The Amaranth Debacle: *A Failure of Risk Measures or a Failure of Risk Management?*

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The impact of the activities of investors and speculators on financial markets has long been of great interest to academics and practitioners alike.[1] Since 2000, the amount of assets managed by hedge funds has nearly tripled from a total of $490 billion to $1,336 billion and although still a small percentage of total assets worldwide, hedge funds account for an even larger part of the liquidity in certain markets (HFR Industry Report [2006]). In September 2006, the activities of a Connecticut hedge fund named Amaranth Advisors LLC[2] significantly impacted the natural gas market. Building up large losses in trading natural gas futures, the story of Amaranth bears all the hallmarks of a near miss in terms of endangering systemic financial stability. What happened? What went wrong? And most importantly—perhaps—does this strengthen the widespread call for tighter regulation of hedge funds or the futures market?[3] This article addresses these questions in more detail. Furthermore, the article looks for answers on whether the failure of Amaranth was just "business as usual" in the natural rise and fall of hedge funds or if standard risk management practice could have signalled that something was amiss.

At least since the spectacular implosion of LTCM, hedge funds have been featured prominently in regulators' primary concerns about maintaining the orderly functioning of markets. Indeed, in recent years, regulators have actively debated the merits of a more prudent regulatory framework for hedge funds both in public and more private settings such as the Basel Committee for Banking Supervision.[4] In the collapse of Amaranth by September 21, 2006, the firm had lost roughly $4.35 billion or one half of its assets under management as a result of its energy trading business, in particular, the funds' activities in natural gas futures and options. These losses occurred in just under a month between August 31 and September 21, 2006 (assets fell from $9.67 billion to $5.32 billion). The fund consequently sold its energy portfolio trading book to J.P. Morgan and Citadel Investments and liquidated the remainder of its portfolio.

Since the collapse of Amaranth in September 2006, several authors have attempted to understand what positions and risk levels Amaranth was engaged in to cause such a dramatic collapse (Chincarini [2006, 2007] and Till [2006]). Chincarini [2006, 2007] used information from newspapers, CEO statements, and actual natural gas futures data to quantify the nature of the most likely trades that were made at Amaranth. That article hypothesized that Amaranth had engaged in a short summer, long winter natural gas trade primarily using natural gas futures. Based on these backward-engineered positions, the article examined both the market and liquidity risk of Amaranth's positions prior to its collapse.

On June 25, 2007, the Committee of Homeland Security and Government Affairs released a document containing a detailed investigation of the Amaranth scandal entitled "Excessive Speculation in the Natural Gas Markets." The U.S. Senate Permanent Subcommittee on Investigations used its subpoena power to analyze the trading records at the New York Mercantile Exchange (NYMEX), the Intercontinental Exchange (ICE), as well as the trades of Amaranth and other traders. It also conducted numerous interviews of natural gas market participants, including natural gas traders, producers, suppliers, and hedge fund managers, as well as exchange officials, regulators, and energy market experts.

This article discusses the causes and details of the collapse of Amaranth. It also compares the Senate findings of the actual positions of Amaranth with those postulated in Chincarini [2006, 2007] before any public information on these positions was known. The next section discusses the background of Amaranth and the natural gas futures market. The following section discusses the types of trades that Amaranth had constructed in the natural gas futures market and compares these to the hypothesized trades in Chincarini [2006, 2007] and also discusses the events in the natural gas futures market in September that caused the Amaranth positions to perform so poorly. The section after that discusses the risk management aspects of Amaranth's energy positions, followed by some conclusions.

BACKGROUND

Amaranth Advisors LLC

Amaranth Advisors LLC was a hedge fund operating in Greenwich, CT.[5] The hedge fund launched in 2000 as a multi-strategy hedge fund, but by 2005–2006 had generated over 80% of its profits from energy trading. Although Amaranth had several funds, the principle fund, with $7.85 billion at the end of August, 2006, was the Amaranth LLC fund. This fund was structured as a multi-strategy fund that could invest in virtually any market without any position limitations. The various types of strategies included energy arbitrage and other commodities, convertible bond arbitrage, merger arbitrage, credit arbitrage, volatility arbitrage, long-short equity, and statistical arbitrage.

Amaranth was slightly unique in terms of risk management in that it had a risk manager for each trading book who would sit with the risk takers on the trading desk. This was believed to be more effective at understanding and managing risk.[6] The risk group produced daily VaR and stress reports with VaR confidence levels of 68% and 99.99% over a 20-day period. The risk management team also produced a liquidity report which would present positions and their volumes for each strategy. In addition, Amaranth maintained a certain amount of risk capital to be used for anticipated margin calls on its positions. For example, in May 2006, it had $3 billion or 30% of capital in cash for these purposes. Amaranth used several prime brokers and excess borrowing facilities to fund its positions.

In terms of Amaranth's capital, about 60% came from funds-of-funds, about 7% from insurance companies, 6% from retirement and benefit programs, 6% from high-net-worth individuals, 5% from financial institutions, 2% from endowments, and 3% was insider capital. The insider capital was not charged management or incentive fees. Amaranth commenced operations in 2000 with approximately $200 million in capital, mainly provided by Paloma entities. The largest investor in Amaranth by 2006 amounted to 8% of total capital. Investors could withdraw funds with the following restrictions.

1. Initial deposits had a 13-month initial lock-up with 90 days required written notice.
2. After this initial lock-up period, investors could withdraw quarterly, in January, April, July, and October with 45 days written notice and a 2.5% withdrawal fee.
3. Investors could also make annual redemption of profits with 45 days written notice.
4. Beginning in February 2005, new investors were subject to a two-year lock-up period on capital.

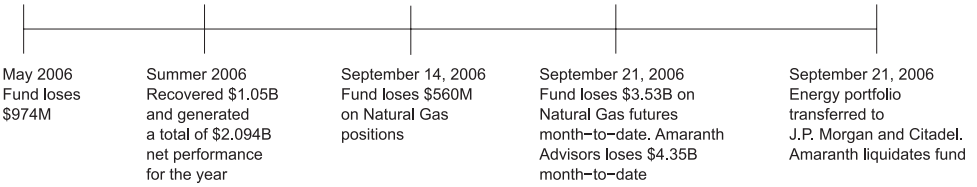
Minimum investments in Amaranth were $5 million. The management fee was 1.5% and the incentive fee was 20%. A high watermark was also employed.

The Event Timeline

The sequence of events of the Amaranth collapse is depicted in Exhibit 1.

