

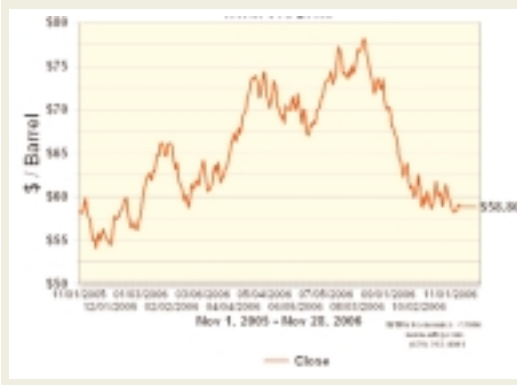


longer-term utility function of the investors in the fund. Rogue trades - those that violate (1) and (2) - can be taken as long as (3) never occurs. In the case of Amaranth's natural gas bets, their leverage was about 8:1 so \$7 was borrowed for every \$1 the fund had from its clients. Positions were on exchanges and over the counter. They were thus very vulnerable. Those not skilled in risk control can argue that situation (3), that would wipe them out, simply would not occur because it is far too improbable, that it is too far in the tails of the distribution of the underlying asset. They would typically assign zero to the probability of such rare events.

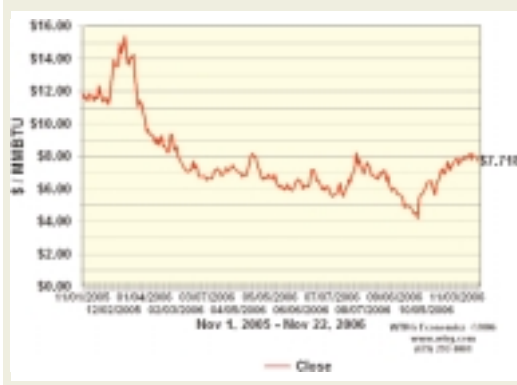
Even skilled risk control experts such as Jorion (2000) and Till (2006) refer to LTCM as an 8-sigma event and Amaranth as a nine-sigma event. The problem is that even modified VAR gives erroneous results and is not safe. Such wipeouts occur with events far more frequent than eight- or nine-sigma: three-sigma is more like it. Till (2006) argues that daily volatility of Amaranth's portfolio was two per cent making the September losses 9-sigma losses, but the possible losses are not stationary. We argue that this analysis is misleading; the two per cent is with normal, not negative, low probability disaster scenarios. Furthermore, diversification can easily fail, if, as is typical, it is based on simply averaging the past data rather than with scenario dependent correlation matrices. It is the diversification, or lack of it, according to the given scenario that is crucially important, not the average past correlation across the assets in the portfolio.

A series of charts illustrates the nature of the natural gas market. Figure 1 shows crude oil prices from November 1, 2005 to November 28, 2006. This shows much volatility with prices usually above \$60 and at times exceeding the August 30, 2005 post Katrina high of \$70+. The prices peaked at \$77 in July 2006 then declined to around \$60. This decline coincided with the decline in the price of natural gas in September 2006. Figure 3 shows natural gas futures in 2006. Starting from over \$11/million BTU the futures prices fell to about \$5. The event that triggered the Amaranth crisis was the drop in the price of natural gas from \$8 in mid July to around \$5 September. Since the gas prices have climbed to

