

Natural Gas Price Transparency and Liquidity

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This paper describes the transparency, liquidity and efficiency of the wholesale natural gas market in the United States, both in absolute terms and compared to other commodity markets. Natural gas compares favorably to robust markets in currencies and equities, and trading is far more transparent than many critical agricultural commodities. For all markets there is an intrinsic link between transparency, liquidity and efficiency. Also for all markets, hedging, speculative trading and thus open interest tend to increase in response to increased market volatility. The natural gas market's extensive transparency enables traders to observe prices continuously and prevents significant deviations from fundamentals. Arbitrary changes in transparency, especially in view of the status of the well established transparency and efficiency of the natural gas market, are likely to have unintended consequences, possibly harming market efficiency by discouraging trading.

The format of the paper is to first provide some definitions for liquidity and transparency. Next the relationship between liquidity and transparency is explored. This is followed by a discussion of open interest and then the role of speculation. A discussion of the features of some of the important commodity markets comes next, followed by a discussion of natural gas trading, and some concluding remarks regarding market evolution.

Liquidity

Liquidity describes the sensitivity of price to trading. A liquid market has small price changes in response to orders. Fundamental demand for, and supply of, a commodity generates natural trading demands, while speculative trading provides liquidity and smoother prices. For example, in Kyle (1985) and a host of subsequent papers, more speculators, or noise traders, lead to a more liquid market.¹ Speculators absorb information shocks, and an increase in speculation means that an information shock is distributed among more noise traders, mitigating any excessive price disturbance.

A trader with a demand for an immediate trade in an illiquid market causes price to move significantly, though temporarily. For example, an order to buy a significant quantity of a stock may cause the price to move. If the current price for a stock is \$20.43 a share, and an order is entered to buy 1,000 shares right now, the price may rise to \$20.60. The next order to sell may bring the price back to \$20.43. A more liquid market, for instance trading in a stock which is followed by more speculators, would see smaller price jumps for the same order, all else constant.

Transparency

Transparency is the ability of market participants to view information associated with market orders and transactions. Traders naturally benefit from seeing other traders' information. Conversely, traders would naturally prefer that others not be aware of their

¹ Kyle (1985) represents significant financial market research. Google scholar lists 1711 citations of Kyle as of September 2006, by far one of the foundations of market microstructure, the study of trading. The Kyle model is the basis of much financial market research.

own information. Thus, transparency involves a “free rider” issue, and exchanges evolve to solve this problem. (See, e.g., Mulherin et al., 1991.)

Some transparency occurs before a trade is executed, such as in the posting of bids or offers. Desired quantities may be also be revealed with these quotes. After a trade has occurred, various bits of information may be revealed. For example, ICE and NYMEX natural gas prices are reported instantly worldwide, making these markets as transparent in this facet as NYSE or NASDAQ. In addition, publishers such as *Platts* report price and volume information for physical natural gas trades from the previous day for many prominent trading locations.

A much rarer bit of information is revealing who has traded. Disclosure of participants to a trade may reveal proprietary strategies or positions. The great success of electronic trading venues such as the NYMEX or ICE natural gas futures markets, similar to NYSE or NASDAQ, is due to anonymity, placing all traders on a level playing field, protecting trading strategies and thus encouraging trading.

The Link between Liquidity and Transparency

Liquidity is a market characteristic which directly impacts individual trades, whereas transparency has a broader relationship with trading. Some markets are transparent and illiquid, while others are liquid with little transparency. The real estate market is generally transparent, with many competing sellers listing homes. However, a home owner desiring to sell immediately would expect to sell at a steep discount, reflecting a lack of liquidity. Thus, the housing market can be considered to have good transparency, especially post trade, with low liquidity. The automobile market is not very transparent. While some suggested prices are listed, everyone knows that the

negotiations which lead to a trade are uncomfortably idiosyncratic. There is no public disclosure of trades. Yet the market is considered liquid because the price to buy or sell does not vary much, since indications of price are available widely.

