firm had reduced the risk of its Amaranth positions by two-thirds during the first two weeks of October. Since the natural-gas curve bottomed out at the end of October, we infer that Citadel essentially finished unwinding the risk of the remaining positions during the last two weeks of October.

4 - This section is based on Till (2007b).

We expect that commercial-market hedgers were the natural other side to Citadel's orderly unwind of October 2006. Commercial-market participants probably elected to realise their substantial hedging windfall at this time.

Figure 12 - Natural Gas Spread



Notes: NG is an abbreviation for natural gas. H and J are symbols for the March and April futures contracts respectively.
Source of Data: Bloomberg.

Figure 12 shows that there does not appear to be further liquidation pressure on the natural-gas curve in November and December 2006. Given how stable the curve was during this time, this is when normal two-sided flow likely resumed.

Given how orderly Citadel's unwind was during October 2006, the firm probably only sustained relatively small losses during this time. Therefore, it appears that Citadel was able to realise substantial net profits, given the $1.425-billion payment that Citadel ultimately received for agreeing to take on Amaranth's distressed portfolio. [$1.425-billion = $2.15-billion (concessionary payment received by Citadel and JP Morgan) minus the $725-million (that Citadel paid JP Morgan so that Citadel could fully take on the entire Amaranth energy portfolio and all remaining concessionary payments.)]

A key lesson from the Amaranth debacle was noted by Greer of PIMCO, as cited in Hougan (2008): "... the market showed that someone can actually be so big that the market will punish them, rather than reward them for their size."

Tying the MotherRock and Amaranth debacles back together, the two firms were on the opposite sides of two natural-gas spreads: the NGH-J (March-April) and the NGF-V (January – October) spread,[5] according to Leising (2007b), who quoted the June 25th Senate report on the Amaranth debacle. The Senate report, in turn, cited an unnamed trader. In particular, MotherRock had been short the March-April 2007 spread:
"'When Amaranth's trading caused a sudden 72-cent jump in the March/April price spread, a number of MotherRock's positions were directly affected, and MotherRock was unable to pay its broker, the [Senate] report said. MotherRock 'no longer had sufficient funds to continue operations. The hedge fund folded soon after.'"

In summary, MotherRock shut down after being short the March-April natural-gas spread. Correspondingly, Amaranth shut down one month later after being long the March-April natural-gas spread. It is no wonder that traders refer to the March-April natural-gas futures spread as the "widow-maker."

5 - We had previously noted that Amaranth's positions were very highly correlated to the March-April 2007 spread and the November-October 2006 spread. The November-October 2006 spread, in turn, had been highly correlated to the January (2007) - October (2006) spread.

What makes this spread so unstable? At the end of the winter, if there is a cold shock and inventories are at their seasonal low, the end-of-winter futures contract's price can explode relative to later-month contracts in order to limit current use of natural gas to absolutely essential activities. This scenario occurred in the winter of 2002/3 and is illustrated in Figure 13. Lammey (2005) quotes a futures trader regarding the extremely cold winter of 2002-3: "I remember that season well, because we started off the winter with intense cold, and ended the season late with intense cold – and many participants in the industry were seriously worried that there might not be enough gas to get us across the finish line."

Figure 13 - Panel A February 2003's Near-Stock-Out Scenario
U.S. Natural Gas Inventories in Billion Cubic Feet During the Winter of 2002/3

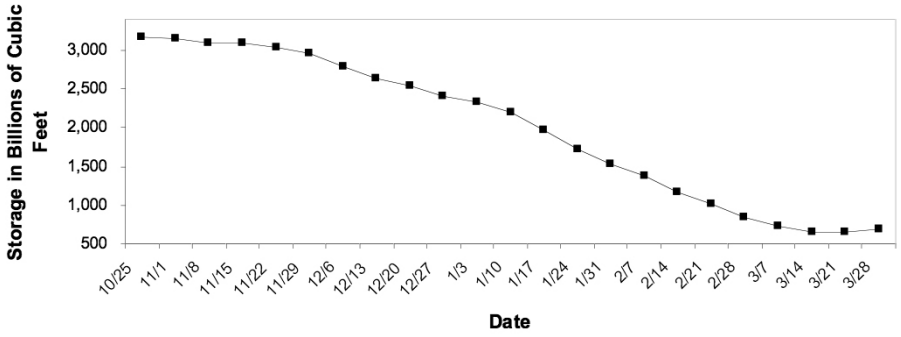
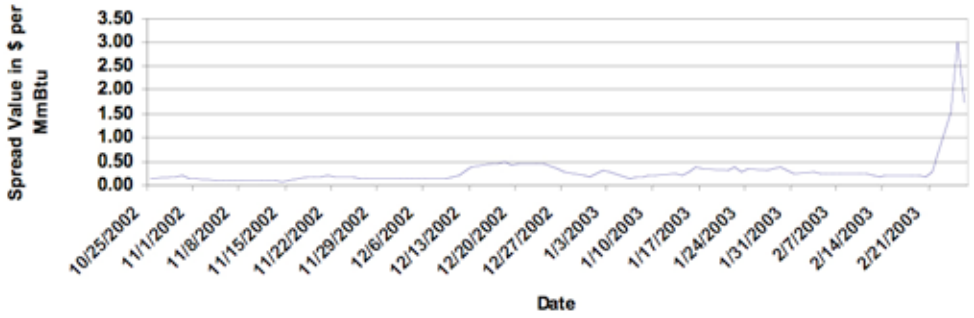


Figure 13 - Panel B
Natural Gas March-April Spread During the Winter of 2002/3

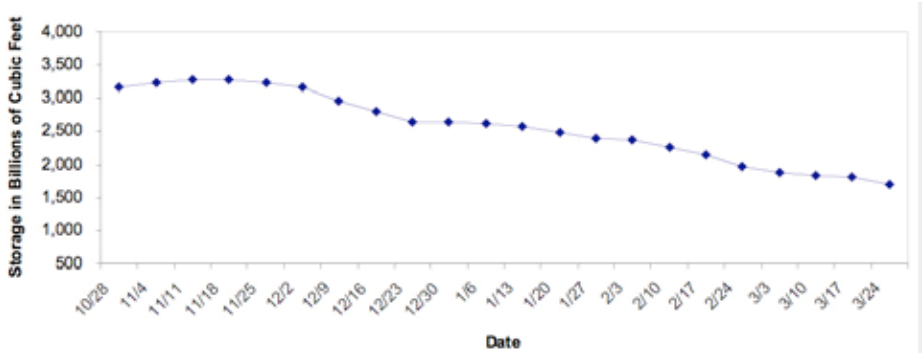


Source: Till (2006b).

