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Derivative, Risk Management, and Policy in the Energy Markets

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Derivatives, Risk Management, and Policy in the Energy Markets

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Summary

Risk management is important in the energy industries because of the volatility of oil and natural gas prices. Price volatility can reduce the profit of business strategies and hurt consumers. The use of financial derivatives, both traded and over-the-counter, has developed as a low cost method of hedging price risk. However, the use of derivatives has also been linked to major financial scandals and bankruptcies.

Risk management strategies can be undertaken without the use of derivatives. Vertical integration of the production process, inventory control, and long-term, fixed price contracts can all compensate for the effects of price volatility. Whether one of these choices, or a derivative strategy, is chosen depends on the cost and flexibility of each alternative. Derivative use has expanded rapidly both in value and volume.

Exchange traded and over-the-counter derivatives have different characteristics with respect to their liquidity, safety, transparency and flexibility. The benefits and costs of using either instrument depend on the circumstances and goals of the firm setting up the strategy. A wide variety of derivative contracts exists, including forwards, futures, options and swaps which can be put together to achieve a wide variety of objectives.

Although exchange traded derivatives are self regulated with oversight by the Commodity Futures Trading Commission, over-the-counter derivatives are largely unregulated. Whether these transactions should be regulated might depend on their effect on commodity price volatility, their effect on the stability and integrity of U.S. capital markets, their ability to reduce the cost of capital, enhancing domestic real investment and the value of more open disclosure and price transparency.

Congress considered proposed derivative legislation in the 107th Congress. Senator Dianne Feinstein introduced legislation in the Senate, while Representative Peter DeFazio independently introduced a bill in the House. In the 108th Congress, Representative DeFazio again introduced a derivative regulation bill (H.R. 1109) and the 109th Congress considered H.R. 1638 and S. 509. In the time since the collapse of Enron, many specific proposals to reform the derivative markets have appeared. These include tying derivative trading more closely to the underlying business interests of the market traders, establishing a clearinghouse to manage transactions, establishing structured derivative trading companies and enhancing reporting and documentation requirements. Each proposal has its strengths, but each could also reduce the effectiveness of the derivative industry in managing risk.

This report will be updated as events warrant.

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Introduction

The use of financial derivatives by American industry began in agriculture in the 19th century.[1] Later, they were widely used in foreign exchange transactions, as well as in the bond markets. Their use in energy markets began in a modest way with the introduction of a heating oil futures contract in 1978 at the New York Mercantile Exchange (NYMEX). The NYMEX has since become the dominant market for traded energy derivatives in the United States.[2] This initial contract expanded over the next fifteen years to include contracts on unleaded gasoline, sweet crude oil, propane, natural gas, and sour crude oil. In 1986, the first option contract, on crude oil futures contracts, appeared. This was followed by a host of other contracts on a variety of energy products as well as margins between products, and over time, which are called spreads. Use of these contracts expanded rapidly and they have become an important part of the financial and physical sides of the energy business. In 2004, the NYMEX traded and cleared approximately 169 million contracts on all commodities, a record, which was then surpassed in 2005, when over 204 million contracts were traded and cleared.[3]

Paralleling the growth of traded energy derivatives was the development of over-the-counter (OTC) derivative contracts. These contracts were originally arranged through an intermediary, generally a financial institution. The two parties to the agreement both had an interest in protecting themselves against future price movements as well as shifting risk, but needed more flexibility in the contract terms than standardized contracts on the NYMEX could provide. OTC contracts today are largely written on foreign exchange, interest rates, and equities, although commodity based contracts have also grown in importance. The Bank for International Settlements estimates that at the end of 2005 the notional value of outstanding OTC contracts worldwide was $284 trillion. Of this total, $3.6 trillion were commodity based.[4]

By 1993, problems related to the general use of financial derivatives began to surface. Derivatives were implicated in cases that resulted in huge financial losses. Orange County, California, lost $1.7 billion trading derivatives and went bankrupt. That same year, Metallgesellschaft lost over $1 billion in energy trading in the United States. The year 1998 brought the crisis at Long Term Capital Management, a leveraged hedge fund, that required intervention by the Federal Reserve Bank of New York, which arranged a rescue operation by major financial institutions. In 2001, Enron Corp., a company known for its promotion and use of derivatives through its trading arm, Enron Online, went bankrupt amidst major financial scandal.[5]

As a result of this association with bankruptcy and financial scandal over the past decade, questions have arisen as to whether derivative contracts are a legitimate requirement for functioning energy markets and companies, or are merely a dangerous financial game where the

[1] Derivatives are financial instruments, designed to manage risk, that derive their value from that of an underlying asset, usually a financial asset or a commodity.