**Figure 1: Crude oil spot: North Sea Brent; November 1, 2005 to November 28, 2006**

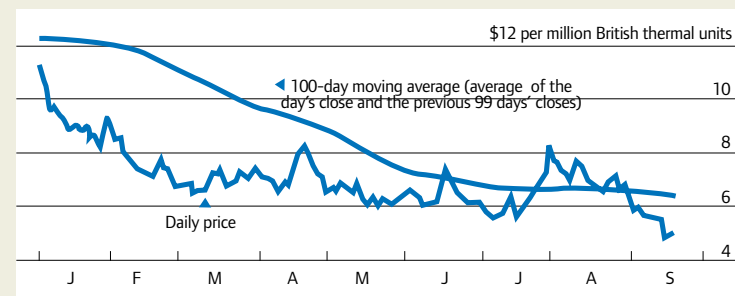


**Figure 2: NYMEX natural gas futures close, November 1, 2005 to November 22, 2006**



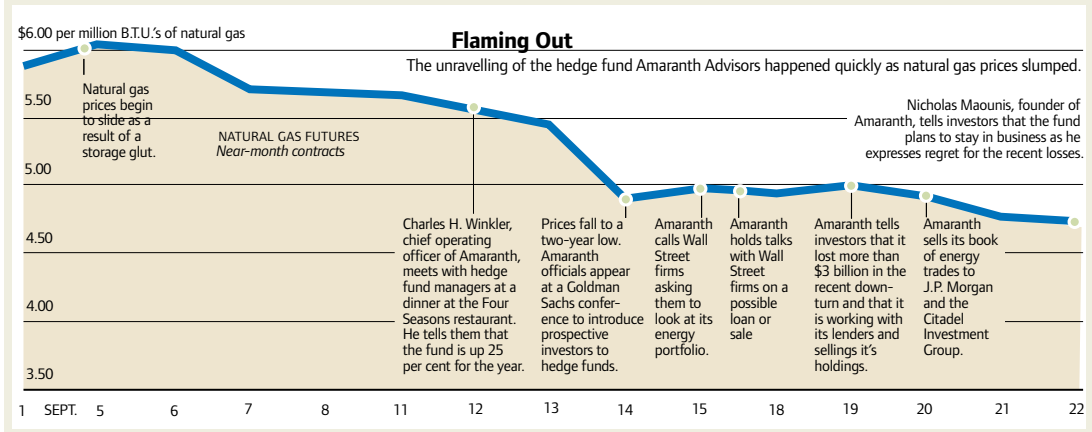
\$15 and fallen to \$2 in recent years, such a drop is plausible in one's scenario set and should have been considered. There are fat tails in these markets. There is a large difference between the daily and long-term moving average price of natural gas making it a very volatile commodity. Thus such a drop is not a eight- to nine- sigma event. In the 1990s, natural gas traded for \$2-3 per million BTUs. However, by the end of 2000 it reached \$10 and then by September 2001 fell back to under \$2. Figure 2 shows the NYMEX natural gas futures from November 1, 2005 to

**Figure 3: Natural gas futures in 2006 to September. Source: Wall Street Journal**



November 22, 2006 which like Figure 1 shows much price volatility. The November 22 price of 7.718 had recovered 50 per cent from the September lows.

**Figure 4: Amaranth timeline of a collapse. Source: New York Times, Sept 23, 2006**



**Figure 5: Daily change in P/L from Amaranth inferred natural gas positions, June 1 to September 15, 2006. Source: Till (2006)**

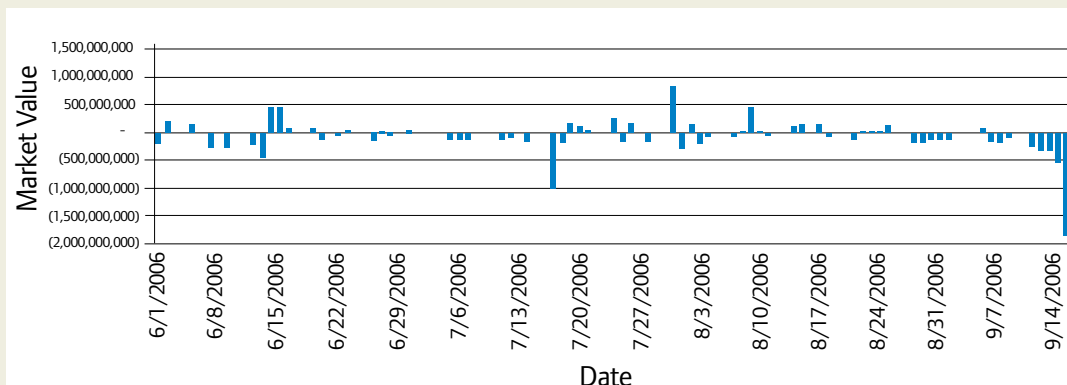


Figure 4 shows a chronology of the collapse and Figure 5 is a day-by-day recreation of Amaranth's possible losses including the disastrous last two months and final collapse recreation (a loss of \$560 million on September 14, 2006) by Till (2006)

### Valuing a fund

Actually the statement that Amaranth had \$9.25 billion on September 1 is a bit of a stretch because that was the mark-to-the-market value of their portfolio, the value on which fees were charged. But, in fact, with an estimated 250,000+ natural gas contracts, an enormous position built up over the previous two years, the liquidating value of the portfolio even without (3), the crisis was much less. Indeed much of the previous profits were derived by pushing up of long natural gas prices in an illiquid market. So the real profits were actually much lower. Indeed, those who liquidated Amaranth's positions bought them at a substantial discount. Of course, with different data forecasts such discrepancies might occur occasionally but if they are consistently there, assumptions or risk assessments may be questioned.