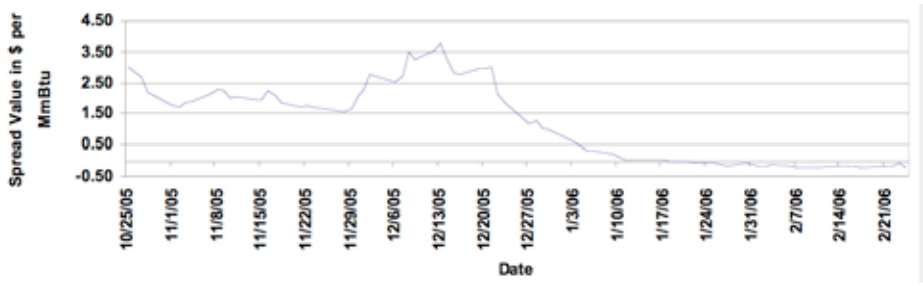
Note in particular how extremely positively-skewed the March-April natural gas spread can be, if there is a near-stock-out scenario in natural gas, as shown in the lower panel of Figure 13.

Instead, if the winter is unexpectedly mild, and there are still massive amounts of natural gas in storage, then the near-month price of natural gas plummets to encourage its current use and the curve trades in contango (that is March trades at a discount to April) in order to provide a return to any storage operator who can store gas. This occurred, for example, during the end-of-the-winter in early 2006. This is illustrated in Figure 14.

Figure 14 - Fear-Premium-Drained-Out-of-Spread-Market Scenario
U.S. Natural Gas Inventories in Billion Cubic Feet During the Winter of 2005/6



Natural Gas March-April Spread During the Winter of 2005-6



Source of Data: Bloomberg.

As one examines the performance of the March-April spread over the past 8 years, it appears that this spread has a binary outcome: either it trades in steep backwardation (with March over April) if there is a sufficiently cold winter and insufficient end-of-winter inventories, or it trades at a contango level, representing the returns to storage, if there is a mild-to-normal winter. This observation will help us understand the continual problems that hedge funds (who do not have physical storage capabilities) have with positions in the March-April natural-gas spread.

But first we should note that the Amaranth debacle of 2006 was already foreshadowed by the unsuccessful trading experience of BP's propane traders. The CFTC complaint against BP and its propane trading activities shows that BP's propane traders had studied the experience of early spring 2003. The BP traders noted how (1) *propane* inventories had been drawn-down substantially; and they also documented how (2) nearer-month-delivery *propane* had traded at a substantial premium to later-month-delivery propane at the end-of-the-heating-season. A chart showing a propane calendar spread during February 2003 in BP's "Lessons Learned" presentation, which, as noted, is included the CFTC complaint, qualitatively looks identical to Figure 13's natural-gas spread, over the same period. Assuming that 2003's season-ending inventories indicated true scarcity, the BP traders believed they had a fundamental indicator for whether a similar tight situation could develop in 2004, and which they could further profit from, if they established "a dominant position" in end-of-winter-delivery propane.

In fact, physical propane was not scarce in March 2004, and the BP traders lost twice as much as their worst-case scenario in carrying out their speculative strategy. As noted previously, the trading loss was $10 million, at least according to the "Lessons Learned" presentation. Again, though, the greater loss was from the civil and criminal penalties exacted by the CFTC and DOJ for adopting a strategy to corner a commodities market with the fines totaling $303 million.

One of the unresolved elements of the Amaranth case is what civil penalties may be assessed against the hedge fund and its principals. From the outcome of the BP propane case, as announced on October 25th, 2007, one might expect substantial fines could also be potentially levied against Amaranth. Given that the CFTC had also fined a BP gasoline trader as an individual, one might also expect that Amaranth's principals could be at risk as well.

Perhaps it is not a surprise then that both the CFTC and the Federal Energy Regulatory Commission (FERC) have been pursuing actions against the former hedge fund.[6] These actions were announced on July 25th and 26th, 2007. That said, as of the writing of this article, Amaranth's current and former principals were vigorously countering the regulatory actions against the firm and its former traders.

While the Senate report focused on whether Amaranth's position-taking pushed *up* the price of forward winter natural gas prices, the CFTC and FERC's (publicly known) investigations were much more narrowly focused on Amaranth's trading activities on several days of 2006.

6 - This section is excerpted from Till (2008c).

The CFTC's regulatory authority mainly covers the exchange-traded futures markets, so their investigation narrowly focused on the fund's documented activities on the NYMEX. Correspondingly, the FERC is responsible for overseeing the wholesale natural gas and electricity markets in the U.S. The monthly settlement price for the expiring NYMEX natural gas futures contract is frequently used in pricing physical natural gas transactions, so the FERC may have oversight jurisdiction if there is an attempted (or actual) manipulation of the NYMEX settlement price for expiring contracts.

Essentially, both the CFTC complaint of July 25th, 2007 and the FERC preliminary findings of July 26th, 2007 allege that Amaranth and its energy traders attempted to manipulate the settlement price of the expiring NYMEX futures contract downwards on several occasions in order to benefit very large over-the-counter Intercontinental Exchange (ICE) swaps that were positioned short.[7] The fund's ICE swaps cash-settled against the NYMEX settlement price and so would benefit from a decline in the NYMEX price.

Figure 15, for example, shows the relative positioning of Amaranth's futures and swaps positions going into the April 26th expiry of the May 2006 natural gas futures contract. This figure illustrates how the ICE short position became much larger than the NYMEX long position as of the late-April expiry. The CFTC and FERC cite numerous trading records, showing how the fund concentrated its sales of its long position in NYMEX futures until the very end of the trading day. This strategy may have had a large impact in driving down the price of the expiring contract.