The relative riskiness of Amaranth's energy fund can be mapped by the volatility of its profits and losses. In May, the fund suffered losses of $974 million, although over the summer, the trading of the energy portfolio was able to recoup these losses as well as produce additional

EXHIBIT 1
Timeline of the Amaranth Collapse



profits for the firm. In June, the fund generated $548 million, in July, it lost $44 million, and in August, it generated $550 million for investors in the Amaranth Advisors LLC fund. Amaranth as a whole lost other assets in the Amaranth Partners LLC fund (this shall be referred to as the "Partners Fund" throughout the rest of this article). By the end of the summer, the Amaranth Advisors LLC fund was up $2.094 billion for the year. The month of September saw the Amaranth debacle occur. During the month, the fund lost approximately $3.53 billion of a $7.85 billion fund. Amaranth lost an even greater amount if one considers assets in its partners' fund and its global equities fund. During this same period, it lost a total of $4.35 billion out of total assets of $9.668 billion. On September 14, 2006, the fund experienced its worst day with losses of around $560 million.[7] The situation was so severe that on September 15, 2006, the principals of the fund began seeking parties that might be able to buy its energy portfolio. On September 20, 2006, the energy portfolio was sold to two investors, J.P. Morgan and Citadel, and Amaranth liquidated the rest of its portfolio.

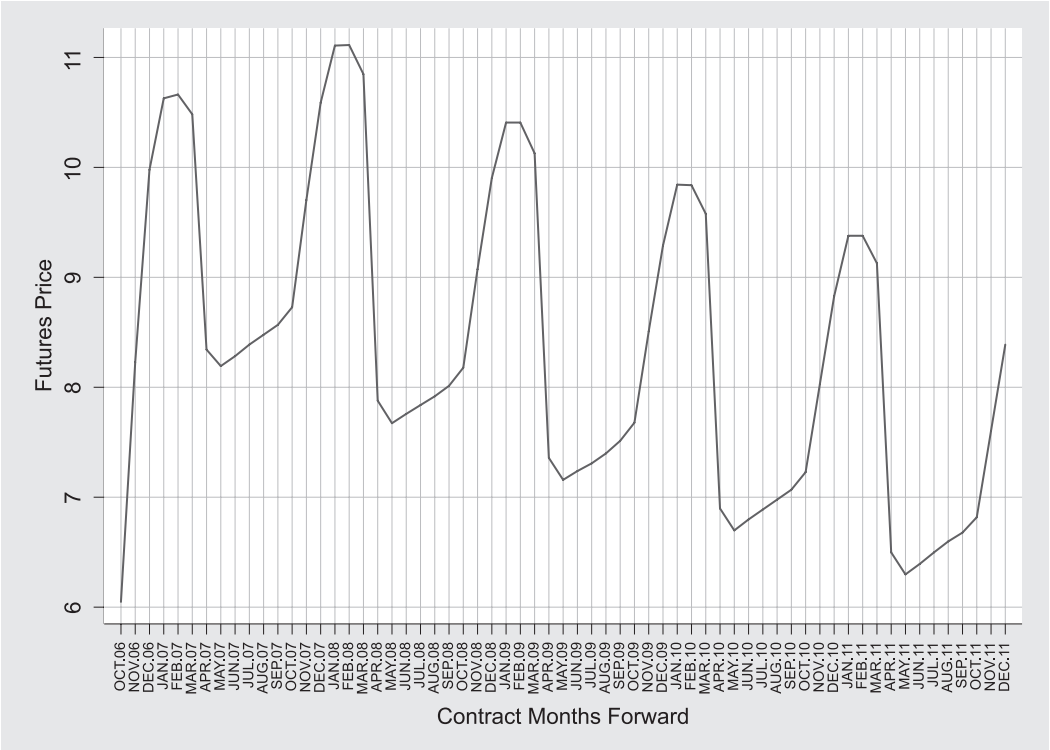
THE NATURAL GAS FUTURES MARKET

The natural gas futures market is a very unique market in several respects.[8] Firstly, natural gas is used to heat 54% of U.S. homes. Additionally, natural gas is used in 78% of restaurants, 73% of lodging facilities, 51% of hospitals, 59% of offices, and 58% of retail buildings. Natural gas generates approximately one-fifth of the domestically produced electricity in the U.S. Demand for natural gas is at its lowest during summer months, although in recent years, summertime demand for natural gas has risen to meet short-term needs of electric utilities during heat waves. Secondly, natural gas demand peaks in winter months and ebbs during the summer months. "During the summer months when supply exceeds demand, natural gas prices fall, and the excess supply is placed into underground storage reservoirs. During the winter, when demand for natural gas exceeds production and prices increase, natural gas is removed from the underground storage."[9] In fact, the futures curve for natural gas futures is quite unlike many other commodities. The futures curve consists of a sine-like wave of altering contango and backwardation segments. Exhibit 2 depicts the natural gas futures curve as of August 31, 2006. The x-axis represents the particular futures contract of concern, while the y-axis represents the price for the specified futures contract. For example, the price of the October 06 futures contract is $6.048 and the price of the November 06 futures contract is $8.228. The October 06 contract is a contract to deliver natural gas in October 2006, while the November 06 is a contract to deliver natural gas in November. The one consistent feature for contracts delivered up until December 2011 is that the futures' prices for winter months (November–March) are higher than prices for non-winter months (April–October).[10]

Traders in natural gas futures have several options. Firstly, the largest exchange for trading natural gas futures is the NYMEX which has futures contracts for every delivery month up to five years out. They also have options on all of the futures contracts, as well as spread options whose payoff is based on the difference between the futures contract prices of two different months. The initial margin requirement on futures contracts varies by type of trader (non-member customer, member customer, and clearing member and customer) and also vary by time to maturity of the contract. Contracts closer to delivery have stricter margin requirements. To give a flavor of the margin differences as a percentage of notional value, on August 31, 2006, $12,150 was required for each October 2006 contract, which had a futures value of $60,480, thus representing about 20% of the futures notional position. The March 2007 contract had a margin requirement of $7,425 (Tier 5) with a notional value of $104,830 or 7.08%. The expiration of the contracts is usually a few days before the end of the prior month and there are conventions for the last trading day of each contract which can be obtained from the NYMEX.

