Original Article

Did Amaranth Advisors LLC engage in interday price manipulation in the natural gas futures market?

Received (in revised form): 15th June 2009

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ABSTRACT Price manipulation in US energy markets has become a heated political and economic issue because of events such as the Enron scandal, California's electricity crisis, and volatile movements in natural gas and petroleum prices. This article tests to determine whether Amaranth Advisors LLC manipulated natural gas prices during 2006. Amaranth is of particular interest because, during 2006, it controlled as much as 80 per cent of the natural gas open interest on the New York Mercantile Exchange and InterContinental Exchange. As a result of its dominant market position and suspicious trading activities, the Commodity Futures Trading Commission (CFTC) charged Amaranth in 2007 with attempted intraday price manipulation in the natural gas derivatives market, and the Federal Energy Regulatory Commission (FERC) followed the day after with charges that the fund engaged in perfected intraday price manipulation in the natural gas spot market. This study complements the CFTC and FERC investigations by testing whether Amaranth engaged in interday price manipulation in the natural gas derivatives markets during 2006. Using Granger causality tests, we find no convincing evidence of one-way causality from changes in Amaranth's positions to changes in the prices of natural gas derivatives contracts.

Journal of Derivatives & Hedge Funds (2010) **15**, 261–273. doi:10.1057/jdhf.2009.23

Keywords: Amaranth Advisors; price manipulation; natural gas derivatives market; granger causality test; cost of carry

INTRODUCTION: WHAT IS PRICE MANIPULATION?

Price manipulation can have direct and disadvantageous effects on consumers, producers and traders. The problem is that this practice is as difficult to recognize as it is to define. For this reason, the United States has no precise definition of what constitutes illegal price manipulation. A workable theoretical definition is any intentional act that reduces market liquidity and distorts price signals that efficiently allocate scarce resources.^{1–6} But even this definition is problematic because of the tenuous nature of an ‘efficient allocation of scarce resources’.

In the absence of transparent laws, the United States relies on regulators and a long-standing history of court-based opinions to provide operational and legal guidance. US case law places heavy emphasis on a company’s intent and ability to artificially move prices to self-serving levels.⁷ But proving intent is challenging because price changes can be the *active* result of manipulation strategies or the *passive* result of large, innocent transactions in relatively shallow markets.

This article expands the body of literature on price manipulation by investigating Amaranth Advisors LLC (Amaranth), a hedge fund that in 2006 lost US\$6.4 billion and was soon thereafter charged with *attempted* and *perfected* intraday price manipulation by the Commodity Futures Trading Commission (CFTC) and Federal Energy Regulatory Commission (FERC), respectively. Literature review of price manipulations in derivatives markets section

provides an overview of the scholarly research on price manipulation. Natural gas derivatives market regulation section discusses how natural gas derivatives markets are regulated. Price manipulation charges against Amaranth section reviews the CFTC’s charges against Amaranth for attempted price manipulation in the natural gas derivatives markets, and Empirical analysis of interday price manipulation section employs contemporaneous correlations and Granger causality tests to analyze whether Amaranth’s position changes had significant effects on natural gas derivatives prices. Finally, Conclusions section offers conclusions and further insights.

LITERATURE REVIEW OF PRICE MANIPULATIONS IN DERIVATIVES MARKETS

Despite the lack of a precise definition, price manipulation can be divided into three major categories.^{3,5,6}

- *Information-based manipulation* is caused by activities such as insider trading, providing false statements (for example, publishing erroneous balance sheet and income statements) and acting on private information. The Enron scandal provides an excellent and relatively recent case in point.
- *Action-based manipulation* (or contract-based manipulation) is caused by *individuals outside a company*, whose actions give a false impression of the underlying supply and demand conditions in a market. For example, a trader might purchase large quantities of a

company's shares in order to give the impression that a serious takeover bid is imminent. Not knowing that these actions are frivolous, individuals might then purchase shares of the faux takeover target and, thereby, support the higher price. At this point, the action-based manipulator could reverse his/her position at a profit.

- *Trade-based manipulation* occurs when an individual executes large buy or sell orders for the purpose of profiting from the movement in market prices. The distinguishing feature of such a manipulation is that artificial price movements are a discretionary part of the individual's strategy and not just an endogenous result of large transactions.