[2] The International Petroleum Exchange (ICE Futures since 2005) was established in 1980 in the United Kingdom and trades products similar to those traded on the NYMEX, but with different underlying commodities.

[3] New York Mercantile Exchange Press Release, January 17, 2006.

[4] One of the problems in analyzing the OTC sector is that data is not routinely reported to regulatory agencies and hence may be an estimate. See Bank for International Settlements, Press Release, November 8, 2002, Table 1, p.5.

[5] The Enron bankruptcy was not the direct result of derivative trading, but to revelations of financial and accounting manipulation. These revelations had the effect of reducing confidence in the company, and by association, the markets in which Enron did business.

stakes are high and the potential for financial ruin very real. Are the potential effects on the physical energy supply, the financial condition of energy companies, the financial markets, and the economy as a whole significant enough to warrant a public policy response, and, if so, what factors might be important in developing appropriate policy?

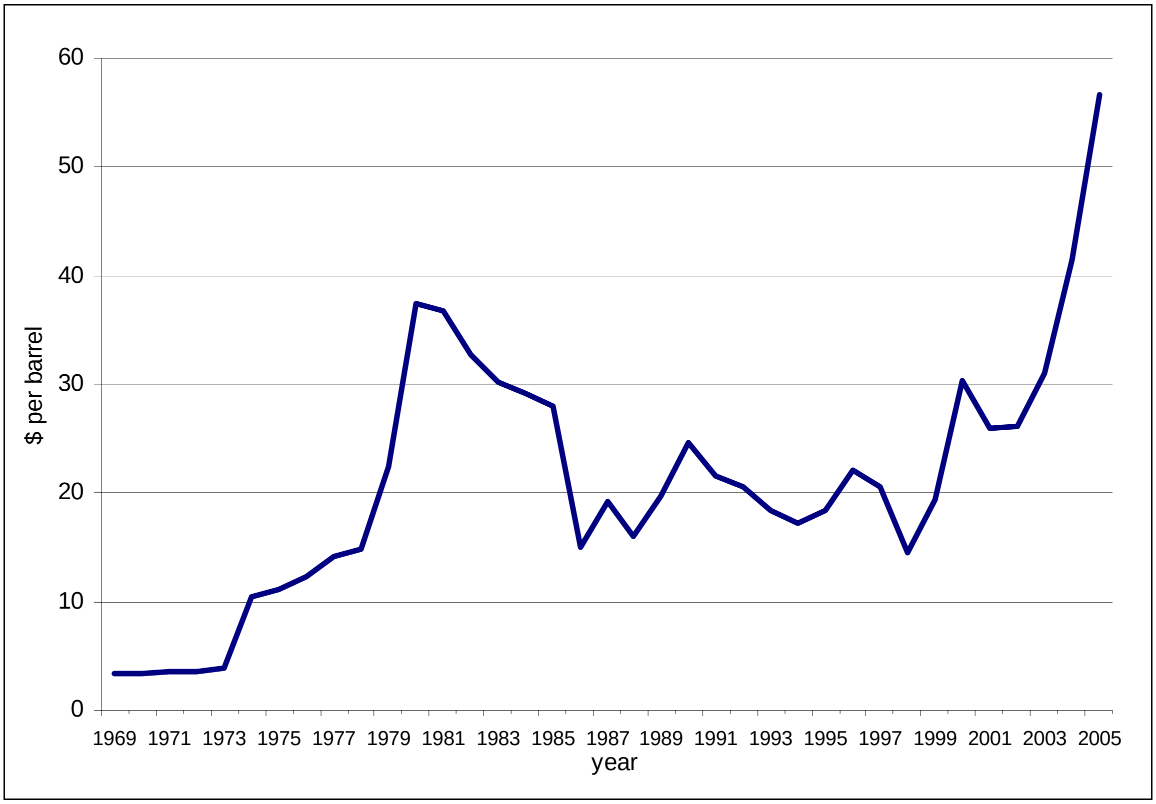
This report provides a systematic guide to understanding the use of financial derivative contracts in the energy industry, focusing specifically on the petroleum and natural gas sectors.