Figure 15 - Amaranth April 2006 Daily Positions: May NG Futures Contracr vs. May Swaps

Source: Based on Figure 10 of FERC (2007).

In addition to trading records, both the CFTC and FERC cite voluminous e-mail exchanges, instant messages, and recorded phone conversations in bolstering their allegations of an attempted (or actual) price manipulation.

The CFTC also alleged that Amaranth made false statements to the NYMEX when the exchange formally asked the fund about the justification and commercial purpose of its May-contract expiry trading.

The CFTC complaint requests that the U.S. District Court in the Southern District of New York enter an order prohibiting Amaranth and its former head trader from "engaging in any business activities related to commodity interest trading" amongst other prohibitions.

The FERC was granted anti-manipulation authority in the physical natural gas markets by the Congress in 2005, and the Amaranth case is the first such exercise of this authority.

7 - To be more precise, the CFTC complaint alleges *attempted manipulation*, while the FERC order alleges *actual manipulation*.

Procedurally, the FERC issued a "show cause order" on July 26th, 2007 "after making a preliminary finding of serious manipulation in the natural gas markets." The FERC is "proposing to order disgorgement of unjust profits and civil penalties totaling nearly $300 million," including a penalty of $30 million for Amaranth's former head trader.

The FERC order explains why the commission was calling for very large monetary penalties for Amaranth and two of its natural gas traders:

"There are strong enforcement and deterrence policy bases for setting the civil penalties for individual traders at a high level. The traders in this industry have historically been capable of easily recovering from disastrous performance or misconduct by simply moving to, or starting up, another trading operation. Even after spectacular failures, a trader can attract capital to start new trading activities or a new fund. ... Under the circumstances, the Commission sends here a clear message that manipulation will have severe personal consequences for individual traders in order to deter them and others from violative behavior."

Saracen

We had previously stated that the March-April natural-gas spread can have a binary outcome, depending on whether there is an extreme winter or not. For markets with storage, delivery, or processing rigidities, the inter-market or intra-market spreads frequently have binary outcomes. Arguably, this has essentially also become the case for gasoline crack spreads. One either has insufficient refining capacity and the margin of gasoline over crude oil (the gasoline crack spread) becomes $35 per barrel, as in the summer of 2007; or one has sufficient capacity, and the gasoline crack becomes negative, as in March 2008.

In binary markets such as the end-of-winter natural-gas calendar spread (and the summer gasoline crack), one can see what probability the market is pricing in for extreme outcomes in the future, and then decide whether those odds make sense for a trading strategy.

The following is an example of this methodology employed by Premia Capital for the March-April (H-J) natural gas spread. If there is a near stock-out at the end-of-February, the March-April spread can trade to $2.99 per MMBtu, as in the winter of 2003. If there is a mild-to-normal winter, the spread can mature to about -15c per MMBtu, as in the past four winters.

As of December 29th, 2006, the forward natural-gas spreads with maturities in 2007 through 2011 had the following values:

NGH-J7: -10c
NGH-J8: $1.14
NGH-J9: $1.33
NGH-J0: $1.30
NGH-J1: $1.29

Average from 2008 thru 2011: $1.265.

Say p is the probability of a stock-out scenario, and (1-p) is the probability of a comfortable winter.

$1.265 (forward price of NGH-J) = [p * $2.99] + [(1 - p) * -$0.15]. ==> p = 45%.

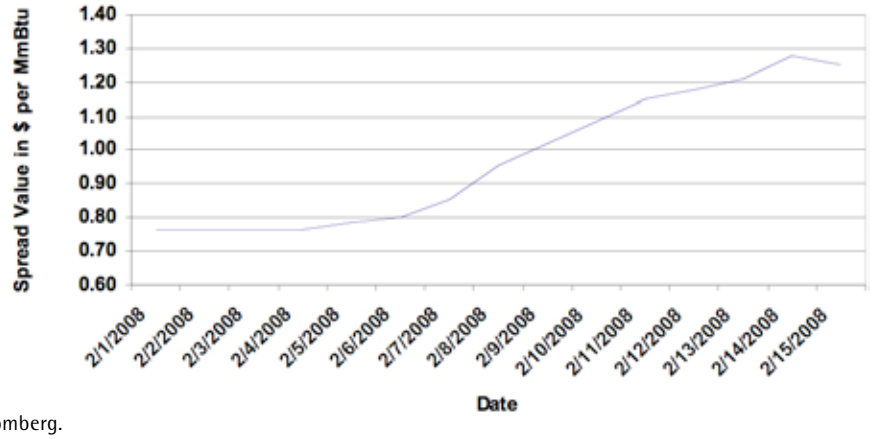
As of December 29th, 2006, the forward natural-gas market was pricing in a continual 45% chance of stock-out-fears coming to pass over the following four years.

Is this probability a low or a high number? It would depend on one's information on whether sufficient new production, storage, or Liquid Natural Gas (LNG) terminals would come on-line over time to make a stock-out scenario unlikely. In the absence of sufficient new capacity, then the NGH-J spread is purely a bet on Mother Nature, which is rather difficult to risk-manage.

On February 16th, 2008, Whitehouse *et al.* (2008) reported that Houston-based Saracen Energy Partners LP had "posted undisclosed losses on natural-gas trading and ... [had] been forced to liquidate positions." The firm operates in the "energy markets, including those for natural gas, coal, refined products, and electricity. Natural-gas traders said the fund incurred losses betting on the difference between March 2009 and April 2009 natural-gas contracts."

"The Saracen fund had $1.6 billion in assets under management at the end of January [2008] ... The fund ... dropped 31% year-to-date, as of Thursday [February 14th, 2008] ... According to traders, Saracen bet that the spread between the March and April 2009 contracts would decline, when in fact it widened by 41% in a month," reported Whitehouse *et al.* (2008). Figure 16 shows the evolution of the NGH-J 2009 spread during the first two weeks of February 2008.

Figure 16 - Natural Gas March-April 2009 Spread (2/1/08 through 2/15/08)



Source of Data: Bloomberg.