If the markets are broad and deep, then how is price manipulation possible, especially for *trade-based manipulation*? To address this issue, researchers have tried to find clues in both financial and commodity markets. Their results provide conflicting evidence. In the financial markets, Felixson and Pelli⁸ analyzed minute-by-minute trading data of individual firms and brokers on the Helsinki Stock Exchange and found only weak evidence that closing prices were manipulated. Stronger evidence of price manipulation was found by Jiang, Mahoney and Mei⁹ in their analysis of daily trading prices and volumes of 'stock pools' during the late 1920s. The authors found that, even though they can cause short-term, abnormal trading volumes, the effects of stock pools on market prices are rather small, and evaporated with time.

By contrast, Khwaja and Mian¹⁰ found evidence of trade-based price manipulation in their analysis of daily broker-level data for stocks traded on Pakistan's Karachi Stock Exchange for a 32-month period. Their results indicated

that price manipulation accounted for almost half of brokers' earnings. But the Karachi market is shallow and undeveloped relative to many other markets worldwide. Therefore, Khwaja's and Mian's results might apply only to developing markets. It is for this reason that price manipulation evidence uncovered by Merrick, Naik and Yadav¹¹ in the UK bond market was so interesting. Their study found strong evidence of profit-making through trade-based price manipulation by major market participants. Because England's government bond market is among the most developed in the world, these empirical results could not be dismissed by attributing them to the capital market's early stage of development.

Empirical studies of trade-based manipulation in commodity derivatives markets are just as limited and conflicting as studies of financial markets. One of the major obstacles to meaningful analysis has been the lack of adequate data, which tends to be highly aggregated with low frequency. For this reason, data limitations could be a major cause of the conflicting empirical evidence. For instance, Haigh, Hranaiova and Overdahl,¹² Fung and Hsieh,¹³ Irwin and Yoshimaru,¹⁴ Brown, Goetzmann Park,¹⁵ and Brorsen and Irwin¹⁶ found either no evidence or weak evidence of any significant causal links between changes in trader positions and changes in the prices of futures contracts. Finally, Sanders, Boris and Manfredo¹⁷ concluded that a positive correlation exists between noncommercial traders' positions and futures prices, that a negative relationship exists between commercial traders' positions and futures prices, and that feedback trading occurs, but they showed no evidence that traders' positions led market returns.

Over the past 20 years, some researchers (see Hartzmark^{18,19}) have been able to access more detailed, confidential information on large-trader positions, but these studies are exceptions. The CFTC has access to detailed information on exchange-traded derivatives, but the data it can release are limited by law. To be sure, the Commission walks a fine line between traders' rights to confidentiality and the public's need to better understand cause-and-effect relationships in the derivatives markets. It is for this reason that the government's release of detailed information about the multibillion dollar implosion of Amaranth in 2006 was so important.²⁰ Our study was able to use this information to link Amaranth's daily trading activity to daily prices and open interest on the New York Mercantile Exchange (NYMEX). To our knowledge, this study is the first to link a large hedge fund's daily trades with the market prices and open interest of a major derivative exchange.

NATURAL GAS DERIVATIVES MARKET REGULATION

In the United States, derivatives traded on organized exchanges are regulated by the Commodity Exchange Act (CEA), which was passed by the US government in 1936. The CEA made price manipulation or attempted price manipulation of commodity prices a punishable crime. At the same time, it provided no specifics on when a company crosses the line between fair and unfair trading practices.²¹ This Act was amended in 2000 by the Commodity Futures Modernization Act, which created a category of exchange called an 'exempt commercial market' (ECM). An ECM is virtually free from federal oversight, but to

qualify, it must be an electronic over-the-counter (OTC) market that trades energy and metals contracts for sophisticated investors (called 'eligible commercial entities'), such as banks, insurance companies, investment companies, registered security brokers and government agencies.²² Only in cases of fraud and manipulation do federal regulators retain substantial powers over ECMs.²³

Natural gas derivatives markets in the United States are monitored by diverse, and sometimes overlapping, layers of federal and local regulations. For bilateral OTC contracts, there is virtually no regulation outside normal contract law. But for exchange-traded derivatives contracts, the two principal regulators are the CFTC and individual commodity exchanges, such as NYMEX.

Congress created the CFTC in 1974 to regulate commodity derivatives traded on regulated exchanges in the United States. Even though the CFTC's mandate has evolved over time, its principal mission has always been to prevent fraud, manipulation and abusive trading practices in exchange-traded derivatives markets.²⁴ The CFTC's Division of Enforcement investigates and prosecutes alleged violations of the CEA and Commission regulations. Broad classes of violations include price manipulation, unregistered activities and fraud, illegal instruments, improper solicitation and advertising, record-keeping violations, and other supervision, compliance and audit cases.