Transparency may reduce liquidity by reducing participation.² Some transparency will have the effect of revealing particular trading strategies, which would otherwise be valuable proprietary information. This will discourage participation and harm liquidity. Anonymous trading, as in stocks, futures, and natural gas trading on ICE and NYMEX, provides a marketplace where traders need not fear revelation of their particular strategies when executing their trades. The main reason why these markets work so well is the fact that traders large and small come as anonymous equals, competing solely on the basis of price and time priority. Changes to required transparency will impact market liquidity and thus efficiency. In the extreme case, some traders may be driven away from exchanges to bilateral phone markets with extremely low transparency, or disappear into overseas markets. This needless fragmentation has the potential to harm exchange liquidity and exacerbate any market inefficiencies.³

Open Interest

In derivatives markets, including natural gas futures, for every buyer there is a seller. Thus, a person who is “long” natural gas futures has agreed to purchase some natural gas at a time in the future, and for every such person there is a corresponding person who is “short” natural gas futures, having agreed to deliver natural gas in the future: There is no “net” open interest, in the sense of an excess of buyers or sellers. For example, when a trader wishes to buy a futures contract, for hedging or speculative

² Bloomfield and O’Hara (1999) describe the transparency/liquidity trade off in a laboratory setting.

³ Mendelson (1987) discusses market fragmentation and integration.

purposes, they must find a counterparty wishing to sell. The traders may be producers or consumers of gas, dealers, or other traders. Together, the buyer and seller, if they are not offsetting current positions, add to open interest with the trade. Open interest is a measure of the volume of contracts open at any time: this is the quantity to be delivered, and, similarly, the quantity to be received, should the positions remain the same.⁴ Any particular trade may increase or decrease open interest, depending on the prior positions of the two traders executing a trade.⁵

The level of trading and the level of open interest in a commodity market naturally increase when volatility increases, as for example, recently in the natural gas market. Many firms find it beneficial to hedge at least some of their future trading needs, particularly when they perceive increased volatility.⁶ It is easy to see how the increase in natural gas price volatility and threatened disruptions (such as political or weather related) have naturally increased the demand for hedging. This increase in volatility also draws in increased speculation. Since this increased speculation follows close on the heels of increased volatility, it is an all-too-common error to falsely attribute the cause of volatility to the speculation.⁷ In fact, the opposite is true: speculators seek profits at the time of increased volatility, and this action actually serves to moderate price movements. For example, Bessembinder and Seguin (1993) show that increased open interest

⁴ Particular standardized delivery requirements are specified by each exchange for each of its contracts.

⁵ Consider the case where there is a 1 contract trade where A buys from B, and where neither had a position before. This creates a new open interest of 1 contract. Now suppose A sells to C. This is another trade, but open interest is still 1, and A is out of the market. Now suppose C sells to B. After this trade open interest is 0, because A, B and C are now out of the market. Thus, in general, a trade can either increase, decrease, or simply not affect open interest.

⁶ See, e.g., Chang, Chou and Nelling (2000). Similarly, Chen et al. (1995) show how an increase in volatility leads to increased open interest. Also, *Futures Industry*, Sept/Oct 2006 covers energy market hedging.

⁷ This is similar to the common error that the introduction of futures trading causes increased volatility. Instead, profit-seeking exchanges naturally introduce new contracts when there is sufficient volatility in that commodity price, and thus a demand for hedging. Contracts with insufficient hedging demand fail.

mitigates volatility. They attribute this affect to increased depth or liquidity from the open positions.

The Role of Speculative Trading in Markets

Markets benefit from speculative trading. Speculative trading is also referred to in finance literature as uninformed or “noise” trading, reflecting a lack of information about the fundamentals of a commodity. In the commodities markets such as natural gas, speculative traders include hedge funds, investment banks, and other managed money, as well as a small retail trader component. For example, a speculator may buy corn futures based on some technical analysis (simply looking at price patterns), without knowing anything about current supplies or demand for corn. Such trading is clearly not based on fundamental information, simply perceived inefficiencies related to prices themselves, perhaps based on some empirical model. Speculators help solve the no-trade problem, where informed buyers and sellers might otherwise hesitate trading with each other. In the extreme case, two traders each feeling the other has information will be hesitant to trade with each other.⁸ Speculators add liquidity, such as in the Kyle (1985) model. With more noise traders buying and selling there is more of a chance that fundamental traders demanding immediacy will have counterparties willing to trade at the same time and place. The alternative, a lack of speculation, is potentially large liquidity shocks, with prices pushed far from fundamental values. One example of this is the difference in liquidity between thinly traded stocks and blue chip stocks. The blue chip stocks can

⁸ Grossman and Stiglitz (1980) present a model of the process of how information becomes incorporated into price, requiring noise to facilitate the incorporation of information. Hayek (1945) provides essentially the same argument regarding the requirement of trading to reveal information, without the mathematics. Stiglitz and Hayek both received the Nobel prize for economics.

absorb a lot of trading with little price movements, while the thinly traded illiquid stocks will jump quite a bit with even small trading volumes.