The trigger for the crisis was a substantial drop in natural prices largely because of high levels of stored gas, coupled with a perceived drop in demand due to changing weather. This altered the seasonal pattern of trade. The trading theory was based on the dubious assumption that the

natural gas market would under-price winter from summer natural gas prices.

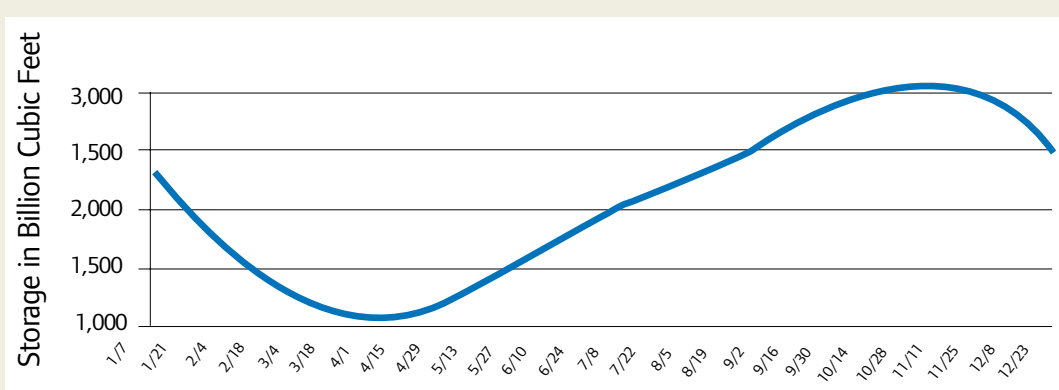
### Background, adapted from Till (2006)

The natural gas market has two main seasons: peak winter demand and generally lower spring and fall demand. Storage facilitates provide some smoothing of the price. However, in the US, there is inadequate storage capacity for the peak winter demand. Therefore, the winter natural gas contracts trade with ever increasing premiums relative to summer and fall months to both encourage storage and the creation of more production and storage capacity. Basically the market tries to lock in the value of storage by buying summer and fall natural gas and selling winter natural gas forward.

The prices of summer and fall futures contracts typically trade at a discount to the winter contracts (contango) thus providing a return for storing natural gas. An owner of a storage facility can buy summer natural gas and simultaneously sell winter natural gas via the futures markets. This difference is the storage operator's return for storage.

When the summer futures contract matures, the storage operator can take delivery of the natural gas, and inject it into storage. Later when the winter futures contract matures, the operator can make delivery of the natural gas by drawing it out of storage. Figure 6 shows the average build-up of inventories over the year. As long as the operator's financing and physical outlay costs are under the spread locked in through the futures market, this will be profitable. This is a simplified version of how storage operators can choose to monetize the value of their physical assets. Sophisticated storage operators actually value their storage facilities as an option on calendar-spreads. Storage is worth more if the calendar spreads in natural gas are volatile. As a calendar spread trades in steep contango, storage operators can buy the near-month contracts and sell the further-out month contracts, knowing that they can ultimately realize the value of this spread through storage. But a preferable scenario would be for the spread to then tighten, which means that they can trade out of the spread as a profit. Later if the spread trades in wide contango again, they can reinstate a purchase of the near-month versus far-month natural gas spread. As long as the spread is

**Figure 6: Average US natural gas inventories in BCF over the year, 1994-2005. Source: Till (2006)**



volatile, the operator/trader can continually lock in profits, and if they cannot trade out of the spread at a profit, they can then take physical delivery and realize the value of their storage facility that way. Till (2006) believes that both storage operators and natural gas producers were the ultimate counterparties to Amaranth's spread trading.