The CFTC's first lines of defense against fraud, price manipulation and other trading abuses are the exchanges, which are self-regulating organizations that are expected to implement systems that deter these offenses.²⁵ Exchanges have major oversight responsibility for day-to-day futures and option transactions on

the exchanges. When problems or issues arise, they have the first opportunity to resolve them.

To protect against the potentially harmful effects of active and passive price changes in derivative markets, US exchanges are required to impose limits on the influence any one trader has on prices. For instance, NYMEX imposes both *position limits* and *accountability levels* to regulate traders.²⁵ Position limits in natural gas futures and options markets are set at 1000 contracts, but these limits apply only to positions held during the three business days before a contract's expiration. By contrast, NYMEX's accountability levels are notification triggers, and not *limits* in the strict sense of the word. When a trader's position reaches a threshold level, notification is sent to the CFTC. For natural gas derivatives contracts, the CFTC has set this limit at 12 000 contracts for any particular month (called the *any-one-month* accountability level), and it has also set a 12 000-contract limit for the sum of all the contracts owned by a trader at any one time (called the *all-months* accountability level).

PRICE MANIPULATION CHARGES AGAINST AMARANTH

Two overlapping debates emerged from Amaranth's failure. The first one focused on whether the natural gas derivatives markets functioned efficiently and effectively in 2006 (that is, during the Amaranth crisis) and whether these markets' built-in stabilizers ameliorated potential negative externalities from this crisis. The other debate focused on how, when and if a single trader, like Amaranth, could gain sufficient market power to harm consumers by artificially changing derivatives prices and/or volatilities. This controversy was important

because it addressed whether derivatives markets were purely competitive and, if not, whether broader or more directed regulation was needed.²⁶

On 25 July 2007, nearly a month after the government released detailed information on the hedge fund's failure, the CFTC filed a civil enforcement action suit against Amaranth and Brian Hunter, its lead trader, on grounds that they intentionally and unlawfully *attempted to* manipulate *intraday* natural gas *futures* prices. A day later (26 July 2007), the US FERC issued a 'Show Cause Order',²⁷ charging Amaranth entities, Brian Hunter and Matthew Donohoe, an Amaranth trader, with *perfected manipulation* of *intraday* natural gas *spot* prices. What made the CFTC and FERC's charges so interesting was that Amaranth neither produced nor consumed natural gas. Therefore, the fund never supplied or demanded the physical commodity in connection with its natural gas derivative positions. Amaranth was a pure speculator, hoping to profit from its proprietary trading strategies.

Our analysis focuses on *interday derivatives* market price manipulation, which is different from the FERC's interest in Amaranth's ability to conduct *intraday spot* market price manipulation and the CFTC's focus on *intraday derivatives* market price manipulation. In short, the CFTC and FERC concentrate on whether Amaranth was able to *punch-the-close* on NYMEX, while our interest is more closely related to Amaranth's ability to manipulate the *cost of carry trade* in natural gas derivatives contracts.

Punching-the-close

The CFTC and FERC accused Amaranth of 'punching-the-close' on NYMEX, which means

making large volume trades at Blitzkrieg speed just minutes before a contract expires.²⁸ Such trades have the potential to change futures prices because, often, liquidity levels are relatively low near a contract's expiration. By using these tactics to alter exchange-traded prices, traders can earn significant profits.

Manipulating the cost of carry market

The forward price of natural gas should not exceed the *cost of carry*, which is the cost to store, finance, transport and insure natural gas between the time it is purchased and sold. If the forward price exceeds the cost of carry, a hedger can earn riskless profits by purchasing natural gas in the spot market and simultaneously selling it in the forward market because the price differential between the forward and spot markets is more than sufficient to cover the cost of carrying the commodity from purchase to sale. Amaranth was not formally charged by the CFTC with this type of price manipulation, but there were strong suspicions that it was part of the hedge fund's investment strategy.²⁹

EMPIRICAL ANALYSIS OF INTERDAY PRICE MANIPULATION

This section uses contemporaneous correlations and Granger causality analysis to test whether changes in Amaranth's positions led to *interday* changes in the prices of natural gas derivatives contracts. It is important to remember that the data requirements for interday analyses are different from intraday analyses, such as were conducted by the CFTC and FERC. Intraday analyses require minute-by-minute trading data, which have not been made public by the

exchanges or government agencies. Therefore, the results in this article should be viewed as complements to, rather than substitutes for, analyses of the two US regulatory commissions.