For market participants, it was noteworthy that the March-April spread appeared to be the culprit in trading losses once again, this time from the short-side, whereas Amaranth's difficulties arose from trading this spread from the long-side. And arguably, BP's propane strategy was highly correlated to this end-of-winter strategy as well, where they were approaching this situation from the long side, like Amaranth.

The five-(business-)day move in the NGH-J9 spread from February 7th, 2008 to February 14th, 2008 was equal to a 7-standard-deviation move, based on the spread's previous three-months of trading history. This is for a spread that matured one year into the future. It is unlikely that expectations on one-year-out storage had changed in a week, so this is a sign of a distressed liquidation.

Based on the binary-outcome model described above, a spread value for NGH-J9 of +85.5c (which was where the spread was trading on February 7th, 2008) implies a market forecast of there being a (near-)stock-out of 32% one-year forward. A spread value of +$1.25 (which was where the spread was trading on February 14th, 2008) gives a corresponding probability of 46%.

Whether fading the possibility of a future stock-out in the natural-gas market is a good idea or not, one would definitely conclude that for short-options-like trades such as this, that sizing should be constrained to where an exit would not result in undue liquidation pressure on the market.

When examining an energy trading loss such as Saracen's in light of the diminished liquidity and credit existing during the spring of 2008, one might reasonably assert that we are missing the overall point. If Bear Stearns, the (previously) fifth largest investment bank in the United States, could so completely misjudge its liquidity situation in mid-March 2008 that it nearly went bankrupt, then it might not be unusual that other market participants had temporarily overlook that the trading environment had fundamentally changed as well.[8]

To be fair to commodity traders who have been in the press for experiencing 20%-plus losses, investors in commodity funds are conditioned to expect both volatility and draw-downs from individual commodity managers. A large loss does not mean that a commodity fund is no longer viable, as long as the loss is within investor expectations and no fraud is involved. For example, the highly-regarded commodity hedge-fund firm, Ospraie Management LLC, closed one of its hedge funds, the Ospraie Point Fund, after it lost -29% during the first five months of 2006, according to Bentley (2006). The firm's flagship fund also lost -19% over the same period. As of the writing of this article, since June of 2006 this hedge-fund firm has both been profitable for its clients and been successful in increasing assets under management; the firm currently manages $9-billion (as of the end of March 2008), according to Kishan and Batcho-Lino (2008).

While we have focused on the natural-gas markets quite extensively in this article, one should note that the most consistent calendar-spread strategies have historically arisen from inflection points in seasonal build-draw cycles in commodity inventories. The reasoning described in this section for natural-gas calendar spreads applies across all storable and quasi-storable commodity markets. This underlying principle was originally described for the grain futures markets in Cootner (1967) and reviewed in Till (2007a).

Exit Strategy[9]

Provided that one's sizing in the commodity futures markets is modest enough that liquidating a position does not cause a many standard-deviation move in price, which then causes one's investors and/or creditors to create a further distressed liquidation, we would recommend the following strategy for deciding when to exit a losing strategy.

Using long-term data, one can directly examine the worst performance of a commodity trade under similar circumstances in the past. In practice, we have found that such a measure will sometimes be larger than a Value-at-Risk measure based on recent volatility.

If the loss on a particular commodity futures trade exceeds the historical worst case, this can be an indication of a new regime that is not reflected in the data. This should trigger an exit from a trade since one no longer has a handle on the worst-case scenario.

During the summer of 2005, a very good example of a market undergoing fundamental changes has been the petroleum complex. A historically reliable strategy had been to enter into the gasoline versus heating oil spread. Until 2005, traders had expected gasoline to outperform heating oil coming into the U.S. summer driving season. The market historically provided large monetary incentives to refiners to maximise the production of gasoline at the expense of heating oil to sufficiently service U.S. summer gasoline demand.

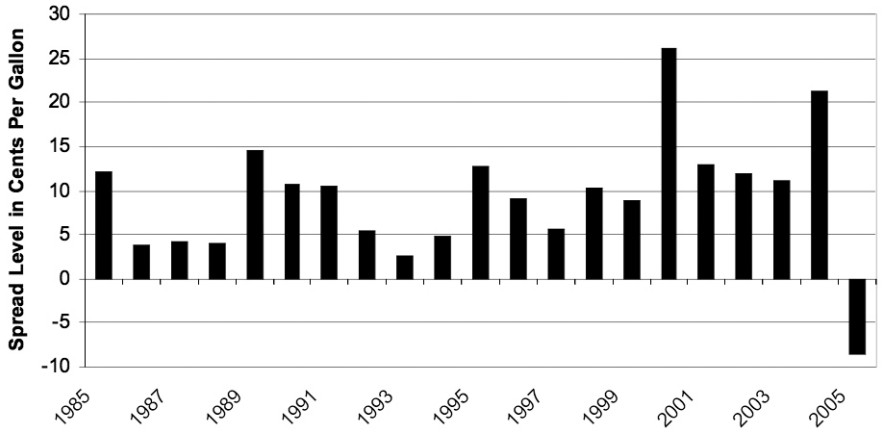
2005 was different. Fusaro (2005) revealed that in the summer of 2005, "the big Wall Street houses and some other hedge funds lost many ... hundreds of millions [of dollars] on gasoline/heating oil spreads. They could not imagine that heating oil would go higher than gasoline in June. It just never happened before."

8 - Further, Credit Suisse's ex-CEO, Oswald Gruebel stated in late April 2008 that the international financial system had been close to the brink in mid-March-2008, according to Thompson (2008). Fortunately, the Federal Reserve Board and the European Central Bank realized this, and on a *de facto* basis took over the inter-bank market. "We've narrowly escaped a system collapse. This has never happened before," Gruebel said. (The intense stress on the global financial system, which occurred in September 2008, during the aftermath of the bankruptcy of Lehman Brothers, occurred after the writing of this article.)

9 - This section is excerpted from Till (2006a).

Figure 17 shows the gasoline versus heating oil spread differential as of the beginning of June since 1985. Indeed, it had been unprecedented for heating oil to be priced at a premium to gasoline during that time of year.

Figure 17 - July Gasoline vs. Heating Oil Spread Differential as of the 5th Business Day of June 1985 through 2005



Source: Till (2006a).