EXHIBIT 2

The Natural Gas Futures Curve on August 31, 2006



In addition to NYMEX, traders can use the ICE, which is a virtually unregulated exchange but performs very similar functions. ICE is the leading exchange for the trading of energy commodity swaps in natural gas and electricity. "The ICE natural gas swap and the NYMEX natural gas futures contract perform the same economic functions. The ICE swap contract even provides that its final settlement price will equal the final settlement price of the NYMEX futures contract for the same month, which means that the final price for the two financial instruments will always be identical." (Senate Report, p. 29) Traders also can use the ICE trading screen to enter into bilateral, non-cleared transactions rather than cleared transactions; that is, OTC transactions with other parties to buy or sell natural gas. One major difference between NYMEX and ICE is that ICE has "...no legal obligation to monitor trading, no legal obligation to prevent manipulation or price distortion, and no legal obligation to ensure that trading is fair and orderly..." (Senate Report, p. 41) due to its status as an electronic trading facility. In addition, the CFTC had no authority or obligation to monitor trading on ICE.

THE AMARANTH TRADING POSITIONS AND NATURAL GAS VOLATILITY IN SEPTEMBER

Amaranth's Actual Positions

The Permanent Subcommittee on Investigations' detailed report entitled "Excessive Speculation in the Natural Gas Market" details very precisely the exact positions that Amaranth had taken in the natural gas market. In this section, we focus on some of the key positions. Perhaps the most important positions are those that Amaranth had in place on August 31, 2006, prior to the volatile events in the natural gas market in September and Amaranth's subsequent collapse. Exhibit 3 shows the actual positions that Amaranth had in natural gas futures equivalent contracts on this date for the first 12 months of futures contracts.

These positions consist of both NYMEX and ICE positions.[11] In front-month contracts, one can observe the spread trade that Amaranth had, essentially short non-winter months and long winter months. The two exceptions were the December 2006 and February 2007 contracts for which, although being winter months, Amaranth was actually short

EXHIBIT 3

Actual Positions and Hypothesized Positions of Amaranth on August 31, 2006 by Contract

Contract	Actual Positions	Hypothesized Positions	NYMEX Open Interest	Percent of Open Interest
OCT.06	(94,441)	(93,518)	116898	-80.8
NOV.06	59,247	56,386	70483	84.1
DEC.06	(27,757)	40,918	51147	-54.3
JAN.07	61,825	39,412	49265	125.5
FEB.07	(7,464)	24,734	30918	-24.1
MAR.07	58,365	63,788	79735	73.2
APR.07	(77,527)	(50,058)	62572	-123.9
MAY.07	(140)	(19,463)	24329	-0.6
JUN.07	869	(12,100)	15125	5.7
JUL.07	(1,612)	(9,250)	11562	-13.9
AUG.07	406	(10,478)	13098	3.1
SEP.07	(1,128)	(9,408)	11760	-9.6

Note: Contract represents the particular natural gas futures contract that was used in the spread position, Hypothesized positions refers to the positions hypothesized in Chincarini [2006, 2007], NYMEX Open Interest is the open interest in each contract on NYMEX for August 31, 2006, and Percent of Open Interest is the percentage of open interest of the actual Amaranth positions on August 31, 2006. The actual positions of Amaranth are represented as NYMEX natural gas futures equivalents.

these contracts. Although not shown in this exhibit, Amaranth had positions in natural gas futures contracts well out until the 2011 maturity. The main trade or strategy of Amaranth was a spread bet on natural gas futures long winter and short non-winter. The leverage of the fund for the positions shown in the Senate report was 5.54 based upon the total fund value of $9.668 billion, that is the partners fund, as well as other funds managed by Amaranth. This was computed by finding the dollar value of all futures contract positions on August 31, 2006, and dividing by Amaranth's total assets under management. In Exhibit 3, one can also observe Amaranth's excessive ownership of natural gas futures contracts. For the October 2006 contract, Amaranth's positions on ICE and NYMEX equaled 80.8% of the open interest on NYMEX. For January 07 and April 07, it was even more extreme, with Amaranth's positions representing 126% and 124% of the open interest on NYMEX.

The positions of Amaranth for May 31, 2006, and other months were similar in nature. That is, Amaranth had a similar long winter, short non-winter spread on natural gas futures contracts. The size and distribution of the positions were slightly different in each case. Another important difference between earlier months and August 31 was that the leverage was lower. For example, the leverage of the May 31 position was 3.83 compared to the 5.53 at the end of August. That is, Amaranth increased its leverage with respect to natural gas futures significantly over the summer of 2006.

The Hypothesized Positions

Chincarini [2006, 2007] used data on natural gas futures prices and open interest from NYMEX,[12] newspaper articles (see Exhibit 4), and publicly available statements of the CEO of Amaranth to recreate the types of trades that Amaranth may have made in August to result in such dramatic losses in September 2006.

Chincarini's analysis concluded that it was highly unlikely that Amaranth's losses in September were due to simple straight long positions in natural gas futures or options. These positions would have required too much direct exposure to the natural gas exchange-traded market and would have likely been prohibited by NYMEX. The article concluded that it was highly likely that Amaranth's losses in September were due to a spread trade that was short non-winter months and long winter months. The analysis defined winter months to be those from November to March and all other months were considered non-winter months. Amongst other reasons, this strategy had done well historically and in other years in which Amaranth had done

EXHIBIT 4

Most Relevant Information from Newspapers and Other Sources

Item	Information
1.	By September 22, 2006, the NAV of the fund has decreased 65% month-to-date and 55% year-to-date.[a]
2.	On September 14, 2006, the funds experience roughly $560M in trading losses on natural gas positions.[a]
3.	By February 28, 2006, approximately 39% of the fund's capital was allocated to the energy and commodities portfolio.[a]
4.	He sometimes held positions to buy or sell tens of billions of dollars of commodities.[b]
5.	Amaranth's overall fund gained around 6% in June, was roughly flat in July, and rose 6% in August according to investors.[b]
6.	...from $9B at the start of September.[b]
7.	Spreads and options are of their very nature instruments that allow the user to capture upside with a much clearer understanding with respect to downside exposure.[c]
8.	Mr. Hunter sometimes held 100,000 positions in a single contract...[c]
9.	People familiar with the trades say he bet prices for nearby-month contract months would fall and winter contracts would rise.[c]
10.	Some of Amaranth's trades wagered that prices for natural-gas futures contracts for March 2007 would be much higher than those for April 2007.[d]
11.	UBP officials said 80% of Amaranth's performance last year and most of its performance this year was driven by energy investments—suggesting there mightn't be much else.[e]
12.	The New-York Mercantile Exchange told Amaranth Advisors LLC that the natural gas bets were too big a month before the trades led to a $6B loss...[f]