Risk Management

There was little need for the use of derivatives in risk management in the energy industry before 1973. The domestic price of oil was stabilized through production restrictions and the international price of oil was managed by the large international oil companies. In this environment, price volatility, which could upset operational plans as well as profit forecasts, was not of major concern. Short run price volatility became a factor in the U.S. oil market following the first oil price shock of 1973/74. By 1981, when oil price regulation ended in the United States, the effects of oil price volatility were of major concern to producers as well as consumers of energy. **Figure 1** demonstrates the volatile nature of oil prices as they reacted to OPEC actions as well as changing economic and political circumstances. As the figure shows, in relatively short periods of time the price of oil could rise more than two-fold, only to decline by almost two-thirds later on. This volatility in oil prices naturally spilled over into the product markets for gasoline, heating oil, jet fuel, and other refined products, directly affecting consumers and firms.

Price volatility, on the scale represented in **Figure 1**, gives rise to risk. Risk is defined as a situation in which a variable, in this case the price of oil, is likely to take on a value differing from that which was expected. Economists, and other analysts use a statistical tool, the standard deviation, to measure risk. The standard deviation measures the spread of possible outcomes around the average, or expected, value of the variable in question. Larger values of the standard deviation imply more risk. Risk management encompasses a range of activities designed to re-allocate risk to other parties more willing to bear it, and to mitigate the effects of remaining risk exposure.

Figure 1. West Texas Intermediate Crude Oil Prices (1969-2005)



Source: Energy Information Administration and Energy Security Associates, Inc.

Although managing price risk has become a major consideration for energy companies, this doesn't necessarily require the use of financial derivatives. Several alternatives to derivative based strategies exist that might accomplish similar results. Vertical integration, the incorporation of the various stages of the production process, from exploration and production to final retail distribution, into one entity, allows the firm to control price risk. Vertically integrated firms are able to manage how a change in the price of a primary factor of production is incorporated into the cost structure of the firm. This strategy, to be fully implemented, requires the firm to own its oil or gas reserve base, an increasingly unlikely circumstance. Also, although the oil industry is characterized by integrated firms, it is also characterized by firms that operate in only one, or a limited number, of sectors of the industry. Even if the capital were available to form more vertically integrated firms, the most likely way this would be achieved in the oil industry would be through mergers and acquisitions, which have the potential of reducing competition.

Price risk may also be managed through inventory control. If firms maintain substantial stocks of natural gas or oil in inventory, it is possible to use these stocks to effectively smooth out price movements. Draw down in periods of high market prices could be compensated by spot market purchases when the price is low. The problem here is cost. Storing oil and natural gas is expensive, making this strategy unattractive if cheaper alternatives are available.

Long term contracting at fixed prices might also reduce the firm's exposure to price volatility. However, this strategy creates risks of its own. If the agreed upon contract price turns out to be higher than the actual market price in the future, the buyer of the product might find itself at a competitive disadvantage. For example, if a refinery agreed to purchase crude oil at $70 per barrel from an oil trader, and the price of crude oil then fell substantially, the refinery might not be able to produce competitively priced gasoline and might be forced to close or might possibly default on the contract. Similarly, if the price of oil turned out to be above $70 per barrel, the seller of the oil would have an incentive, at least in theory, to default on the contract and sell the oil on the higher value spot market leaving the refiner exposed to the higher price. The long term contract, which was designed to reduce price risk, accomplishes that goal by increasing default risk. To mitigate default risk, parties to the contract might diversify their purchases, buy insurance, require collateral, or only deal with well established firms.

Managing price risk has become a necessity in the oil and natural gas industries to maintain profitability and to avoid being at a competitive disadvantage. A recent report by the Energy Information Administration (EIA) studied financial derivative use in the marketing, producing and refining sectors of the oil and natural gas industries. The study used company data and Securities and Exchange Commission filings and determined that virtually all of the largest energy firms use derivatives to hedge risk. However, the value of contracts held by companies varied widely.[6] Since volatile energy prices may well continue in the future, firms are likely to undertake a strategy to protect themselves from price volatility. The chosen strategy must be cost effective, flexible, and reliable. Financial derivative based strategies fit these requirements for many firms in the energy industries.