In the natural gas market, the benefit of speculation is to smooth the natural gas market price matrix across time and geography. For example, if there is an upsurge in demand in one region of the country, then speculators may seek profits by selling gas in that region while buying in another region. This arbitrage trading will serve to keep prices balanced across the country. Such arbitrage also works across time. If there is an anticipation of high future demand, speculators may purchase gas in the futures or forward markets, raising forward prices and encouraging storage, conservation and increased production to meet that anticipated demand. This serves to allocate natural gas efficiently across time. The seasonal natural gas pattern reflects this efficiency.

Almost by definition, speculation leads to both positive and negative profits for speculators, although this fact is often ignored. There are many examples of speculative losses, some huge, such as Long Term Capital Management or Metallgesellschaft from the 1990s. (For a brief list, see Hull, pp 730-731.) Recently, the hedge fund Amaranth lost quite a bit trading natural gas derivatives, according to published reports. Similarly, there are examples of occasional large speculative gains. On average, speculation by managed money such as hedge funds earns a small return, perhaps more than treasuries or the stock market, but typically not much more, especially as competition among these funds has intensified. For some recent evidence, see the article on hedge fund returns by Zuckerman in the *Wall Street Journal* from September 13, 2006, "Hedge Funds Miss Their Target."

A Brief Survey of Markets

Across commodities there is a vast array of market structures, from floor trading to electronic trading, from auction market to dealer market. The Internet has resulted in a fantastic amount of information being made available to many individuals in a wide variety of markets, including equities and commodities, as well as natural gas and other energy markets. Each group of commodity traders has developed market structures to fit their particular underlying needs.

Equities, bonds and currency markets are the most well known, with evolution in these markets continuing in response to technological innovation. Real time quotes on thousands of stocks, bonds, currencies as well as futures and options on these are available globally. Even retail investors are able to view real time bids and offers and enter trades on a variety of exchanges. Trades are anonymous, and prices from these exchanges are viewed in real time globally. It is a fabulous array of information.

Futures markets on a wide variety of commodities, including natural gas, have a similar amount of information available in real time. Electronic futures markets allow automatic trading, bypassing the arcane floor. On the other hand, cash markets, markets for physical commodities, such as the molecules of natural gas, often differ from these financial markets, with many idiosyncrasies. While these cash markets differ, widely, price discovery in most commodities occurs in a financial market such as a futures exchange.

For example, there are resilient futures markets in many metals, both precious and industrial, in the U.S. on COMEX and the Chicago Board of Trade. The London Metal Exchange offers a matrix of cash and forward metal trades, similar to the ICE energy

market. Actual cash trades in metals use prices based off of these exchange-based cash, forward and futures prices.

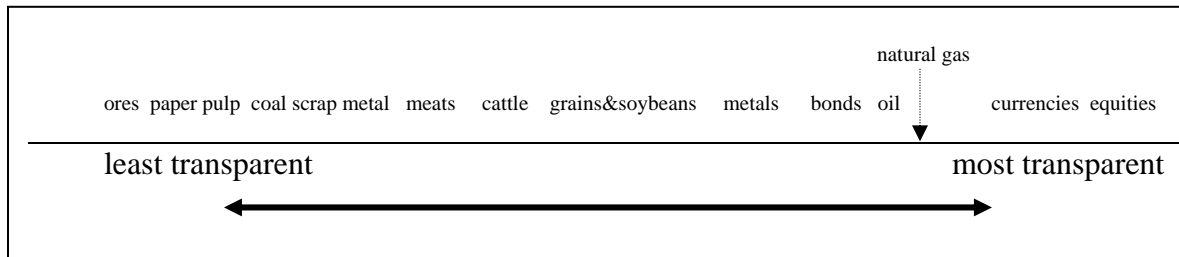
Agricultural commodity markets differ somewhat. Unlike metals, agricultural products have a finite life. There are two steps in the marketing of grains and soybeans, the first the movement from farm to elevator, the second the movement from the elevator to the processor. The first step often involves forward contracting by the grower with a particular local elevator, with this trade perhaps done in the spring for part of the expected fall harvest. The elevator typically hedges this trade with an offsetting position in futures. Elevator quotations are in terms of a local basis from the futures price. This is similar to hub pricing in natural gas at a basis (differential) from Henry Hub cash or futures (NYMEX or ICE).⁹ These elevator bases are publicly quoted, though not as transparent as on ICE. A corn elevator in Nebraska would typically not be able to know in real time what a corn elevator in Iowa is quoting. The second step, where the grain is shipped to a processor, is a much less transparent market, with bilateral trades, not necessarily reported.