What happened? One hypothesis is that Chinese demand patterns have created structural changes in the commodity markets, as alluded to previously. According to Stein (2005), "This is the first business cycle where Chinese demand is having a global effect on prices, notably of energy and other raw materials."

In the specific case of petroleum products, Farivar (2005) stated that "in China, diesel demand has been rising rapidly, because power shortages have forced many companies to use stand-alone generators. Diesel accounts for a significant portion of the overall rise in Chinese oil demand over the past year." Because diesel and heating oil have similar compositions, heating oil futures are frequently used as a proxy hedge for diesel inventories, which means that a rise in diesel prices tends to lead to a rise in the value of heating oil futures.

It appears that the Chinese demand for diesel trumped the American consumer's demand for gasoline, a scenario that was historically unprecedented.

In 2005, once the summer gasoline-versus-heating-oil spread had declined more than had been the case in previous years, one had a signal that a structural break was occurring, and the prudent reaction was to exit the strategy before further potentially catastrophic losses ensued.

Scenario Analyses

As described in Till and Gunzberg (2006), when designing a risk management program for a commodity investment, one needs to address both idiosyncratic risks and macro risks. Idiosyncratic risks include those unique to a specific commodity market. Examples include simulating the impact of the discovery of Mad Cow disease in the U.S. on live cattle futures positions as well as examining the impact of the New York harbor freezing over on the price of near-month heating oil futures positions. Macro risks include discovering those risks in the portfolio that can create inadvertent correlations amongst seemingly uncorrelated positions. Examples include simulating the impact of a 9/11/01 event on a portfolio that is long economically sensitive commodities as well as examining the impact of surprisingly cold weather at the end of the winter on a portfolio of energy positions.

Leverage Level

Another consideration in a commodity futures risk-management program is how much leverage to use. Futures trading requires a relatively small amount of margin. 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.

Since the spring of 2006, the choice of leverage level has become more difficult, given the periodic bouts of de-risking and deleveraging that have occurred as the commodity markets have become more correlated with other risk assets, at least over short time-horizons.

Commodities were clearly not immune from sharp episodes of widespread deleveraging of risky investments during the past two years, as occurred during May and June of 2006; end-of-February 2007; and again in mid-August 2007, and which was commented upon by the Bank of Japan in "Monitoring Commodity Markets From the Perspective of Understanding Global Financial Market Trends."

During the May/June 2006 deleveraging of risky investments, for example, commodities appeared to become the same trade along with other risk assets. This is illustrated in Figure 18. In observing this correlation, one might temper the amount of leverage applied to long commodity trades, or include other assets in the portfolio that would be expected to do well during any deleveraging. That said, the risk in the current environment may be more about being careful about the solvency of one's counterparties rather than about being concerned about future episodes of de-risking and deleveraging. According to Delaney *et al.* (2008), the UBS Equity Risk Appetite Indicator was languishing in extreme risk-aversion territory, so the likely problems, as of the spring of 2008, were due to not enough risk capital being devoted to risky trades rather than the other way around.

Figure 18 - May 10, 2006 throigh June13, 2006
*The VIX Increased from 11.78% on 5/10/06 on 6/13/06

"Risk Indicator"	
VIX (Equity Implied Vol)*	12.0%
"Risk Assets"	Percent Change
Bovespa (IBX50)	-23.5%
Nasdaq	-10.4%
S&P 500	-7.3%
Nikkei	-10.4%
Silver	-32.4%
Copper	-18.2%
Gasoline (RFG)	-3.6%
"Safe Havens"	Percent Change
Long Bond	1.8%
Dollar vs. Yen (Long Dollars)	4.5%

Source: Till (2008b).

Another example of simultaneous deleveraging is from February 27th, 2007. At the end-of-the-trading day, market participants saw algorithmic strategies simultaneously deleverage across numerous risky investments, including in popular commodity plays. In this unusual environment, the normally illiquid platinum market was more liquid than the gold futures market, as leveraged participants rapidly tried to simultaneously unwind gold positions.

This phenomenon, again, became of concern on August 16th, 2007, the day before the Federal Reserve Board cut the discount rate. On that date, all commodity markets in the Dow Jones AIG Commodity Index were down, along with all other risky assets; this is illustrated in Figure 19. The next day, after the announcement of the Fed's action, most risk assets simultaneously rallied, including commodities.

Figure 19 - Risky Asset Price Changes on August 16, 2007

Global Unwind	16-Aug-07
VIX (Equity Implied Vol)*	31%
	Daily
Risk Assets	Percent Change
Bovespa (IBX50)	-2.11%
Nasdaq	-1.01%
Nikkei	-1.99%
Silver	-8.44%
Copper	-7.26%
Gasoline	-1.52%
NZD vs. Yen	-5.32%
"Safe Haven"	Percent Change
Long Bond	0.94%
Crack Spreads (Refinery Margins)	Daily Change
Gasoline Crack	$1.05
Heat Crack	$0.48

* Absolute level of the VIX (and not change in level as in previous figure.)

DJAIG MOVERS 8/16/2007 10:07am CST				
Commodity		Price	Change	% Change
LMAHDS03	Aluminum	2543.00y	-9.00	-0.35
NGX7	Natural Gas	7.791	-0.046	-0.59
W Z7	Wheat	688 3/4	-8 1/4	-1.18
LCV7	Live Cattle	94.600	-1.325	-1.38
LHV7	Lean Hogs	67.550	-1.025	-1.49
LMZSDS03	Zinc	3230.00y	-65.00	-1.97
XBX7	RBOB Gasoline	187.43	-3.95	-2.06
GCZ7	Gold	665.20	-14.50	-2.13
CTZ7	Cotton	58.85	-1.33	-2.21
CLX7	Crude Oil	71.10	-1.73	-2.38
HOX7	Heating Oil	201.55	-4.99	-2.42
C Z7	Corn	336 1/2	-8 3/4	-2.53
LMNIDS03	Nickel	26500.0y	-800.0	-2.93
SBV7	Sugar	9.16	-0.29	-3.07
KCZ7	Coffee	119.30	-3.90	-3.17
BOZ7	Soybean Oil	35.27	-1.25	-3.42
SIZ7	Silver	12.290	-0.445	-3.49
S X7	Soybeans	821	-33 1/2	-3.92
HGZ7	Copper	314.80	-17.40	-5.24

Source of Data: Bloomberg

Source: Till (2008b).