Data and summary statistics

A lack of adequate data has been a major barrier to price manipulation studies. It is for this reason that the release of detailed information by the Permanent Subcommittee on Investigations (PSI) on the multibillion-dollar implosion of Amaranth in 2006 was so important. The PSI Report of 25 June 2007 provided detailed information on Amaranth's *daily* trading activities in the natural gas derivatives markets on NYMEX and the InterContinental Exchange (ICE), which we combined with daily market prices and open interest information on NYMEX. Unfortunately, the PSI data could not be combined with information from ICE because it does not make this information publicly available.

Our analysis uses four major variables to measure the relationships between Amaranth's positions and its power over derivatives prices. The fund's four positions are measured by its daily (1) NYMEX futures-only positions (see Table 1-A); (2) NYMEX futures, swaps and options positions (see Table 1-B); (3) NYMEX futures-and-swaps positions (see Table 1-C); and (4) combined positions (futures, swaps and options) on NYMEX and ICE (see Table 1-D). Our sample period ranges from 3 January 2006 to 31 August 2006 because this period corresponds to the interval during which Amaranth had its greatest market power.³⁰ Even though this fund failed in mid-September 2006, the analysis period was curtailed because the interval from early to mid-September 2006 was

Table 1: Summary statistics for Amaranth's positions and NYMEX natural gas prices

<i>A</i> <i>Amaranth natural gas positions NYMEX futures-only commitments</i>						<i>B</i> <i>Amaranth natural gas positions NYMEX futures, swaps and options commitments</i>			
<i>Contract</i>	<i>No. of obs</i>	<i>Mean</i>	<i>SD</i>	<i>Min</i>	<i>Max</i>	<i>Mean</i>	<i>SD</i>	<i>Min</i>	<i>Max</i>
March 2006	37	−8697.2	6517.7	−16 258	3319	−18 379.1	7826.5	−27 169	−588
April 2006	60	−6110.9	9345.8	−21 494	6369	−6007.6	9719.4	−20 795	7270
May 2006	79	−7103.0	11 594.8	−32 070	5831	−7088.3	11 488.3	−32 058	5191
June 2006	101	−2486.7	9754.8	−25 729	10 742	−5023.5	11 486.0	−36 586	16 028
July 2006	123	−6833.0	12 519.0	−43 802	1032	−8624.0	12 926.2	−43 127	−372
August 2006	142	−7604.7	10 722.2	−36 657	2630	−11 893.4	16 102.9	−52 368	2243
September 2006	165	−12 035.7	17 236.9	−62394	5298	−14 246.3	19 394.2	−69 789	171
October 2006	178	−12 689.5	22 276.2	−74 859	7076	432.2	20 872.8	−73 585	44 643
November 2006	178	−17 259.2	12 800.3	−39 320	6511	−17 694.4	19 788.3	−55 898	23 104
December 2006	178	−1325.3	4580.4	−15 114	7769	−6217.9	16 365.7	−54 496	7673
January 2007	178	21 558.9	9487.0	504	38 434	29 160.9	17 205.9	1025	58 751
February 2007	178	7543.8	2594.1	154	11 390	5130.6	4237.8	−10 089	11 523
March 2007	178	19 359.7	16 230.4	178	56 555	16 202.8	14 936.1	−795	54 240
April 2007	178	−7631.8	12 958.8	−41 737	5592	−17 575.0	25 407.7	−73 285	5903