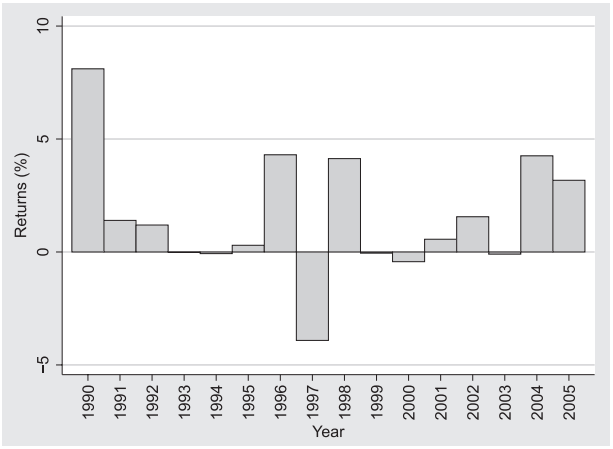
Note: [a]Remarks by Nick Maounis, President, CEO and CIO, Amaranth Group, Inc. Investor Conference Call, September 22, 2006, Unknown Source. [b]"How Giant Bets on Natural Gas Sank Brash Hedge-Fund Trader," Wall Street Journal, September 19, 2006. [c]"What Went Wrong at Amaranth", Wall Street Journal, September 20, 2006. [d]"How the Wreck from Amaranth was Contained", Wall Street Journal, October 5, 2006. [e]"J.P. Morgan, Citadel Acquire Amaranth's Energy Portfolio", Wall Street Journal, September 21, 2006. [f]Leising, Matthew. "Nymex told Amaranth in August to Cut Risky Trades, People Say", Bloomberg News, September 27, 2006.

well. Exhibit 5 shows the performance of this type of trade over the last 16 years prior to 2006.

For the analysis, the article also made some simplifying assumptions, such as that Amaranth's positions were proportional to the outstanding open interest of the futures contracts traded on NYMEX. The hypothesized positions for the first 12-month contracts on August 31, 2006, are shown in Exhibit 3.

EXHIBIT 5

Historical Returns of Long Winter, Short Non-Winter Spread Trade in September (1990–2005)

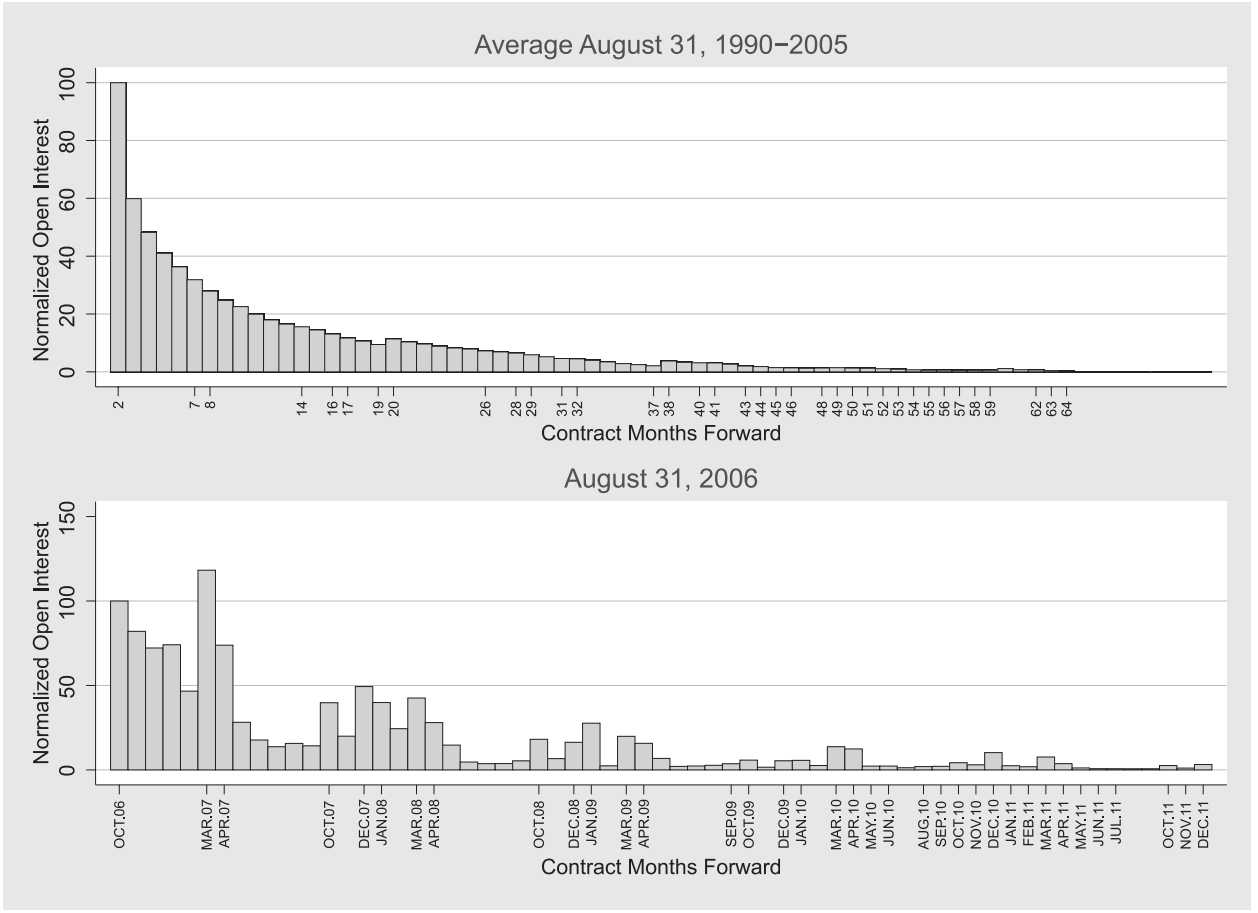


Despite many rumors that Amaranth's losses came from one particular spread trade, the March–April spread trade, Chincarini [2006, 2007] found that this could not be the case and that the Amaranth positions had to consist of a more general long winter, short non-winter spread trade. Part of the analysis consisted of comparing the open interest of natural gas futures contracts on August 31, 2006, with the contracts' historical norm. Exhibit 6 shows the historical normalized average dollar open interest versus futures maturity on August 31 from 1990–2005 versus the normalized dollar open interest versus maturity on August 31, 2006.