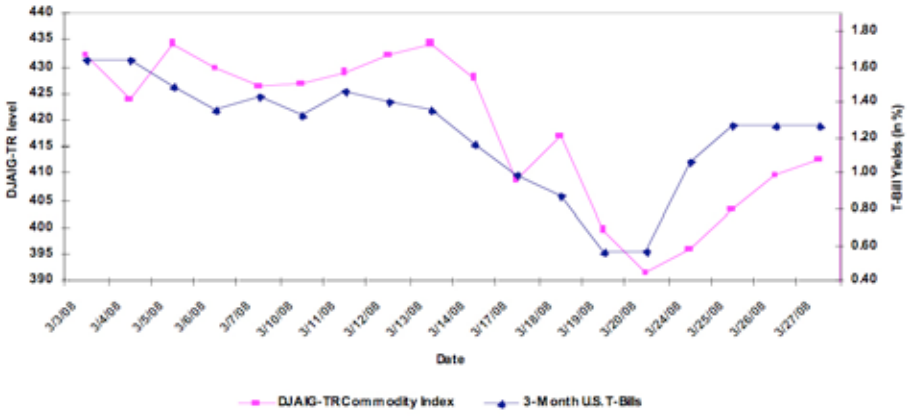
One exception to the "global unwind" of the time was petroleum-complex refining margins, which were underpinned by relatively low product inventories, particularly in gasoline.

Figures 18 and 19 illustrate how the VIX, the equity-index implied volatility gauge calculated by the Chicago Board Options Exchange, has been an useful early indicator of the market entering into a de-risking environment, that in turn can negatively impact popular commodity plays.

During the week of March 17th, 2008, market participants appeared to embrace a "preservation-of-capital" stance in the aftermath of the near collapse of Bear Stearns. Not only did three-month U.S. Treasury Bills (T-Bills) hit a nadir of 39 bps in (annualized) yield, but the commodity markets witnessed a weekly sell-off, the scale of which had not been seen since 1956, according to Carpenter and Munshi (2008). Figure 20 shows how the fortunes of the Dow Jones AIG Commodity Index fluctuated in March 2008, according to the degree to which investors were embracing T-Bills.

As of the spring of 2008, T-Bill yields have been the best early indicator of the market entering into a powerful deleveraging environment, which in turn can have a strong adverse effect on leveraged commodity strategies.

Figure 20 - Dow Jones AIG CommodityIndex - Total Return and 3-Month U.S. Treasury Bills 3/3/08 to 3/27/08



Source of Data: Bloomberg.

Conclusion

Until recently, one could only gain expertise in commodity-derivatives relationships if one had worked in niche commodity-processor companies or in banks that specialised in hedging project risk for natural-resource companies. The contribution of this article is to help fill the knowledge gap in the risk management of commodity derivatives trading. The article emphasises the constant challenges to a trader when attempting to navigate the very dynamic flows of both the commodity markets and the prevailing risk environment. The article also emphasises that operational controls are paramount in an age of increasing legal and regulatory risk, particularly for firms involved in large-scale commodity derivatives trading.

Endnotes

The author would like to thank Hendrik Schwarz for helpful comments.
The ideas and opinions expressed in this article are the sole responsibility of the author.
The information contained in this article has been assembled from sources believed to be reliable, but is not guaranteed by the author.

References

• Akey, R., 2005, "Commodities: A Case for Active Management," *Journal of Alternative Investments*, Fall, pp. 8–29.

• Akey, R., 2007, "Alpha, Beta, and Commodities: Can a Commodities Investment be Both a High-Risk-Adjusted Return Source and a Portfolio Hedge?", a chapter in Intelligent Commodity Investing (Edited by H. Till and J. Eagleeye), London: Risk Books, pp. 377-417; and in *Journal of Wealth Management*, Fall 2006, pp. 63–82.

• Akey, R., H. Till, and A. Kins, 2006, "Natural Resources Fund of Funds: Active Management, Risk Management, and Due Diligence," a chapter in Funds of Hedge Funds (Edited by G. Gregoriou), Oxford: Elsevier Finance, pp. 383-399.

• Baer, J., 2006, "JP Morgan Sold Its Amaranth Energy Trades to Citadel," *Bloomberg News*, November 29.

• Bank of Montreal, 2007a, "CAN 6-K for 5/29/07 Ex-99-1," Securities and Exchange Commission File 1-13354.

• Bank of Montreal, 2007b, "CAN 6-K for 8/29/07," Securities and Exchange Commission File 1-13354.

• Bentley, A., 2006, "Ospraie Closes $250 Mln Commodity Hedge Fund," *Reuters*, June 8.

• Blanco, C. and R. Mark, 2007, "BMO's Derivatives Blow Up", *The Desk*, June 1.

• Boyd, R., 2006, "Mother of All Losses," *The New York Post*, September 15, accessed electronically through LexisNexis.

• Burns, G. and J. Boak, 2008, "Ultraspeedy Trades Can Rack Up Big Losses, Fast," *Chicago Tribune*, March 2, accessed electronically through chicagotribune.com.

• Burton, K. and M. Leising, 2006, "Amaranth Says Funds Lost 50% on Gas Trades This Month," *Bloomberg News*, September 18.

• Cameron, D. and A. Lucchetti, 2008, "MF Global Takes a Large Loss On Unauthorized Wheat Trades," *Wall Street Journal Online*, February 28.

• Carpenter, C. and M. Munshi, 2008, "Commodity Prices Head for Biggest Weekly Decline Since 1956," *Bloomberg News*, March 20.

• Cashin, A., 2008, "Market Commentary," UBS Financial Services, March 18.

• Christory, C., S. Daul, and J.R. Giraud, 2006, "Quantification of Hedge Fund Default Risk," *Journal of Alternative Investments*, Fall, pp. 71-86.