<i>C</i> <i>Amaranth natural gas positions NYMEX futures and swaps</i>						<i>D</i> <i>Amaranth natural gas positions NYMEX and ICE futures, swaps and options</i>			
<i>Contract</i>	<i>No. of obs</i>	<i>Mean</i>	<i>SD</i>	<i>Min</i>	<i>Max</i>	<i>Mean</i>	<i>SD</i>	<i>Min</i>	<i>Max</i>
March 2006	37	−10 842.0	7656.6	−19 483.0	2439.0	−26 637.2	10 330.2	−40 294.9	−3736.3
April 2006	60	−6205.0	9503.1	−21 019.0	6740.0	−8373.5	14 032.2	−27 641.0	10 214.7
May 2006	79	−6667.0	11 021.2	−29 685.3	5223.0	−5979.4	9983.9	−27 272.4	5998.1
June 2006	101	−2535.9	10 093.6	−26 421.0	16 189.5	−4282.5	9309.4	−29 412.5	15 980.0
July 2006	123	−9328.1	14 121.2	−46 780.5	−584.5	−9935.3	15 183.3	−55 214.8	144.2
August 2006	142	−11 947.6	15 788.1	−51 445.5	2084.8	−13 032.9	16 146.8	−57 964.3	1272.0
September 2006	165	−14 503.2	20 173.0	−77 107.5	371.5	−21 832.3	28 628.0	−104 707.0	203.3
October 2006	178	−9178.6	28 798.7	−110 273.0	21 145.0	−13 864.1	39 374.7	−136 206.2	35 134.2
November 2006	178	−18 964.6	17 558.6	−55 029.0	16 672.5	−9961.3	39 461.9	−70 438.6	104 440.9
December 2006	178	−5021.5	15 859.4	−52 014.3	8920.5	−4831.4	18 288.8	−60 142.1	17 266.5
January 2007	178	29 982.7	17 514.9	1040.0	60 800.3	46 685.7	30 277.7	1 092.5	146 832.4
February 2007	178	5475.6	4441.6	−9452.0	11 650.0	4987.3	4308.0	−8595.7	10 915.9
March 2007	178	17 425.2	14 704.6	−886.0	54 156.5	22 700.2	23 056.2	−680.3	75 025.4
April 2007	178	−11 692.0	18 224.7	−50 797.5	6590.5	−20 918.0	32 642.7	−90 163.7	7695.0

one during which Amaranth was desperately trying to exit the futures markets. Therefore, its ability to exert the amount of power needed to engage in active price manipulation was probably non-existent.

This study tests 14 contracts that were issued during the March 2006 – April 2007 period to

determine whether there are significant, contemporaneous, lead-lag relationships between natural gas derivatives prices and changes in Amaranth's positions. These particular contracts were chosen because they were those in which Amaranth held its largest open interest and also those responsible for the

hedge fund's failure. In the following section, only significant results from our analyses are listed in the tables. Complete output from these tests is available upon request.

Amaranth's positions

Table 1 provides summary statistics of Amaranth's positions in the four aforementioned general contract categories. The results show that, during the sample period, Amaranth changed positions frequently and by large magnitudes. Of the 56 standard deviations (that is, four contract categories and 14 contract months), six of the top eight are for Amaranth's combined NYMEX-and-ICE positions. The October and November 2006 contracts provide telling evidence of the degree of volatility Amaranth added to the market. For the October 2006 contract, Amaranth switched from a net short position of 136 206 contracts to a net long position of 35 134 contracts, a turnaround of more than 171 000 contracts. For the November 2006 contract, the fund switched from a net short position of 70 439 contracts to a net long position of 104 441 contracts, a turnaround of nearly 175 000 contracts. Standard deviations for the other contract groups are, for the most part, lower than the NYMEX-and-ICE values, but, when put in perspective of Amaranth's relative market share, the *potential* for harmful speculation seems real, and the rationale for further inspection seems justified.

Contemporaneous correlations

Derivatives markets react quickly to changing supply and demand forces. Table 2 shows the correlation coefficients and *P*-values from two-sided *t*-tests for only those contracts with significant correlations between changes in the

returns on natural gas derivatives contracts and changes in Amaranth's positions. If Amaranth had enough market power to engage in price manipulation, one would expect there to be a high contemporaneous relationship between these two variables. All four of our contract categories have significant, positive correlation coefficients for the March 2007 contract, with values ranging from 0.208 to 0.335. For the NYMEX futures, swaps and options positions, the August 2006 and September 2006 contracts also have significant, positive correlation coefficients. Finally, for the combined NYMEX and ICE positions, the correlation coefficient for the September 2006 contract is also significant and positive.

A negative correlation implies that changes in Amaranth's positions for this contract month were counter to changes in market prices, indicating the possibility of a contrarian strategy or a low (or no) level of influence over market prices. Two contract months (October 2006 and April 2007 for NYMEX-traded futures, swaps and options positions) have correlation coefficients that are negative and significant.

Overall, the strongest evidence of Amaranth's market power is for the September 2006 and (especially) March 2007 contracts. But even though these correlations are significant, they are also relatively low, which casts suspicion on charges that Amaranth used its market power to influence interday derivative prices.