In the winter natural gas demand is inelastic. If cold weather comes early then there is fear that there will not be enough storage so prices are bid up. The fear of inadequate supplies lasts for the entire heating season. Winter 2005 was an example. At the end of the winter storage might be completely depleted. For example during February to March 2003, prices had moved up intraday \$5.00/MMBtu, but settled only \$2.50 higher, which is why Amaranth hoped for a long winter. As a weak hedge they short the summer (Apr-Oct). Demand for injection gas is spread throughout the summer and peak usage for electricity demand occurs in July/Aug. Being more elastic, this part of the curve does not rise as fast as the winter in an upward-moving market. This was their hedge.

The National Weather Service issued an *El Nino* forecast for the 2006-7 winter so gas storage was at an all-time record and the spreads were out very wide. This plus the fact that the market basically knew about Amaranth's positions, led to their downfall which was a result of their faulty risk control.

### The trade and the rogue trader

Lets take a closer look at the trade that destabilized Amaranth. Brian Hunter, a 32 year old Canadian from Calgary, had fairly simple trades but in enormous size. He had a series of successful returns. As a youth in Alberta he could not afford ski tickets but at 24, with training as an instant expert on derivatives from courses at the University of Alberta, he headed to a trading career. He was bold and innovative with nerves of steel while holding enormous positions. Typically he was net long with long positions in natural gas in the winter months (November to March) and short positions in the summer months (April to October).

Amaranth Advisors was a multi-strategy

fund, which is quite fashionable these days since they only have one layer of fees rather than the two layers in a fund of funds. On their website they say: "Amaranth's investment professionals deploy capital in a broad spectrum of alternative investment and trading strategies in a highly disciplined, risk-controlled manner." They provide a false sense of security from the assumed diversification across strategies. The problem is that

## Hunter had made huge profits for Amaranth by placing bullish bets on natural gas prices in 2005, the year Hurricane Katrina had shocked natural gas refining and production

diversification strategies can be correlated rather than hedged, especially in extreme scenario cases. As a result, too much can be invested in any one strategy negating diversification. In the case of Amaranth, some 58 per cent of assets were tied up in Hunter's gas trades but risk adjusted these trades were 70-90 per cent of Amaranth's capital allocation.

Hunter had made huge profits for Amaranth by placing bullish bets on natural gas prices in 2005, the year Hurricane Katrina had shocked natural gas refining and production. Hoping to repeat the gains, Amaranth wagered with a 8:1 leverage that the difference between the March and April futures price of natural gas for 2007 and 2008 would widen. Instead it went the other way. The spread between April and March 2007 contracts went from \$2.49 at the end of August 2006 to \$0.58 by the end of September 2006. Historically, the spread in future prices for the March and April contracts have not been easily predictable. The spread is dependent on meteorological and political events whose uncertainty makes the placing of such large bets a precarious matter (Wikipedia, 2006).

Jack Doueck of Stillwater Capital pointed out that while a good hedge fund investor has to pick

good funds to invest in, the key to success in this business is not to choose the best performing managers, but actually to avoid the frauds and blowups. Frauds can take on various forms including a misappropriation of funds, as in the case of Cambridge, run by John Natale out of Red Bank, NJ, or a misreporting of returns as in the case of Lipper, or Beacon Hill, or the Manhattan Fund. Blowups usually occur when a single per-

son at the hedge fund has the power to become desperate and bet the ranch with leverage. With both frauds and blowups, contrary to public opinion (and myth), size does *not* seem to matter: examples are Beacon Hill (\$2 billion), Lipper (\$5 billion), Amaranth (\$9 billion).

Amaranth's investors will be seeking answers to questions including: to what extent did leverage and concentration play a role in recent out-sized losses. We think the latter; (1) and (2) are the main causes here of the setup before the bad scenario caused the massive losses.

### Is Learning Possible?

Do traders and researchers really learn from their trading errors? Some do but many do not. Or more precisely, do they care? What lessons are taken from the experience? Hunter previously worked for Deutsche Bank. In December 2003 his natural gas trading group was up \$76 million for the year. Then it lost \$51.2 million in a single week leading to Hunter's departure from the Deutsche Bank. Then Hunter blamed "an unprecedented and unforeseeable run-up in gas prices". At least he thought about extreme scenarios. Later in a lawsuit, he argued that while Deutsche Bank had losses his group did not.