• Commodity Futures Trading Commission, 2006a, "U.S. Commodity Futures Trading Commission Charges BP Products North America, Inc. with Cornering the Propane Market and Manipulating the Price of Propane," Release 5193-06, June 28.

• Commodity Futures Trading Commission, 2006b, "Complaint for Injunctive and Other Equitable Relief and Civil Monetary Penalties Under the Commodity Exchange Act," United States District Court, Northern District of Illinois, U.S. CFTC (Plaintiff) v. BP Products North America, Inc. (Defendant), June 28.

• Commodity Futures Trading Commission, 2007a, "Complaint for Injunctive and Other Equitable Relief and Civil Monetary Penalties Under the Commodity Exchange Act," United States District Court, Southern District of New York, U.S. CFTC (Plaintiff) v. Amaranth Advisors, LLC, Amaranth Advisors (Calgary) ULC and Brian Hunter (Defendants), July 25.

• Commodity Futures Trading Commission, 2007b, "BP Agrees to Pay a Total of $303 Million in Sanctions to Settle Charges of Manipulation and Attempted Manipulation in the Propane Market," Release 5405-07, October 25.

• Commodity Futures Trading Commission, 2007c, "Former BP Trader Agrees to Pay $400,000 Civil Penalty to Settle U.S. Commodity Futures Trading Commission Charges of Attempted Manipulation of the NYMEX Unleaded Gasoline Futures Contract," Release 5402-07, October 25.

• Collins, D., 2007, "Commodity Indexes Getting More Complex," *Futures Magazine*, July, pp. 58-61.

• Collins, J, 2001, Good to Great, New York: HarperBusiness.

• Cootner, P., 1967, "Speculation and Hedging." *Food Research Institute Studies*, Supplement, 7, pp. 64-105.

• Davis, A., 2006, "How Giant Bets on Natural Gas Sank Brash Hedge-Fund Trader," *Wall Street Journal Online*, September 19.

• Davis, A., G. Zuckerman, and H. Sender, 2007, "Hedge-Fund Hardball: Amid Amaranth's Crisis, Other Players Profited," *Wall Street Journal Online*, January 30.

• Delaney, J., W. Darwin, J. Palma, and T. Adolff, 2008, "Global Risk Radar," UBS Investment Research, February 11.

• De Souza, C. and M. Smirnov, 2004, "Dynamic Leverage," *Journal of Portfolio Management*, Fall, pp. 25-39.

• Dowd, G., 2007, "The Move to Electronic Trading: What to Expect in the Natural-Resources Markets," a chapter in Intelligent Commodity Investing (Edited by H. Till and J. Eagleeye), London: Risk Books, pp. 501-515.

• Eagleeye, J., 2007, "Risk Management, Strategy Development, and Portfolio Construction in a Commodity Futures Programme," a chapter in Intelligent Commodity Investing (Edited by H. Till and J. Eagleeye), London: Risk Books, pp. 491-497.

• Farivar, M., 2005, "Diesel Prices Take on Life of Their Own as Demand Surges," *Dow Jones Newswires*, May 20.

• Federal Energy Regulatory Commission, 2007, *Amaranth et al.*, Docket No. IN07-26-000, "Order to Show Cause and Notice of Proposed Penalties," July 26.

• Fusaro, P., 2005, "Energy: An Immature Financial Market," Energy Hedge, October 1, p. 1.

• Gains, K., 2007, "Citadel Wellington LLC & Citadel Kensington Global Strategies Fund Ltd. Operations Quality Rating Report," Moody's Investors Services, March 23.

• Giraud, J.R., 2003, "Managing Hedge Fund Operational Risks," *EDHEC-Risk Institute Publication*.

• Goldstein, M., L. R. Silva, and M. Davis, 2006, "MotherRock Cries Uncle," *TheStreet.com*, August 3.

• Gordon, D., 2003a, "Risk By Any Other Name," Glenwood Capital Investments, LLC, Presentation to Chicago QWAFAFEW, http://www.qwafafew.org, October 16.

• Gordon, D., 2003b, "Risk by Any Other Name," *Journal of Alternative Investments*, Fall, pp. 83-86.

• Grant, K., 2004, Trading Risk, Hoboken: Wiley Trading.

• Harris, C., 2006, "Landing on His Feet," *Financial Times*, November 3, accessed electronically through FT.com.

• Herbst-Bayliss, S., 2007, "After Huge Hedge Fund Failure, Amaranth Trader Woos Investors For New Fund," *Reuters*, March 23.

• Hougan, M., 2008, "An Interview with Bob Greer," HardAssetsInvestor.com, March 25.

• Kat, H. and F. Menexe, 2003, "Persistence in Hedge Fund Performance: The True Value of a Track Record," *Journal of Alternative Investments*, Spring, pp. 66-72.

• Kennedy, W. and M. Leising, 2006, "BP Traders, Trying to 'Corner' Market, Lost $10 Mln," *Bloomberg News*, July 3.

• Kishan, S. and S. Batcho-Lino, 2008, "Ospraie to Buy ConAgra Trading Unit for $2.1 Billion," *Bloomberg News*, March 27.

• Lahav, O., 2007, "Brevan Howard Master Fund Ltd. Operations Quality Rating Report," Moody's Investors Service, October 16.

• Lammey, A., 2005, "Choppy Winter Forecasts Suggest Healthy 1 TcF End to Drawdown," *Natural Gas Week*, December 5, pp. 2-3.

• Leising, M., 2006, "MotherRock Energy Hedge Fund Closing After Losses," *Bloomberg News*, August 3.

• Leising, M., 2007a, "Nymex Director Quits Optionable Over CEO's Jail Time," *Bloomberg News*, May 15.

• Leising, M., 2007b, "Amaranth Trading Led to MotherRock Loss, Senate Report Says," *Bloomberg News*, June 25.

• Leising, M. and K. Burton, 2006, "MotherRock Energy Hedge Fund Closing After Losses," *Bloomberg News*, August 3.

• MarketWatch, 2006, "Hedge Fund's Failure May Threaten ABN Amro, UBS Deal: Report," August 9.

• Mavin, D., 2007, "BMO Moves On Auditors' Report: Source," *National Post*, May 10.