Derivative Basics

Derivatives are financial contracts whose value is based on another, underlying asset. For example, owning a futures contract on 1000 barrels of light, sweet, crude oil dated July 2007, at a price of $60, obligates the owner of that contract to purchase oil at that time, at those terms. In what sense does the futures contract have value? If, near the settlement date in July 2007, light, sweet crude is selling for $70 per barrel on the spot market, holding a legally enforceable right to buy the oil at $60 per barrel creates a value of $10 per barrel for the owner of the futures contract. Conversely, if oil is available on the spot market for $50 per barrel on the July 2007 settlement date, the futures contract is a liability for the contract holder in that it requires the oil buyer to pay $10 more for oil than the spot market price. In practice, very few futures contracts traded on markets like the NYMEX are ever settled through physical delivery of the product. The NYMEX contracts allow for cash settlement. Physical purchases can then be made on the spot market at then current market prices. While cash settlement expands the spectrum of participants in the market and is more efficient than physical delivery for most contract holders, it can create the perception that the motivation and focus of the contracts are a purely financial bet on the future price of oil rather than a business strategy designed to reduce risk.

An important distinction between derivatives is whether they are traded on an organized exchange like the NYMEX or whether they are traded on the OTC market. Energy derivatives traded on the NYMEX are standardized contracts for a fixed amount of underlying product, delivered at a specified date, with a specified price, at a particular location. For example, the light, sweet crude oil futures contract discussed above is for 1000 barrels of West Texas Intermediate, on one of a set of pre-specified dates, for delivery at Cushing, OK. The "same" oil

[6] Energy Information Administration, *Derivatives and Risk Management in the Petroleum, Natural Gas, and Electricity Industries.* October, 2002, pp.27-28. This report can be found at http://www.eia.doe.gov/oiaf/servicerpt/derivative/ index.html.

delivered at a different location at a different time might well have a different value. The specificity of traded NYMEX contracts stimulates the need for OTC derivatives by creating basis risk. Basis risk arises from the fact that a physical good's location, delivery time, quality, and other product characteristics might cause its price to differ from a similar good with different characteristics. The implication of basis risk is that it is not generally possible to establish a perfect hedge using only exchange traded futures.

In contrast to NYMEX traded contracts, OTC contracts are custom designed to reflect the specific needs of the contracting parties. These contracts are typically one-on-one arrangements, traditionally with a financial institution acting as a fee-earning middleman, broker and manager. During the 1990s, a number of energy trading companies, of which Enron was perhaps the best known, became active participants in the OTC derivative market. Not only did these trading firms broker contracts, they also expanded their role to become the counterparty to the contracts.[7] Since the terms and specifications of the contracts can literally be anything the parties agree upon, the degree and scope of risk faced by the counterparty trading firms is increased substantially. The ability to customize contracts to provide a unique risk management profile brings distinct advantages which must be balanced against the disadvantages of OTC contracts.

Derivatives traded on the NYMEX have a high degree of liquidity, while OTC contracts generally are less liquid. A party on either side of a NYMEX contract can cancel its position at any time by buying, or selling, a contract that is opposite its original contract. For example, if a firm had purchased a futures contract on 1000 barrels of crude oil, it could sell a contract with identical terms which would effectively cancel the firm's obligation. From the point of view of the exchange, the firm would have netted out its position, having bought and sold contracts obligating it to 1000 barrels of oil, leaving it, in effect, out of the market. This type of transaction can be undertaken at any time because all contracts are standardized and have the central clearinghouse, which is owned by the market, as counterparty to the contracts. If the contract were OTC, the only way the contract could be terminated or modified would be through mutual negotiation and agreement between the principals. A firm that chose to abrogate an OTC contract it found financially disadvantageous would likely face a more complicated procedure, possibly including penalties to the counterparty, who would suffer damages, as well as dealer fees.