Later in July 2006, after having billion dollar swings in his portfolio (January to April +\$2B), -\$1B in May when prices for autumn delivery fell, +\$1B in June - he said that "the cycles that play out in the oil market can take several years, whereas in natural gas, cycles are several months." The markets are unpredictable. Of course, most successful traders would lower their bets in such markets. Our experience is that when you start losing, you are better off taking money off the table not doubling up in the hope of recouping the losses. It is better to lose some resources and be able to survive then to risk being fully wiped out. However, instead they increased the bets.

Amaranth was a favorite of hedge funds of funds, investment pools that buy into various portfolios to try to minimize risk. Funds of funds operated by well known and successful invest-

ment firms Morgan Stanley, Credit Suisse, Bank of New York, Deutsche Bank and Man Investments all had stakes in Amaranth as of June 30, 2006. From September 2000 to November 30, 2005 the compound annual return to investors, net of all costs was 14.72 per cent. Amaranth had liquidated a significant part of its positions in relatively easy to sell securities like convertible bonds, leveraged loans and blank check companies or special purpose acquisition companies. Liquid investments were sold at a small discount while others, like portfolios of mortgage-backed securities, commanded a steeper discount.

As is common among hedge funds, Amaranth severely restricts the ability of investors to cash in their holdings. For example, investors can withdraw money only on the anniversary of

their investments and then, only with 90 days' notice. If they try to withdraw at any point outside that time frame there is a 2.5 per cent penalty. If investors redeem more than 7.5 per cent of the fund's assets, Amaranth can refuse further withdrawals,

Recall from previous columns that if you lose 50 per cent of a \$2 million fund, you will have a hard time relocating to a new fund or raising new money, but if you lose 50 per cent of \$2 billion the job prospects are much better. So Brian moved on to Amaranth whose founder and chief executive, Nick Maounis, said on August 11, 2006, that more than a dozen members of his risk management team served as a check on his star gas trader "what Brian is really, really good at is taking controlled and measured risk".

Amaranth said they had careful risk control but they did not really use it. Some 50 per cent of

assets in one volatile market is not really very diversified at any time and is especially vulnerable in a crash and doubly so if one's bets are a large percent of the market. Such a large position is especially dangerous when the other traders in the market know that a fund is overextended in this way and many hedge funds such as Citadel and JP Morgan were on the other side of the market. Then, when the crisis occurred, spreads widened that added to the losses. Hunter's response was to bet more and more (in effect doubling up) until these trades lost so much they had to be liquidated. That is exactly what one should not do based on risk control considerations, but, as discussed below, it makes some sense with traders' utility functions.

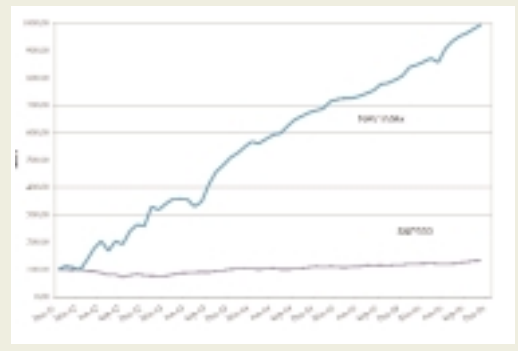
Successful traders neither make a large number of hopefully independent favorable bets which, although they may involve a lot of capi-

tal, are not a large percent of the capital nor are they in on illiquid market should one need to liquidate. Warren Buffett's Berkshire Hathaway closed-end hedge fund frequently makes \$1 billion risky bets but these are with a substantial edge (positive expected value) and about one percent or less of Berkshire Hathaway's more than \$140 billion capital. A typical Buffett trade was a loan of some \$945 million to the Williams pipeline company of Oklahoma at some 34 percent interest in 2002 during the stock market crash, the oil price was low and the pipeline company was in deep financial trouble. Banks refused to bail them out. But Buffett knew he had good collateral with their land, pipeline and buildings. Williams recovered largely due to this investment and better markets and paid off the loan early and Berkshire Hathaway made a large profit.

The problem is that rogue traders are grown in particular organizations and are allowed by the industry. While they are winning, they are called great traders, then they become rogue traders when they blow up their funds. The Hunter case is similar to those of Nick Leeson and Victor Niederhoffer but different from Long-Term Capital Management (LTCM). In the first three cases, there was a major emphasis on trade in one basic commodity. The trouble was the risk control, namely our (1) and (2) and combined with the bad scenario (3). As discussed below the firm's and rogue trader's utility function likely caused this problem by making it optimal for these utility functions to over bet. LTCM is much more subtle. The confidence scenario that hit them was the result of faulty risk control based on VAR and historical data. They needed scenario dependent correlation matri-



**Figure 7: Futures account January 1, 2002 to November 30, 2006**



ces like those discussed in other issues of *Wilmott Magazine*.