LEAD-LAG RELATIONSHIPS BETWEEN AMARANTH'S POSITIONS AND FUTURES PRICES

To analyze the lead-lag relationships between changes in Amaranth's derivatives positions and

Table 2: Contemporaneous correlation coefficients between returns on natural gas futures contracts and Amaranth's position changes from 3 January 2006 to 31 August 2006

<i>Contract date</i>	<i>Correlation coefficient R_t^c: ΔAP_t^c</i>	<i>P-value</i>
<i>Amaranth's natural gas positions NYMEX futures-only commitments</i>		
March 2007	0.335**	0.00
<i>Amaranth natural gas positions NYMEX futures, swaps, and options commitments</i>		
August 2006	0.187*	0.03
September 2006	0.293**	0.00
October 2006	-0.254**	0.001
March 2007	0.272**	0.001
April 2007	-0.183*	0.02
<i>Amaranth's natural gas positions NYMEX futures and swaps commitments</i>		
March 2007	0.208**	0.008
<i>Contract date</i>	<i>Correlation coefficient</i>	<i>P-value</i>
<i>Amaranth's natural gas positions NYMEX and ICE futures, swaps and options commitments</i>		
September 2006	0.252**	0.001
March 2007	0.280**	0.000

**Correlation coefficients are significant at a 1% level; *correlation coefficients are significant at a 5% level.

changes in natural gas futures prices, the Granger causality approaches used by Sanders, Boris and Manfredo,¹⁷ Wang³¹ and Hartzmark¹⁹ are employed to estimate equation (1):

$$R_t^c = \alpha + \sum_{i=1}^m \gamma_i R_{t-i}^c + \sum_{j=1}^n \beta_j \Delta AP_{t-j}^c + \varepsilon_t \quad (1)$$

R_t^c is the return rate for contract c at date t , where $R_t^c = \ln(P_t^c) - \ln(P_{t-1}^c)$. P_t^c is the end-of-day settlement price for contract c at trade date t . For example, $P_{3\text{Jan}2006}^{\text{Oct}2006}$ represents the end-of-day settlement price on 3 January 2006 for the October 2006 natural gas futures contract.

Finally, ΔAP_{t-j}^c is the first difference of Amaranth's position for contract c at time period $t-j$.

The Augmented Dickey-Fuller test is used to verify that AP_t^c and P_t^c are unit-root stationary and also to verify that the first difference of AP (that is, ΔAP_{t-j}^c) and R_t^c (that is, $\ln(P_t^c) - \ln(P_{t-1}^c)$) is stationary. Akaike's and Schwarz's information criterion are used to select the order of lags (m,n). The Durbin-Watson test, Engle's LM test and the Breusch-Godfrey test are performed to determine the first-order and higher-order serial correlation in the residuals. All these tests show no evidence of serial correlation in the residuals.

Table 3: Granger causality of the lead-lag lagged relationship between changes in Amaranth's position and returns on natural gas futures contracts from 3 January 2006 to 31 August 2006

	October 2006	November 2006	March 2007	April 2007
<i>Amaranth natural gas positions NYMEX futures-only commitments</i>				
(m,n) ^a	(1,1)	(1,1)	(2,3)	(2,2)
Impact ^b	-2.01E-06	1.78E-06	2.25E-06 ^d	-3.71E-06
Observations	158	158	146	152
R ²	0.034	0.034	0.101	0.09
P-value ^c	0.021★	0.024★	0.003★★	0.027★
	October 2006			October 2006
<i>Amaranth natural gas positions NYMEX futures and swaps</i>			<i>Amaranth natural gas positions NYMEX futures, swaps and options</i>	
(m,n)	(1,1)	—	(m,n) ^a	(1,1)
Impact	-1.25E-06	—	Impact ^b	-1.27E-06
Observations	158	—	Observations	158
R ²	0.027	—	R ²	0.027
P-value	0.039★	—	P-value ^c	0.039★
	June 2006	August 2006	October 2006	November 2006
<i>Amaranth's natural gas positions NYMEX and ICE futures, swaps and options commitments</i>				
(m,n)	(1,4)	(1,4)	(1,1)	(1,1)
Impact	-2.16E-06 ^d	3.95E-07 ^d	-1.00E-06	1.00E-06
Observations	83	115	158	158
R ²	0.166	0.169	0.03	0.048
P-value	0.009★★	0.001★★	0.029★	0.007★★

^aThe lag orders (m,n) for $R_t^c = \alpha + \sum_{i=1}^m \gamma_i R_{t-i}^c + \sum_{j=1}^n \beta_j \Delta AP_{t-j}^c + \varepsilon_t$ are determined based by AIC and SIC.

^bThe cumulative impact of Amaranth's position changes is calculated as $\sum_{j=1}^n \beta_j$.