The October (i.e., two-months forward) contract's open interest is normalized to 100 in both cases. In order to identify unusual activity on August 31, 2006, the names of the contracts whose open interest was greater than 50% of the historical normalized open interest are written in

EXHIBIT 6

Unusual Activity in Certain Maturity Contracts on August 31, 2006



the graph. In the top graph, contracts are labeled by months forward, since this is an average of previous years. Thus, 2 is for the October contract of the same year on August 31, 3 is for the November contract of the same year for August 31, and so on. Basically, the two graphs are stacked upon each other to represent the appropriate comparison. From this simple graph, one can observe that something unusual was occurring with the March–April contracts; they all had unusually large open interest compared to their historical normalized averages. However, this wasn't the entire story; many other contracts, such as the December–January contracts also had unusually large open interest. Thus, the unusual activity seemed very consistent with a winter versus non-winter spread trade, of which the March–April trade was a subset of this strategy. More importantly, Chincarini [2006, 2007] showed that the March–April spread trade alone could not produce the size of losses that Amaranth had in September. The losses on those spread trades represented only 1/4 of the losses, even if they had owned all of the open interest in them on NYMEX.

Chincarini [2006, 2007] also ruled out that spread options or straight natural gas futures options were a large part of the Amaranth strategy.

The final analysis found that the hypothesized winter/non-winter strategy could have generated losses of $5.86 billion from August 31 to September 21, 2006. Note that this was not the amount Amaranth actually lost, but that hypothesized from the limited public information available. The total number of contracts either short or long had a notional value of $65,526,136,832 or 80% of the total open interest on NYMEX. The hypothesized position implied a leveraged position of 7.28 for Amaranth ($65,526,136,832/$9,000,000,000). The net of the long and short contracts was 48,661 contracts. Finally, the net return on this spread trade was –8.9366% from August 31, 2006 to September 21, 2006.

A Comparison of Amaranth's Actual Positions to the Hypothesized Positions

The hypothesized positions of Chincarini [2006, 2007] are shown in Exhibit 3 alongside the actual positions of Amaranth. The positions for these particular months, as well as for other months, are not identical. The work of Chincarini [2006, 2007] was based on very limited information and some of it was incorrect. However, given these limitations, the similarity in the positions is quite strong. Amaranth had shorted 94,441 of the October 06 contracts and gone long 59,247 of the November 06 contracts. Chincarini [2006, 2007] had hypothesized that Amaranth was short 93,518 and long 56,386 contracts, respectively. Also, generally, both the actual positions of Amaranth and the hypothesized positions represented a short non-winter, long winter spread trade in natural gas futures contracts. Of course, there were discrepancies in the actual values, but for the larger positions, the two were similar.

Chincarini [2006, 2007] hypothesized that Amaranth had a leverage level of 7.28, while Amaranth's actual leverage in natural gas futures was closer to 5.54. This was mainly due to a piece of incorrect information. Chincarini [2006, 2007] had used a statement from the CEO of Amaranth which had said that they had lost 65% from August 31, 2006 to September 21, 2006. This, combined with an assumption of assets under management of $9 billion, resulted in a loss of $5.85 billion over this period. The actual assets under management at Amaranth at the end of August were $9.668 billion and the losses through September 21, 2006 were actually $4,350,600,000 or 45% of the total assets under management. Had these appropriate exhibits been available, the leverage would have been estimated at around 5.04; very close to the actual leverage.

Chincarini [2006, 2007] had also used the same basic strategy to try and replicate the returns of June, July, and August 2006. Exhibit 7 shows the implicit size of the positions, dollar gains and losses, and the percentage of the fund's net assets this would represent for the spread trade in other periods. The actual returns for these periods are also listed in the exhibit. The actual returns for June, July, and August were 7.07%, –0.53%, and 6.98%. The hypothesized position returns were higher, but directionally similar. That is, 15.23%, –1.52%, and 15.66%.

There are two explanations for the discrepancies in the actual returns and those in Chincarini [2006, 2007]. One straightforward explanation was that Amaranth did not have the same type of trade on for prior months as it did for September. Another possible explanation was that Amaranth actually increased its leverage immediately prior to September. In fact, it implied that Amaranth doubled its leverage from prior months hoping to cash in on the historical September anomaly. In this sense, Chincarini's [2006, 2007] analysis was on the right track. In fact, Amaranth's actual position at the end of May had a leverage ratio of 3.83, while the leverage prior to the events of September was

EXHIBIT 7
Performance of Spread Trade in Other Periods During 2006

Period	Size of Position	Return of Spread Trade	Dollar P/L	Return of Fund (%)	Actual Amaranth Returns (%)
June, 2006	55,680,000,000	2.19	1,220,000,000	15.23	7.07
July, 2006	58,080,000,000	-0.22	(129,000,000)	(1.52)	-0.53
August, 2006	69,120,000,000	1.93	1,330,000,000	15.66	6.98

Note: Period represents the period for which the natural gas futures spread trade returns are calculated. Size of Position represents the absolute value of all contracts that were used to enact the spread trade. Return of Spread Trade represents the returns of the spread trade for that particular period. Dollar P/L represents the total P/L on the spread trade for that particular period assuming an investment of 80% of the total open interest of all futures contracts on NYMEX consistent with the previously constructed strategy. Return of Fund represents an approximation of the return this position would represent as a percentage of the total assets estimated to be owned by Amaranth. The numbers are constructed using the same methodology for spread trades in other months. That is, long winter months and short non-winter months. The last column labeled Actual Amaranth Returns are the actual returns to the Amaranth fund in each period.

5.54 or about 1.5 times the leverage of prior months. Thus, Amaranth did increase its leverage substantially prior to September. Generally, its positions prior to September were long winter, short non-winter spread trades.

Natural Gas Volatility in September

Now that we have discussed the actual positions that Amaranth Advisors had placed in the natural gas futures market, we examine the volatility of prices that led to its large losses. Historically, a spread trade in natural gas futures had done quite well. Exhibit 8 shows the average returns of different maturity futures contracts in the month of September from 1990–2005. One can see that generally, winter month returns are higher than non-winter month returns and that natural gas prices have tended to rise on average in September for the first 36 months out. Some of the near contracts had returns as high as 5.73% on average in September.

In September of 2006, the natural gas futures market behaved entirely differently than it had historically. Exhibit 9 shows the behavior of natural gas futures returns in September of 2006. The x-axis plots the contract months forward. Thus, in this particular exhibit, 1 represents the returns for the October 2006 futures contract during September, 2 represents the returns for the November 2006 contract in September, and so on. One can see from this exhibit the dramatic negative returns of natural gas futures in September, which was as low as –27% for front-month contracts. One can also see that the negative returns were less for non-winter months. That is, although returns were severely negative for most natural gas futures contracts, they were worst for winter months, all the way across the maturity spectrum. For example, for the first year out, the contract months 2–6 did poorly, representing the contracts for November 2006–March 2007, while in months 7–13, the negative returns were less severe representing the months April 2007–October 2007. This pattern is seen for futures contracts in future years as well. This pattern would not bode well for a strategy that was long winter and short non-winter months.