## Possible utility functions of hedge fund traders

One way to rank investors is by the symmetric downside Sharpe ratio (DSSR) as discussed in previous *Wilmott* columns. By that measure, investors with few and small losses and good-sized gains have large DSSRs. Berkshire Hathaway has a DSSR of about 0.90. The Harvard and Ford Foundations endowments are about 1.0. The highest we have seen is Thorp's Princeton Newport's 1968-88 DSSR of 13.8. Those with high DSSRs have smooth wealth curves. For example, Figure 7 below which is from a futures account run from January 1, 2002 to November 30, 2006 for a personal account of the second author run very carefully with strict risk control and trades with advantages.

This is not a utility function but the result of the choices made using a utility function. Those who want high DSSRs are investors trying to have smooth returns with good returns with low volatility and very few losses. Thorp only had three monthly losses in 20 years; the Harvard and Ford endowments and Berkshire Hathaway have 2-3-4 per year.

Consider a rogue trader's utility function. The outcome probabilities are:

1. x per cent of the time the fund blows up and loses 40 per cent+ of its value at some time; the trader is fired and gets another trading job keeping most past bonuses'
2. y per cent of the time the fund has mod-

est returns of 15 per cent or less; then the trader receives a salary but little or no bonus

3. z per cent of the time the fund has large returns of 25 per cent to 100 per cent; then the trader gathers more assets to trade and large bonuses.

At all times the rogue trader is in (1) and (2), that is, the total positions are overbet and non diversified and move markets. There is no plan to exit the strategy since it is assumed that trades can continually be made.

Then in a multiperiod or continuous time model it may well be that for the fund managers' and traders' specific utility functions that it is optimal to take bets that provide enormous gains in some scenarios and huge losses in other scenarios. Kouwenberg and Ziemba (2006) show that in a theoretical continuous time model with incentives, risk-taking behavior is greatly moderated if the hedge fund manager's stake in the fund is 30 per cent or more.

In the case of Amaranth and similar rogue trading situations, there are additional complications such as the fund manager's utility function and his wealth stake inside this fund and outside it. Then there is the rogue trader's utility function and his wealth inside and outside the fund. According to Aumann (2005): a person's behavior is rational if it is in his best interests given information in their possession. Aumann further endorses Tobin's belief that economics is all about incentives. In the case of Hunter, his share of \$1B plus gains (real or booked) was in the \$100 million range. What's interesting is, and this is similar to LTCM, is to continue and increase bets when so much is already in the bank. Recall in LTCM, that they had a \$100 million unsecured loan to invest in their fund. Finally, in such analyses, are the utility functions and constraints of other people's money. In the case of Amaranth Deutsche Bank who had first-hand knowledge of Hunter's previous trading blowups, was an investor along with other well-known firms.

## Winners and losers

Who are the winners and losers here? Hunter is the winner and will get relocated soon. He has hundreds of millions, having made at least \$75 million in 2005, and will likely make more later. Of course, his reputation is tarnished but \$100+

million in fees helps. There might be some lawsuits but Hunter likely will not be hurt much. At 32, he is set for life financially, despite the losses. He is likely to begin again. An executive recruiter has offered to help introduce Hunter to investors. He sees opportunities for Hunter to make a fresh start with high-net-worth investors, possibly in Russia and the Middle East. Hunter has kept a low profile since the blowup, while moving to a new house near Calgary, Alberta and is in no hurry to make a move. Betting on fallen hedge-fund stars is not all that uncommon. John Meriwether, who led Long Term Capital Management until its 1998 implosion, now runs another hedge fund.

Other winners are those on the other side of the trade if they followed proper risk control and could weather the storm created by Amaranth's plays and those [...] who took over Amaranth's portfolio and the Fortress Investment group, which is helping liquidate assets.