^cThe P-value is from the Wald test of the null hypothesis that β_j is jointly zero. Rejection of the null implies that Amaranth's position changes lead changes in futures prices: ★significant at 5%; ★★significant at 1%.

^dThe Wald test indicates a high level of significance, but the cumulative effect, $\sum_{j=1}^n \beta_j$, of this variable is not significantly different from zero. The linear test of parameters for the impact coefficients have P-values for the March 2007 and April 2007 contracts (NYMEX futures-only) of 0.189 and 0.0099, respectively, and the P-values for the June 2006 and August 2006 (NYMX-and-ICE-combined positions) are 0.2911 and 0.8078, respectively. Only the joint P-value for the April 2007 contract (NYMEX futures-only) is significant.

Table 3 summarizes the results of Granger causality tests for contract months during which changes in Amaranth's positions had significant effects on changes in the returns on natural gas derivatives contracts. Generally, the order of lags is short-term, ranging from one to two previous periods. Of the 56 possible combinations of contracts and months, the longest lags (two periods and three periods) are for Amaranth's March 2007 and April 2007 futures-only positions on NYMEX and (four periods) for the fund's futures, swaps and options positions on the NYMEX-and-ICE exchanges in the June 2006 and August 2006 contracts. Although no structural relationship can be inferred from our Granger causality tests, one is struck by how short-term the significant lagged correlations are.

Did changes in Amaranth's positions lead changes in natural gas derivatives prices?

Wald chi-square tests are used to determine whether $\beta_j = 0$ for all lags. Rejection of the null hypothesis implies that Amaranth's position changes led futures price changes. *P*-values from this test are included in Table 3. The variable $\sum_{j=1}^n \beta_j$ is employed to determine the cumulative impact of Amaranth's position changes on futures market prices. Finally, the statistical significance of this cumulative impact is tested to determine whether it is equal to zero.

Significant, negative impact variables

The results for all four groups of contracts and months indicate that a significant lead-lag relationship exists for the October 2006 contract, but the sign of the relationship is

diametrically opposite to what would be expected if Amaranth influenced natural gas futures prices by engaging in price manipulation. Values for the October 2006 contract range from $-1.00\text{E}-06$ to $-2.01\text{E}-06$, which means that the purchase of 1000 natural gas futures contracts by Amaranth had the effect, as measured by the Granger causality test, of *decreasing* the October 2006 natural gas future contract price by a relatively small amount ranging from 0.100 per cent to 0.201 per cent. To support charges of price manipulation, increases in Amaranth's long positions should have raised (not lowered) the price of corresponding futures contracts. Therefore, these results contradict the intuition behind charges that Amaranth wielded significant interday market power and engaged in price manipulation. Similar results are shown for Amaranth's futures-only position on NYMEX for the April 2007 contract and its NYMEX-and-ICE positions for the June 2006 contract. These contracts have coefficients that are significant, but their signs are opposite to what one would expect for a fund engaged in price manipulation.

The cumulative effect of the lagged coefficients also played a role. For example, both the March 2007 (NYMEX futures-only) and June 2006 (combined NYMEX-and-ICE positions) contracts have lags greater than one and highly significant individual coefficients, but the cumulative effect of these contracts' lagged coefficients, $\sum_{j=1}^n \beta_j$, is not significantly different from zero. By contrast, the individual and cumulative effects of the impact coefficients for the April 2007 contract (NYMEX futures-only) are significant, but they are also relatively small. Changes in Amaranth's position by 1000 contracts caused only a -0.371 per cent change in natural gas futures prices.

Significant, positive impact variables

Significant *positive* coefficients are found for Amaranth's futures-only positions in the NYMEX November 2006 and March 2007 contracts and for the fund's NYMEX-and-ICE positions in the August 2006 and November 2006 contracts. Even though the March 2007 (NYMEX futures-only) and August 2006 (NYMEX-and-ICE positions) have significant lagged variables, the cumulative impact of these variables for both contracts is not significantly different from zero. This means significant *and* positive correlations exist only for two contracts, namely, the November 2006 contract for NYMEX futures-only positions and the November 2006 contract for NYMEX-and-ICE positions. The impact coefficients for these two variables are 1.78E-06 and 1.00E-06, respectively. Therefore, the purchase of 1000 natural gas futures contracts by Amaranth had the effect, as measured by the Granger causality test, of increasing the price of the November 2006 natural gas futures contract only by an amount between 0.100 per cent and 0.178 per cent. No significant positive correlations can be found for Amaranth's futures, swaps and options combined positions or its futures-and-swaps positions on NYMEX.³²

CONCLUSIONS

Speculators can provide a valuable service to the markets by supplying liquidity and acting as counterparties to commercial traders, and thus the controversy surrounding Amaranth's failure and derivative market trading practices was never whether speculation is good or bad but rather whether Amaranth engaged in price manipulation, which burdened interstate commerce and harmed consumers.