Financial performance of an exchange traded derivative is guaranteed, while the holder of an OTC contract is exposed to default risk. Exchanges guarantee performance by rigorously evaluating the credit worthiness of traders on the market. Additionally, margin accounts, which act as deposits, or reserves, against losses are marked to market on a daily basis. Marking to market is a cash flow system which calculates the gains or losses of every derivative contract position on a daily basis. The contract holder's margin accounts are then debited or credited to maintain minimal levels of margin equity in the derivative position. This process assures traders that every contract has sufficient capital backing to guarantee performance.

As a final safeguard, the exchange itself guarantees the financial performance of the contracts traded on its market. In the OTC case, there is no equivalent to the marking to market process which can allow losses, backed by little collateral, to accumulate. If the terms of an OTC contract are such that one of the principals to the agreement is suffering large losses, that party might not

[7] A counterparty takes a position opposite that of the original contract. For example, if you buy a derivative contract which entitles you to purchase oil, someone must take the responsibility to sell you the oil at the contract terms; that person is the counterparty to the contract. All derivatives are bilateral, that is, they have a counterparty.

be able to meet the terms of the agreement, raising the possibility of default. The costs of default can be substantial and are very real since OTC contracts are legally enforceable contracts.

Trades on organized exchanges are anonymously, cost efficiently, and competitively implemented with instantaneous price transparency. This is helpful to traders who might want to put a business strategy in place cheaply, quickly, and without revealing their strategy to other market participants. OTC contracts are, in effect, the opposite. Since they are one-on-one arrangements, the principals to the agreement are closely related to one another. The contract may require substantial fees paid to the manager or broker, and, since they are privately negotiated, they are not the result of a competitive process, although more than one dealer may compete to set up the transaction.

Set against these limitations is the important benefit of flexibility. A market traded derivative contract can, at best, implement only a portion of the firm's risk management strategy. For example, a California firm interested in purchasing natural gas might try to hedge its price risk by purchasing NYMEX futures contracts. However, the reference price for these contracts is at Henry Hub in Louisiana. The price of natural gas in California is different than the price at Henry Hub, and therefore, the firm can only cover a portion of the price risk it faces. Through the use of OTC derivatives, the firm may be able to eliminate basis risk and more effectively hedge the effects of price risk. In more extreme cases, the firm may have a strategy which is incompatible with exchange traded derivatives, leaving only a choice between doing nothing or entering into OTC contracts.

Derivative Contract Types

The most basic type of derivative contract is a *forward contract.* In a forward contract the terms are very similar to a cash-and-carry agreement, except that delivery and transfer of ownership of the underlying commodity is in the future. If an oil refiner enters into a forward contract for crude oil delivery, the refinery avoids price risk by locking in a price now, or avoids storage costs if current purchase and storage are an option. The refiner faces the potential of default risk if the price of oil changes substantially, tempting the contract's counterparty not to perform. Also, in these arrangements the credit worthiness of both parties is critical to performance of the contract. Finally, the liquidity of these contracts is low because they are one-on-one relationships that can only be changed by mutual consent.

A *futures contract* is similar in intent to a forward contract, but has some important differences. A futures contract has standard terms and is traded on organized exchanges. It specifies trades of a particular quantity of the underlying commodity at a particular price, at a particular time. For example, NYMEX natural gas futures contracts are for gas equivalent to 10,000 million British thermal units, at Henry Hub, LA, for any one of seventy two consecutive months into the future, at a dollars and cents price for 10,000 million British thermal units of gas equivalent. Although the contract can be settled at expiration in the physical commodity, it is more normally settled in cash through the exchange.

An *options contract* gives the owner the right, but not the obligation, to buy or sell quantities of the underlying asset at a fixed price known as the strike price. The two basic options are calls and puts. A call gives the owner the right to buy the underlying asset at the contract terms, while a put gives the owner the right to sell the underlying asset at the contract terms. For example, on the NYMEX, a call option on crude oil gives the owner the right to buy oil futures contracts at a fixed price, while the owner of a put has the right to sell oil futures contracts at a fixed price. An options contract will only be exercised if it is in the financial interest of the owner, and is allowed to expire if it is not. As a result, option based strategies allow the owner to participate in favorable outcomes while minimizing the effect of negative outcomes. Offsetting this favorable result, options based strategies are more expensive to implement than futures based strategies.