Similarly, there are several broad stages in marketing meat and cattle. Two types of cattle are traded, feeder cattle and cattle near slaughter, called live cattle. Both of these have corresponding futures contracts, currently on the Chicago Mercantile Exchange. The cash auction process, where a producer brings cattle to a central location, and sells the cattle to feeders or packers, depending on the stage, is still in use, but has waned. Local auction prices are reported and available at least the next day. Hardly any other

⁹ Henry Hub has the most volume of the natural gas hubs, or places where many natural gas pipelines connect, and is the delivery point for the NYMEX futures contract.

public information is available about cattle or meat prices. Live hogs and pork bellies follow essentially the same pattern.

Commodities for which there is no trading on organized exchanges have extremely low transparency. Based on the above, a rough ranking of markets by their transparency can be made:



Natural gas, along with crude oil, falls close to the most transparent markets such as equities and currencies.

Natural Gas Liquidity and Transparency

Natural gas liquidity and transparency compare quite favorably or surpass that of the above markets. The most liquid of the natural gas trading venues are the futures and forward exchanges, with global real time price transparency, identical to other futures and equity markets. Exchange competition (ICE v. NYMEX), historically absent in other commodity markets, also promotes efficiency and mitigates regulatory needs. The participants in the natural gas market mirror the participants in the equities and other commodity markets. Among these are producers and consumers of the molecules, who can trade in real time to obtain the best prices. There are also active dealers, who assist in moving the natural gas from production to consumption. Other entities, such as investment banks and hedge funds, absorb shocks to the system and respond to volatility.

While speculative traders and extensive transparency constrain natural gas price volatility across hubs and time, there are some distinguishing issues related to natural gas:

Trading constraints imposed on local distribution companies (“LDCs”) likely cause price inefficiency. Examples of these constraints are state policies effectively mandating index pricing for LDCs, and restricting the hedge trading of LDCs. With a market that relies heavily on index pricing, true underlying demands and supplies are not reflected accurately in the market. A desire to trade at an index price is certainly a defensible strategy: essentially the parties to an index trade agree to pay or receive an average price. However, the resulting index is biased toward a potentially few fixed price traders, relative to the index takers, and this increases inefficiency and volatility in the index. Restricting the timing and quantity of hedging by LDCs means that at any time market prices may deviate from what otherwise would be the best representation of market fundamentals. Combined, these trading restrictions withhold valuable information from the market.

Speculative traders such as hedge funds seek profits from perceived inefficiencies in the natural gas markets. For example, if natural gas prices at two hubs differ by a substantial amount, then arbitrage trading will serve to bring the prices back to equilibrium. Similarly, if forward or futures prices fail to reflect market expectations and costs, intertemporal arbitrage will work to bring cash and futures prices into alignment. The market benefit of speculative trading arises precisely from its unconstrained nature. Constraints imposed on some fundamental traders (such as LDCs) lead to an efficiency vacuum (since their trading needs and information are not accurately reflected in the price) which may be filled by speculative traders. Nevertheless, the level of speculation in natural gas futures, in terms of the reported open interest of the NYMEX natural gas

futures contract, remains low, with relatively balanced speculation of about 10 percent of the open interest on both long and short sides of the market.¹⁰

An efficient market is one where resources such as natural gas are allocated to their highest valued use. In the case of natural gas, this means that the molecules are consumed in their highest valued uses, whether in heating, manufacturing, or conversion to electricity. This also means that the natural gas is extracted at an optimal rate. With huge uncertainties about the future demand for and supply of energy, futures prices are critical in directing the allocation of resources. The natural gas forward and futures markets offer a critical transparent forum for price discovery across hubs and across time. This price transparency allows all traders to judge immediately whether these prices are in line with their expectations or information, and to trade appropriately. In the presence of volatile supply and demand from the end users or providers of natural gas, and trade restrictions, speculation provides needed liquidity to minimize price disruption across this matrix of prices. In other words, as unexpected supply or demand shocks hit the market, from hurricanes or freezes, or supply disruptions, speculators serve to help absorb these shocks and thus prevent unnecessary price swings. In addition, the fact that risk managers rely on the matrix of natural gas cash and futures prices to mark their books validates price efficiency. Even greater natural gas price efficiency could be obtained by encouraging more trading at fixed prices. By extension, a reduction in trading restrictions will not only increase price efficiency, but, would also tend to decrease speculative activity, since the inefficiencies which open the door for speculation will be lessened.

¹⁰ Many agricultural commodities and metals have much higher speculative open interest, well over 20% of one side of the market.