The analysis in this article finds no convincing evidence of one-way Granger causality from changes in Amaranth's positions to changes in the prices of natural gas derivatives contracts. Therefore, Amaranth does not appear to have engaged in interday price manipulation or excessive speculation. It is more likely that movements in natural gas prices during 2006 were caused by unexpected changes in market fundamentals (for example, weather conditions) or expectations (for example, hurricane forecasts). Tangential evidence also supports this conclusion.²⁹ If Amaranth wielded such market power, then the fund itself was a major victim of its own actions because dramatic price movements led to the hedge fund's collapse.

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- 7 The current test for illegal price manipulation requires evidence of (1) an ability to influence the market price; (2) the intention to influence it; (3) a price movement to an artificial level; and (4) a strong link between a trader's actions and the artificial price. See Johnson, P.M. (1981) Commodity market manipulation. *Washington and Lee Law Review* 38: 725–732.

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- 21 See Section 9 of the CEA. 7 U.S.C. § 13(a)(2).
- 22 7 U.S.C. Sec. 1a(11). 7 U.S.C. 2(h)(3). CEA Sections 2(h)(3)–(5), 7 U.S.C. §§ 2(h)(3)–(5). CEA Sections 2(h)(3)–(5), 7 U.S.C. §§ 2(h)(3)–(5).
- 23 Commission Regulation 36.3(b)(iii), (iv), 17 C.F.R. § 36.3(b)(iii), (iv). An ECM is also required to provide a weekly report to the CFTC of basic trade information, along with any allegations or complaints of suspected fraud and manipulation. The CFTC aggregates the information to protect the identity of individual traders. Furthermore, the CFTC has the power to make a 'special call' from an ECM for any information the CFTC deems necessary. See 17 C.F.R. § 36.3(b)(3) and CEA Section 2(h)(5)(B)(iii). Finally, the CFTC has the power to demand any information from an ECM if it is necessary for purposes of price discovery in the cash market of the underlying commodity.
- 24 7 U.S.C. § 7(b)(3) (2006). 49 7 U.S.C. § 7(b)(5) (2006). 50 7 U.S.C. § 7(d)(3) (2006). 51 7 U.S.C. § 7(d)(4) (2006). 52 7 U.S.C. § 7(d)(5) (2006). 53 7 U.S.C. § 7(d)(6) (2006).
- 25 For example, see New York Mercantile Exchange, Inc. Online Rulebook, Chapter 9: Clearing Rules and Appendix A (2009) http://nymex.com/rule_main.aspx?pg=8#9.27A, accessed 11 June 2009.
- 26 See King, M.R. and Philipp, M. (2009) Hedge funds and financial stability: Regulating prime brokers will mitigate systemic risks. *Journal of Financial Stability* 117: 1–15.
- 27 A *Show Cause Order* is a judge-directed charge that requests Party A (for example, Amaranth) to provide convincing reasons why a charge brought by Party B (for example, the FERC) should not be granted. See 18 C.F.R. § 1C.1 (2006) (Anti-manipulation).
- 28 Natural gas futures contracts on NYMEX determine the settlement price of an expiring contract by taking a weighted average of transaction prices during the last 30 min of trading between 14:00 and 14:30.
- 29 Marthinsen, J.E. (2009) Risk takers—uses and abuses of financial derivatives. 2nd edn. *Amaranth Advisors LLC: Using Natural Gas Derivatives to Bet on the Weather*. Boston, MA: Pearson Prentice Hall, pp. 270–314.
- 30 In early August 2006, NYMEX requested Amaranth to reduce its position in the September 2006 and October 2006 futures contracts. Amaranth met the request by switching its positions from NYMEX, a regulated exchange, to ICE, an unregulated exchange. At month's end, Amaranth met NYMEX' position limits but had actually increased its net position on ICE. For this reason, August 2006 was retained in the sample period.
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- 32 These results are consistent with an analysis by the CFTC's Office of Economic Analysis, which concluded that changes in the positions of large managed market traders were a reaction to commodity price changes, and not the cause of these price changes. See Haigh, Hranaiova and Overdahl.¹²