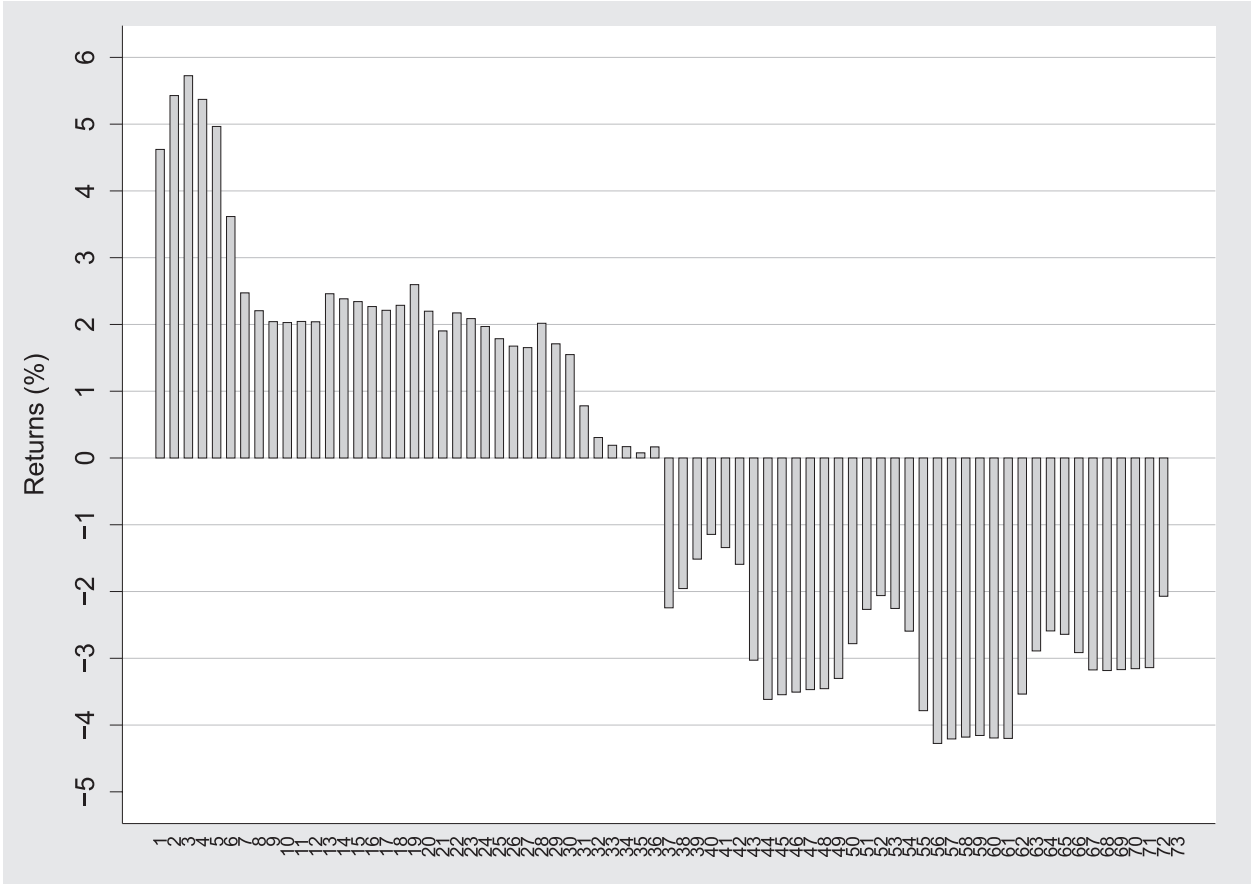
During the period from August 31, 2006 to September 21, 2006, Amaranth's actual natural gas futures positions may have changed for a variety of reasons. However, if we assume its positions during September were quite close to the positions on August 31, 2006, then the changes in natural gas futures in September would have led Amaranth to lose $3,295,239,642. Their actual total loss over this period was $4,350,600,000. Part of the discrepancy could be due to not having access to all of Amaranth's positions, some could be due to losses in other parts of the Amaranth portfolio, and some of it may be due to Amaranth changing their positions during the period. Eventually, margin calls[13] on the large losses led Amaranth to search for buyers of its portfolio and the liquidation of the fund.

RISK MANAGEMENT

In a conference call to investors, the CEO of Amaranth repeatedly mentioned that Amaranth had experienced professionals monitoring the risk of the firm's positions, as well as noting that the events of September were unusual and unpredictable.[14] Amaranth's "...staff included a Chief Risk Officer and 12 risk 'lieutenants' to monitor the risks in the various trading books." (Senate Report, p. 59)

EXHIBIT 8

Historical Average September Natural Gas Futures Returns (1990–2005)



In Chincarini [2006, 2007], Amaranth's risk exposure was examined with respect to the hypothesized positions. Two dimensions of risk were analyzed—liquidity risk and market risk. Market risk is the risk that occurs from the volatility of investment returns, while liquidity risk measures the degree of difficulty in exiting a given trading position.

Market Risk

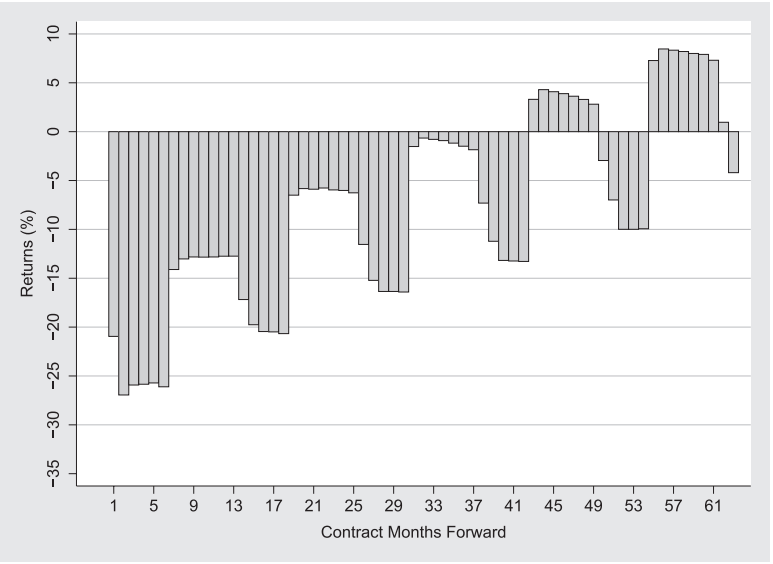
In order to calculate market risk, Chincarini [2006, 2007] used a simple value-at-risk (VaR) measure as well as one that corrected for skewness and kurtosis in returns; a Cornish-Fisher VaR.[15] The analysis of VaR on August 31, 2006, could explain about 65% of Amaranth's losses. That is, a simple VaR calculation by risk managers at Amaranth would have indicated the potential in a worse case scenario (i.e., less than 1% of the time) of losing 65% of their actual losses. Thus, Amaranth's energy trades were, by construction, very risky from a market risk point of view. However, this should not be confused with "carelessness," because the strategy of the fund may have been designed for very high risk. The unexplained 35% of losses were thought to be caused by liquidity losses due to Amaranth's excessively large positions.