It is important to note that price efficiency in natural gas or other markets does not mean stable prices, and certainly does not indicate any particular price level. Instead, efficiency means that price reflects and is sensitive to changes in information. An efficient price will react quickly and strongly to new information, such as the rapid response of energy prices to hurricane warnings, threatened military actions, or supply discoveries. However, these times of large information shocks will typically correspond to a period of price discovery, and increased volatility. Speculative trading absorbs the risk associated with making the distinction between liquidity and information shocks, keeping volatility to a minimum and hastening price discovery.

Market Evolution

Markets evolve as technology changes, as international conditions change, or as the underlying market structure changes. For example, futures trading such as in natural gas, has evolved from open outcry to electronic trading, mainly due to increases in processor and communication speed. Prior to recent changes the computational requirements were simply too costly, so that floor trading persisted for the most liquid futures markets. Indeed, regulatory efforts to encourage electronic futures trading in the 1990s failed, as the technology was simply inadequate for U.S. futures volumes. Market evolution may be assisted by some regulation when there is market failure. For example, there is a synergy between a market's usefulness as a benchmark and its efficiency. This may cause a price to be considered as a public good, wherein every one benefits from knowing the price, but no one receives a benefit from contributing to the price through trading.¹¹ Futures exchanges encouraged regulation which limited the trading of their contracts to the exchange's mechanism. This restriction minimizes the free rider problem, and

¹¹ See Mulherin, Netter and Overdahl (1991).

increases the liquidity and efficiency of the futures price. The result is a price, often a single futures price, such as for oil or natural gas, corn, soybeans, or pork bellies, upon which to base many other trades. Today, if the price of oil, or natural gas, or soybeans, or corn, is discussed in the financial news, the price being discussed is futures price, such as the NYMEX oil or natural gas price, or the CBOT corn or soybean price, or the COMEX or LME copper price.

For the price to have utility, it must have a sufficient degree of price efficiency, and of course must be visible. Thus, price transparency, revealing prices around the world, allows the price, such as the NYMEX or ICE natural gas price, to be used as an indicator of market conditions. In turn, the transparency generates trading, which increases liquidity and price efficiency. This well known argument is necessarily circular.

Markets naturally evolve based on need, and examples abound. In 1861 the U.S. suspended the gold standard. Immediately there was a lively market for gold where there had been none before, since the dollar price of gold was now free to vary. In 1972, the foreign exchange market was not very well developed, since currency rates were fixed. Once the U.S. dollar was allowed to float there was an immediate market in currency forwards, futures and options. In fact this event helped ignite the financial derivatives industry. Similarly for natural gas, markets have evolved as prices have been freed. Today natural gas prices are quick to reflect changes in information, reflecting great efficiency. On the surface, the evolution to market prices may appear to increase volatility. In fact, it is the increased volatility, in this case resulting from the prices quickly reflecting information, which leads to the demand for trading, the need for fundamental traders to hedge, and the important function of speculation.

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Visiting Assistant Professor, Tulane University, 1987-1989

My teaching at the above institutions has included futures and options pricing, corporate finance, micro- and macro-economics, and money and banking.

Other positions

Financial Economist, Commodity Futures Trading Commission, 1989-1999.

While an economist at the CFTC, I worked on various policy issues, mainly related to exchange design and trading rules, applying the competitive market requirements of the Commodity Exchange Act and the regulations passed by the CFTC. In addition, I offered expert help in several fraud cases and cases involving trade practice violations.

Expert Litigation Support

I have offered sworn testimony as an expert witness before the United States District Court for the Southern District of Florida, the United States District Court for the Southern District of New York, the United States District Court for the District of Delaware, the National Futures Association (arbitration panel), and Administrative Law Judges at the United States Commodity Futures Trading Commission. These cases have involved fraud, manipulation, and patent law regarding trading system design.

Publications

My research covers the general area of market microstructure and price discovery, information, and the efficacy of market rules and regulations.

Order Flow, Dealer Profitability, and Price Formation, (with Zhan Onayev), *Journal of Financial Economics*, forthcoming.

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Honors and Other Appointments

- Board of Editors, *Journal of Futures Markets*, 2002-, *Review of Futures Markets*, 2004-.
- Crain Fellowship, George Washington University, 2003
- Peter Vaill Teaching Award, School of Business and Public Management, George Washington University, 2003
- Outstanding Paper in Applied Investments, 1999 Southern Finance Association Meetings
- Outstanding Paper in Futures and Options, 1996 Financial Management Association Meetings
- Salt Award for Outstanding Doctoral Student, Department of Economics, Texas A&M University, 1987
- Bradley Graduate Research Fellowship, Texas A&M University, 1985
- Graduated *magna cum laude*, University of Oregon, 1983
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