Not only are options available on futures contracts directly linked to the underlying physical commodity, but they are also available on critical spreads, or differences, that affect profit. A *crack spread option* protects against an expansion or contraction in the difference between prices. A user of refined products might want protection against price increases when refinery margins grow, even if the price of crude oil is constant. A *calendar spread option* is used to lock in profits over time. For example, a storage facility can lock in a profit on the storage of natural gas by using a calendar spread.

A *swap contract* allows the two parties to the agreement to exchange streams of returns derived from underlying assets. Ownership rights, if any, remain intact and the physical asset is not exchanged. Settlement payments are made in cash at pre-determined points during the life of the agreement to balance out differences in the value of the swapped return streams. For example, a refiner and an oil producer might agree to a five year agreement which has scheduled, periodic payments over its life. The payment, which might either be paid out, or received, by the firm, is equal to the difference between a negotiated fixed price and the currently prevailing spot price for a given amount of oil. If the spot price is above the fixed price, the producer pays the refiner; if the spot price is below the fixed price, the refiner pays the producer the difference. The intent is to insure that both parties to the agreement have predictable, stable costs and revenues, respectively. Swaps represent some of the most common examples of OTC contracts.

In many strategies, options are put together in combination to achieve the risk management goals of the company. The simple building blocks of calls, puts, and future contracts combined with positions in the underlying assets can achieve a wide variety of final outcomes. Many of these outcomes are desirable and perform well in controlling risk and stabilizing profit. However, it is also possible to use the same tools to conceal debt, inflate profit, and render the financial reports of the company opaque.

Workings of Derivative Contracts

This section will illustrate in more detail how derivative contracts manage price risk and at what cost.

The first example is concerned with natural gas transactions. A variety of participants in the natural gas markets might find it useful to use derivative contracts. Marketers can use futures contracts to offer their suppliers and customers futures-based pricing arrangements. They can use options contracts to provide price floors for natural gas sellers, price ceilings for buyers, and combinations thereof, without their customers' direct participation in the market. Producers can use options to establish a floor selling price for their future production while staying in position to reap the benefits of favorable price movements. Pipelines, to the extent that they remain merchant sellers of gas in competition with producers, might find it necessary to provide their customers with futures and options based pricing to remain competitive. Local distribution companies can use options to hedge storage costs as well as providing a ceiling on consumer costs. End users can purchase derivatives to lock in prices for their future requirements. They can actively manage their gas purchase costs whether they feel future market conditions will yield rising, stable, or falling prices.

Consider a manufacturer who uses natural gas in a production process and is concerned about a weather induced price spike during the winter months. The firm also believes that the underlying demand and supply fundamentals are strong so that it is very unlikely that the price of natural gas will fall from its current value. What can the firm do to protect itself from rising gas prices? Several strategies are available. First, the firm might buy futures contracts on natural gas. In this case, if the price of natural gas does rise in the winter there would be a corresponding rise in the value of the futures contract. At the expiration of the futures contract, the firm could buy the required natural gas on the spot market using the profits made on the futures contract to offset the higher spot market price. In this way, the manufacturer would have successfully hedged his needs for natural gas against price risk. Of course, if the price of gas actually declines, the manufacturer will lose on the futures contract. The amount lost is equal to the difference between the gas price specified in the futures contract and the market price. However, the manufacturer gains an equivalent value by purchasing gas at the lower spot market price. On a net basis, this leaves the manufacturer purchasing gas at the futures contract price, exactly as in the first part of the example.

If the manufacturer's forecast about the unlikely nature of a price decline is less certain, then a different strategy might be appropriate. The firm might wish to protect itself from a dramatic price increase, but at the same time be able to participate in the benefits of possible price reductions. Purchase of a call option might be a way to achieve both objectives, but at a cost. The numbers used in the following example are for illustration only. Suppose natural gas futures contracts for three months in the future are currently at $5.20 per million British thermal units. The firm might consider an at-the-money call option which might sell at 15 cents per million British thermal units.[8] If the price of gas fell significantly, the firm would let the option expire and purchase the gas on the spot market at the then current price. The 15 cents the firm paid for the option would be added to the spot price of the gas to get the true total cost of the gas purchased by the firm. If the price of gas instead goes up, the firm could exercise its option contract and buy the gas for $5.20, plus the 15 cents paid for the option.