Liquidity Risk

Liquidity is defined as the ability to sell a quantity of a security without adversely changing the price in response to one's orders. Models for liquidity risk are not as common place as models for market risk. One simple precautionary measure that practitioners use to control liquidity risk is to measure the size of their trades versus the average daily trading volume of a security. A rule-of-thumb is to not hold positions greater than

EXHIBIT 9

Natural Gas Futures Returns from August 31, 2006–September 21, 2006



1/10–1/3 of the average daily trading volume over some specified time interval, such as the last 30 days of trading.

Exhibit 10 shows various positions of Amaranth in natural gas futures on August 31, 2006 as multiples of the trailing 30 day average daily trading volume on NYMEX in each contract. Even though some of Amaranth's positions were with ICE and not NYMEX, these positions were extremely large relative to the average daily trading volume of the largest natural gas futures exchange (NYMEX) and were even large with respect to the open interest.

Chincarini [2006, 2007] also found that contracts whose open interest was much higher on August 31, 2006, than the historical normalized value experienced larger negative returns. In particular, every 10 units more open interest than the normalized average led to an extra decline of 2.6% for that particular futures contract. Given that Amaranth was the main source of this extra open interest in certain contracts, the events of September were adverse from a liquidity perspective as well.

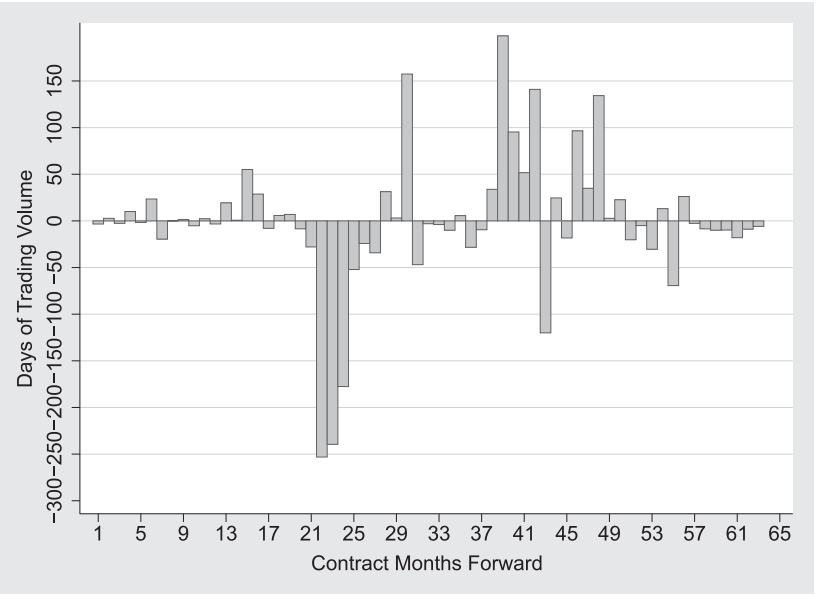
It is difficult to measure liquidity risk directly. However, for the actual spread trades, Amaranth's natural gas positions represented a large portion of the open interest on NYMEX, and in some contracts, its positions on ICE and NYMEX combined represented up to 125% of the open interest on the NYMEX exchange (see Exhibit 3). The Senate report found that Amaranth's NYMEX positions represented 46–81% of the open interest on NYMEX, depending on the day and the particular contract. In fact, the NYMEX compliance officials instructed Amaranth on several occasions to reduce their positions in natural gas contracts. In most instances, Amaranth responded by reducing their positions on NYMEX, while increasing them on the ICE. Thus, Amaranth was being imprudent with respect to its natural gas futures positions in terms of the size versus the market size. This may have resulted in the extra losses not accounted for by simple VaR measures.

Indeed, regulators have long emphasized the importance of comprehensive risk management approaches. In this context, VaR measures constitute a necessary, but by no means sufficient, component of a corporate risk management framework. As in the case of Amaranth, VaR only addresses part of the global risk exposure and, most critically, ignores liquidity risk. This is a well-known shortcoming and has been most famously addressed by the former Chairman of the Federal Reserve Alan Greenspan in connection with adequate risk management techniques for international foreign exchange reserves. As a result, central banks, for example, have embraced integrated approaches to risk management which combine both VaR and liquidity risk measures, particularly for the management of their large intervention portfolios. In the context of hedge funds, Greenspan's [1999] "liquidity-at-risk" (LaR) measure could be defined as follows: LaR quantifies liquidity over a range of trading outcomes and defines the appropriate level of highly-liquid assets that need to be held such that the current positions can be liquidated at a given level of confidence and VaR without either new borrowing or adversely affecting the market in response to own orders. In any case, comprehensive stress testing both in terms of VaR and LaR would have highlighted the underlying risk exposures of Amaranth's even further.

The Senate Committee report also noted that ICE is not regulated, which makes it more difficult for exchanges, like NYMEX, to monitor how large one investor's position is and its potential to manipulate or distort market prices. They argue that the law should be changed so as to regulate ICE, as well as other electronic exchange platforms. This would also be important if a standard for liquidity risk was implemented, since it could only be used effectively if liquidity could be aggregated across exchanges.

EXHIBIT 10

Spread Trade Positions as a Ratio to 30-Day Average Daily Trading Volume



CONCLUSION

The collapse of the $9.668 billion Amaranth hedge fund in September of 2006 due to bets on natural gas attracted widespread media attention. It raised concerns among many investors as to Amaranth's actions in terms of managing the fund which led to major losses. Furthermore, it added to the debate among regulators and authorities that the speculative activities of hedge funds may be riskier than they appear to be.