• McGlashan, B., 2007, "Risk Review: Bank of Montreal Group / Investor Community Conference Call / Q1 2007 / Prior to Restatement," March 1.

• MF Global, 2008, "MF Global Expects Record Volumes and Net Revenues for Fiscal Fourth Quarter 2008: Independent Consultants Report Preliminary Risk Review Findings," April 18.

• Oldfield, R., 2007, Simple But Not Easy, London: Doddington Publishing, as quoted in HFM Week, November 22-28, p. 12.

• O'Reilly, C., 2007, "Ex-Amaranth Trader Sues Agency to Block Enforcement," Bloomberg News, July 24.

• Reuters, 2006, "Amaranth Says Determined to Stay in Business," September 22.

• Smith, E. B. and D. Scheer, 2008, "MF Global's Dooley Lost House on Bad Trades Before Bet on Wheat," *Bloomberg News*, March 26.

• Staff Report, 2007, Permanent Subcommittee on Investigations, Committee on Homeland Security and Government Affairs, United States Senate, "Excessive Speculation in the Natural Gas Market," June 25.

• Stein, G., 2005, "World Oil Demand Revised Down Again," *Lombard Street Research's World Service Daily Note*, September 9.

• Terada, T., and T. Shimizu, 2007, "Monitoring Commodity Markets: From the Perspective of Understanding Global Financial Market Trends," *Bank of Japan Review*, November.

• Tett, G., 2008, "Western Banks Face Backlash As They Hand Out Begging Bowl," *Financial Times*, February 8, accessed electronically through FT.com.

• The Desk, 2007a, "As the Implosion Turns," www.scudderpublishing.com, May 4.

• The Desk, 2007b, "Trader Surprised by Optionable's Dirty Tricks," May 18.

• The Desk, 2007c, "Optionable Debacle: What Next?" May 25.

• The Desk, 2007d, "Desk Chiefs Comment on Marking Your Books," June 1.

• Thompson, A., 2008, "International Financial System Was Close to the Brink: Credit Suisse Ex-CEO," *Thomson Financial*, April 20, accessed electronically through afxnews.com.

• Till, H., 2006a, "Portfolio Risk Measurement in Commodity Futures Investments," a chapter in Portfolio Analysis: Advanced Topics in Performance Measurement, Risk and Attribution (Edited by T. Ryan), London: Risk Books, pp. 243-262.

• Till, H., 2006b, "EDHEC Comments on the Amaranth Case: Early Lessons from the Debacle," EDHEC-Risk Institute Publication, http://www.edhec-risk.com, October 2.

• Till, H., 2007a, "A Long-Term Perspective on Commodity Futures Returns: A Review of the Historical Literature," a chapter in Intelligent Commodity Investing (Edited by H. Till and J. Eagleeye), http://www.riskbooks.com/intelligentcommodity, London: Risk Books, pp. 39-82.

• Till, H., 2007b, "Lessons Learned from the 2006 Energy Hedge Fund Debacles," Financial Analysts Seminar: Improving the Investment Decision-Making Process, Hosted by the Chartered Financial Analyst (CFA) Society of Chicago, July 20.

• Till, H., 2008a, "Lessons from Recent Energy Trading Debacles: The Bank of Montreal Case Study," The Till and Lhabitant Seminar on State-of-the-Art Commodities Investing, EDHEC Asset Management Education, London, January 22.

• Till, H, 2008b, "Intelligent Commodity Investing: Opportunities and Challenges," Presentation to the London Chapter of the Chartered Alternative Investment Analyst Association, January 23.

• Till, H., 2008c, "Amaranth Lessons Thus Far," *Journal of Alternative Investments*, Spring, pp. 82-98.

• Till, H. and J. Gunzberg, 2006, "Absolute Returns in Commodity (Natural Resource) Futures Investments," a chapter in Hedge Fund Investment Management (Edited by I. Nelken), Oxford: Elsevier Finance, pp. 25-42.

• US District Court, Southern District of NY, 2007, "Class Action Complaint", Alexander Fleiss *et al.* vs. Optionable Inc. *et al.*, May 11.

• Vince, R., 1992, The Mathematics of Money Management, New York: Wiley Finance.

• Weisman, A., Patel, S., and A. Suri, 2007, "Chasing Your Tail," Merrill Lynch Draft Paper, March 29; a version of which was presented to the Spring 2007 Seminar of the Institute for Quantitative Research in Finance (Q-Group) in Sea Island, Georgia, March 25-28.

• Whitehouse, K., J. Checkler, and C. Buurma, 2008, "Saracen Cites Losses Tied to Natural Gas," *Wall Street Journal Online*, February 16.

EDHEC-Risk Institute is part of EDHEC Business School, one of Europe's leading business schools and a member of the select group of academic institutions worldwide to have earned the triple crown of international accreditations (AACSB, EQUIS, Association of MBAs). Established in 2001, EDHEC-Risk Institute has become the premier European centre for applied financial research.

In partnership with large financial institutions, its team of 66 permanent professors, engineers and support staff implements six research programmes and ten research chairs focusing on asset allocation and risk management in the traditional and alternative investment universes. The results of the research programmes and chairs are disseminated through the three EDHEC-Risk Institute locations in London, Nice, and Singapore.

EDHEC-Risk Institute validates the academic quality of its output through publications in leading scholarly journals, implements a multifaceted communications policy to inform investors and asset managers on state-of-the-art concepts and techniques, and forms business partnerships to launch innovative products. Its executive education arm helps professionals to upgrade their skills with advanced risk and investment management seminars and degree courses, including the EDHEC-Risk Institute PhD in Finance.

For more information, please contact:
Carolyn Essid on +33 493 187 824
or by e-mail to: carolyn.essid@edhec-risk.com

EDHEC-Risk Institute
393-400 promenade des Anglais
BP 3116
06202 Nice Cedex 3 - France

EDHEC Risk Institute—Europe
10 Fleet Place - Ludgate
London EC4M 7RB - United Kingdom

EDHEC Risk Institute—Asia
1 George Street - #07-02
Singapore 049145

www.edhec-risk.com

EDHEC-RISK
Institute