If the firm feels that the premium of 15 cents for the call is too much to add to the cost of the gas and still remain competitive, it might purchase an out-of-the-money call. An out-of-the-money call has a strike price which is higher than the current market price and, hence, offers less upward price protection, but at a lower cost. The firm might decide to buy a $5.45 call for 7 cents. With this strategy the firm has purchased an insurance policy against a severe price increase, while leaving open the possibility of participating in price declines. By buying the out-of-the-money call, the firm reduces the cost of this insurance from 15 cents to 7 cents. However, the reduction in cost is accompanied by greater upward price exposure ($5.45 strike price compared to $5.20 strike price).

Had the firm not hedged, the net purchase cost of gas would vary with the market price on a cent per cent basis. Had the firm purchased the at-the-money call, the purchase price would be higher

[8] The strike price is the price written into the options contract at which the owner of the option may buy, in the case of a call, or sell, in the case of a put, the underlying commodity, in this case natural gas. An option is said to be at-the-money when the strike price equals the current market price. For a call, when the strike price is higher than the market price the call is said to be out-of-the-money. If the strike price is lower than the market price the call option is said to be in-the-money.

by the cost of the call up to the strike price. At a futures price of $5.35 (strike price plus the 15 cent price of the call) the firm would break even. At prices above $5.35 the firm would be cent for cent better off as a result of the hedge. If the firm had purchased the out-of-the-money call at prices up to $5.52 (strike price plus the 7 cent price of the call) the firm pays more than if there had been no hedge. However, compared to the at-the-money call the firm is better off at prices below $5.28. The breakeven point between the two alternative strike prices is the lower strike price plus the difference in prices of the calls, in this case $5.20 plus 8 cents or $5.28. If the firm believes that prices are likely to be below $5.28, but still wants protection against sharply higher prices, the likely choice is the $5.45 call.

The two examples described above, as well as more complicated variants of them, have several characteristics in common. First, the strategies were carried out using market traded contracts. The value of these contracts are transparent due to the real time availability of prices on the market. Their value to the firm is well understood and can be disclosed on all appropriate financial statements of the firm. If the firm chose to close out its derivative positions for any reason, that could be easily accomplished at predictable cost because of the depth and liquidity of the market. Second, the focus of the strategies was on the underlying natural gas. While the transactions were financial, the motivation for making them was to protect and facilitate the underlying energy business. Purchasing the same derivative contracts with no gas holdings, or business interest in the physical gas market, is far more speculative. Third, even though these transactions were clearly hedges designed to reduce the firms exposure to price risk, it is likely that speculators were part of the transactions. A speculator could have been the purchaser, or seller of a contract opposite almost any of the transactions discussed. In fact, without a counterparty taking an "opposite", speculative, view of how market forces would affect price, it is not clear that a liquid market for derivatives could function effectively.

As the focus of the derivative trader shifts from managing the underlying business assets to managing the financial assets themselves, problems can emerge. Consider the case of a natural gas company which has just signed a prepaid forward contract to supply natural gas one year in the future. The firm received $1 million as a pre-payment for delivery. Next, the same company signs a cash-settlement forward contract with another firm to purchase an equal amount of gas for delivery in one year for a price of $1.06 million. Each of these transactions, as well as both taken together, could be legitimate hedging transactions. However, add in that the counterparty to both forward contracts is the same company. In this case, the gas obligations effectively cancel each other out and we are left with what effectively is a $1 million loan at an interest rate of 6% for one year. This liability can easily be obscured on the company's financial statements, concealing the increased leverage of the firm. Financial engineering of this type, as well as managing earnings and other deceptive practices, may serve to mislead investors and create inefficiencies in capital markets.

Although relatively simple derivative transactions were used in all of the examples considered, the motivation and outcomes of the transactions were quite different. Each of the derivative instruments used was business oriented, in the sense that it could have been part of a normal hedging activity, and yet the last example shows that hedging may have little to do with the underlying motivation for the transaction. Also, the time frame can be important. The de facto loan arrangement of the last example might not have been attractive, or even feasible, if the forward contracts had been for a significantly shorter time than one year. What these examples show is that the derivative contract itself is neither inherently a hedge or speculative, it is merely a tool that helps a firm, or other trader, achieve its business objectives.