The purpose of scientific research is to seek solutions to complex questions, specifically when key data or facts are missing. After the Amaranth collapse, some researchers attempted to understand the positions and risks that Amaranth embraced using the limited available public information. Chincarini [2006, 2007] found that Amaranth's most likely position was a position in natural gas futures that was long winter months and short non-winter months in order to exploit a statistical arbitrage (in the sense that, historically, this trade did well in September) that had been pervasive in the natural gas futures market since the opening of trading on the NYMEX in 1990.

Fortunately, seven months after this research was publicly available, the Senate Subcommittee on Investigations issued a detailed report on the exact trades Amaranth had placed at the end of August, 2006. A comparison of the actual results to those hypothesized in Chincarini [2006, 2007] is quite promising for the scientific method. The actual positions and the hypothesized positions were quite similar and the basic conclusions of the mismanagement and risks posed by Amaranth were identical. Amaranth had taken extremely large positions in the natural gas futures market through the NYMEX and ICE exchanges. Its basic trade was a trade that mainly purchased winter natural gas futures contracts, while simultaneously shorting non-winter natural gas futures months, betting that in September, natural gas futures prices for winter months would increase relatively more than those of non-winter months.

This article also discusses whether the risk management of Amaranth was sufficient or not, based upon work by Chincarini [2006, 2007]. It is found that although the strategy of Amaranth Advisors may have been a reasonable one, Amaranth leveraged the position significantly, causing the trade to contain a huge amount of market risk. Even with simple market risk measures, it was poised to sustain major losses in a "worst case" scenario. Another source of Amaranth's risk was liquidity risk. In Amaranth's actual spread trades on NYMEX and ICE, it had natural gas futures positions that represented from 80%–125% of the total open interest on the NYMEX. Its NYMEX futures contracts alone represented as much as 60% of the open interest on NYMEX. These trades represented much too large a position with respect to the total open interest on the NYMEX exchange. In some senses, Amaranth was close to the entire market in certain futures contracts. A simple analysis in Chincarini [2006, 2007] showed that the most excessive positions generated the greatest losses in September, indicating a liquidity penalty against Amaranth. Thus, the positions of Amaranth were excessive from a liquidity perspective, which may have explained the additional losses in excess of what a simple VaR measure would have predicted. This also raises important questions for regulators about more transparency in the context of hedge funds' trading positions and the regulation of electronic exchanges such as ICE, as well as, perhaps, a communication between exchanges trading similar products.

On the surface, the Amaranth collapse did not significantly impact broader markets. In fact, there are many

positives in that the daily margin collection of the NYMEX worked to prevent a larger crisis. However, when security prices are diverted from their fair values due to bubbles or market manipulation by large players, consumers of these products ultimately bear the burden of an unfair distribution of income. In the natural gas markets, some of these consumers include residents, schools, hospitals, small businesses, local electricity plants, and others. Regulators might ask if transparency would have aided investors in understanding the extent of Amaranth's exposure to energy. Risk managers and regulators alike might also ask for standardized measures of liquidity risk, since liquidity risk seemed to be excessively high perhaps without any obvious signal to risk managers at Amaranth. Finally, a supervisory board like the CFTC might be required to have an oversight committee that has access to positions across exchanges on similar products for a more thorough liquidity analysis. In fact, on September 17, 2007, Senator Carl Levin of Michigan introduced a bill to regulate electronic energy trading facilities by registering with the CFTC (Levin [2007]). The bill also proposes to provide trading limits for energy traders that can be monitored by the CFTC across all energy trading platforms and exchanges, requires that large domestic traders of energy report their trades on foreign exchanges, and defines precisely what constitutes an "energy trading facility" and an "energy commodity."

ENDNOTES

I would like to thank Jim Riley for sparking my interest in this topic and for helpful comments. I especially thank Dan Berkovitz and the Senate Subcommittee headed by Senator Carl Levin for very useful conversations and helpful information. I also thank Guy Adami, Noel Amenc, David Bieri, Raj Gupta, Ed Fraim, Lionel Martellini, and everyone at the Senior Colloqium in Economics at Pomona College for helpful comments. I thank Scott Byrne and Joann Arena of NYMEX for supplying data.

[1]While Keynes [1936] merely refers to speculators as "forecasting the psychology of the market," Friedman [1953] asserts that speculation normally helps to stabilize prices rather than destabilize them. Friedman argues that if speculative trading tended to push prices higher when they are already high and lower when they are already low, then traders must be buying high and selling low. Since such behavior is not profitable on average, speculative traders try to buy low and sell high instead. Such activities would be stabilizing since they tend to push prices up when they are too low and down when they are too high.

[2]"Amaranth" henceforth.

[3]In a recent speech on Amaranth, the deputy Governor of the Sveriges Riksbanks (Nyberg [2006]) argued that such concerns rest on the fact that hedge funds' activities are opaque, that they borrow substantially, and that Amaranth was speculative and prone to herd behavior.

[4]See, for example, the BCBS' recommendations [2000].

[5]Many thanks to Dan Berkovitz for providing the information upon which much of this section is based.

[6]Most of these risk officers had advanced degrees in various fields.

[7]The losses for September 14, 2006, are not from actual data, but rather from statements by the CEO in September. They could be inaccurate.

[8]For a detailed description of the natural gas futures market, see the Senate Committee report.

[9]See the Senate report for more details.

[10]In this article, we divide all months into winter months and non-winter months. We classify November, December, January, February, and March into winter months and all other months into non-winter months.

[11]The positions consist of natural gas futures contracts, swaps, and options all converted to NYMEX natural gas futures equivalents by the Senate Subcommittee.

[12]ICE did not have any historical data available for public use.

[13]By September 8, 2006, margin requirements exceeded $3 billion.

[14]"What Brian is really, really good at is taking controlled and measured risk." "How Giant Bets on Natural Gas Sank Brash Hedge-Fund Trader," *Wall Street Journa*l, September 19, 2006. He also said "...a series of unusual and unpredictable events caused the Funds natural gas positions (including spreads) to incur dramatic losses while the markets provided no viable means of existing those positions" and "We viewed the probability of market movements such as those that took place in September as highly remote..." and "...we had assigned full-time, well-credentialed and experienced risk professionals to model and monitor our energy portfolios risk..." Remarks by Nick Maounis, President, CEO and CIO, Amaranth Group, Inc. Investor Conference Call, September 22, 2006.

[15]Details are explained in Chincarini [2006, 2007].

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