The losers are mainly the investors in Amaranth including various pension funds which sought higher returns to make up for 2000-2003 mistakes. Other losers are hedge funds which were swept up by the Amaranth debacle including those that lost even though they bet on the right (short) direction because Hunter moved the market long on the way up like Mother Rock LP and those who lost along with Amaranth on the way down. They were long October and short September futures. According to Till (2006), they likely were forced out of their short position August 2, 2006 when the spread briefly but sharply rallied. Another loser was Man Alternative Investments Ltd., a fund of hedge funds listed on the London Stock Exchange in 2001 by the Man Group PLC, which shut down after recent losses tied to Amaranth's collapse and persistently poor liquidity in the shares. It is a small fund with little active trading interest, a concentrated shareholder base, and positions that were both difficult to build up and unwind. It had about 31.5 million invested in a portfolio selected by Man Group's Chicago-based Glenwood Capital Investments LLC unit, is part of Man Group PLC, which has \$58 billion in assets under management. The fund lost about one-fifth of its gains this year from the collapse of Amaranth though it was up 6.5 per cent through October.



Archeus Capital, a hedge fund that in October 2005 had assets of \$3 billion, on October 31, 2006, announced it would close returning \$700 million to their investors. The fund, founded and run by two former Salomon Brothers bond traders, Gary K. Kilberg and Peter G. Hirsch, was like Amaranth, a multistrategy fund. However, it had a more conservative approach that focused on exploiting arbitrage opportunities in convertible bonds. Archeus began experiencing redemptions last year after its main investment strategy fell out of favor. The fund's founders blamed the failure of its administrator to maintain accurate records and their subsequent inability to properly reconcile the fund's records, led to a series of investor withdrawals from which they were not able to recover. Also, Archeus's 2006 performance this year did little to inspire its clients. Through the first week of October, Archeus's main fund was down 1.9 per cent for the year. However, the fund had returned 18.5 per cent since July 2005. Still, during a period when hedge fund returns have come under increased scrutiny and have, on average, lagged the returns of the major stock market indexes, such a return was not enough to keep investors on board.

The \$7.7 billion San Diego County Employees Retirement Association has retained class-action firm Bernstein Litowitz Berger and Grossmann to investigate the Amaranth implosion. Its \$175 million Amaranth investment, which was valued at \$234 million in June 2006, is now estimated to

be worth only \$70 million for a \$100+ million loss. They should have done better due diligence in advance. Those who bet the ranch on every trade eventually lose it. Investors should have known that was what they were investing in with Amaranth.

Following Amaranth's collapse, while investors were seeking someone to blame, some argued that these bets showed the need for more or a different sort of regulation of hedge funds, or rather the sort of over the counter trades in the natural gas market. Others including Gretchen Morgenson of the *New York Times*, pointed to the persistence of what many of have called the *Enron loophole*, created in 1993, when the Commodity Futures Trading Commission (CFTC) exempted bilateral energy futures transactions from its regulatory authority. This exemption was extended in 2000 in the commodity futures modernization act to include electronic facilities. Many have argued that Enron used such trades to increase the value of long-term contracts. In the run-up of gas prices in 2005/2006, some analysts and politicians pointed to the role of speculators in changing the demand structure, leading a congressional subcommittee to release a report urging that such trades all be the concern of U.S. regulators. Amaranth's collapse brings a different aspect to this debate, as it shows the limits to such self-regulation by market actors. While it is unclear what policy actions might be taken in this matter, this concern is likely to continue and may change the environment in which such trades are

made in the future. However, there are limits to the role that can be played by such regulation.

Other small losers are funds of funds of Morgan Stanley and Goldman Sachs who lost 2.5 per cent to five per cent from their Amaranth holdings. However as they helped unwind the trades they may well have recouped their losses as the energy markets subsequently increased.

There is little impact from this on the world economy. The hedge fund industry now has a bit more pressure to regulate position sizes but most regulators steer away from risk control. When you mention risk control, you are usually encouraged to change the subject. What they are interested in is operational risk. The exchanges have limits but rogue traders are able to get around these rules. In any event, if VAR were to be used it would not work. As long as risk control is so poorly understood, misapplied and disregarded and pension funds and others are desperate for high returns, such disasters will occur from time to time; and this is fully expected. It is simply part of the hedge fund zero sum gain. For every Jim Simons eking out steady profits using a lot of careful research, excellent execution, position sizing and strict risk control; there is a Brian Hunter trying to make it by over-betting with very little research and a firm which improperly applies risk control. Improper regulation may well hurt more than help.

*This article is dedicated to our late friend and colleague Merton Miller; he would have enjoyed it.*

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