Policy Issues

How valuable is the use of derivatives to the energy industries, the financial markets, even the U.S. economy as a whole?[9] This question has been answered for the traded derivative sector. When Congress established the Commodity Futures Trading Commission (CFTC), it recognized the importance to the nation of orderly, fair, market determined prices on the futures exchanges.[10] As a result, the organized markets, including the NYMEX, self regulate with oversight by the Commission. The question really is addressed to the OTC transactions some associate with the Enron, Long-Term Capital Management, etc. type of financial debacles. Is there a case for regulating these contracts at the national level?[11] While the lack of any dis-aggregated OTC data makes empirical statements impossible, the factors that might enter into a determination can be evaluated.

One factor in determining the value of derivative transactions is the extent to which they can be expected to reduce the price volatility of the underlying energy commodity market. First, note that the very existence of derivatives is predicated on the fact that there is significant price volatility in the underlying market. If the price were regulated, or the underlying demand and supply fundamentals were predictable and slow moving, there would be little likelihood of derivative contracts being written. As a result, if derivative contracts significantly reduced underlying volatility, they would set in motion forces that would lead to their own irrelevance. Given the growth in OTC derivatives, there seems to be little evidence of a decline in use of these contracts. According to the Bank for International Settlements, by June of 2006 the notional value of OTC contracts stood at $370 trillion, a growth of 24% over year-end 2005.[12] Commodity based contracts accounted for only 1.6% of the total, but grew by almost 17% over the period. Interest rate swaps accounted for the vast majority of the contracts (56%). Second, as **Figure 1** showed, there is little evidence that key energy prices have become more stable during the last decade as they continue to be driven by exogenous, geo-political events.

Economists have long theorized on the effects of speculation on market prices. Their conclusions are mixed. Writers from Adam Smith through Milton Friedman suggest that speculative activities tend to reduce price volatility because speculators can be expected to buy low and sell high, providing a kind of "automatic stabilizer" effect to the market. Other writers, notably William Baumol, take the position that speculative activities tend to increase price movements. This occurs because speculators tend to buy as prices are increasing and high and sell as prices have already begun to fall, or are low. This behavior can make price volatility even greater by reinforcing the underlying price dynamic. In either case, it is clear that the availability of derivative trading makes carrying out speculative strategies cheaper and more feasible. Because they are highly leveraged instruments, they make the potential payoffs higher, creating greater incentive to speculate.

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[9] This section draws on the report, Energy Information Administration, *Derivatives and Risk Management in the Petroleum, Natural Gas, and Electricity Industries*. October, 2002.

[10] Section 3 of the Commodity Exchange Act, 7 U.S.C. Section 5.

[11] The Long-Term Capital Management problems emanated from bond arbitrage trading, and not energy derivatives.

[12] Bank for International Settlements, data is available at http://www.bis.org/publ/otc-hy0. Measurement of contracts at notional value is essentially a measure at the "face value" upon which the derivative contract is written, adjusted for double counting. This value may bear little relationship to the market value of the contract.

Efficient capital markets allow firms to raise capital for investment and technological improvement that leads to economic growth. The strength and integrity of these markets also attract capital from around the world. Damage to these markets would have major implications for the domestic and international economies. Could problems in the derivative markets precipitate more general damage to the U.S. capital markets? More specifically, could problems in the energy related OTC trading sector damage the reputation of U.S. capital markets? The logical chain for such an event might start with the failure of a large firm active in derivative trading and perhaps other financial transactions. The result then might be a melt-down of the derivative markets spreading to equity and debt markets. Some point out that the problem with this logic is that it has already happened with only isolated effects on U.S. financial markets. The failures of Enron, Long-Term Capital Management, Barings, PLC, the losses sustained by Metallgesellschaft and Orange County have not paralyzed the U.S. financial system. However, the collapse of Enron's trading operations did put a chill on OTC energy trading and led to calls for a variety of specific reforms which are discussed later in this report. While the integrity, safety, liquidity and efficiency of U.S. markets attract capital, so does their ability to innovate and embrace strategies that offer new profiles of risk and return. These factors might ultimately represent a trade-off. While protecting against this broad risk to the market system, called systemic risk, is valuable, if it comes at the expense of reducing the ability of individuals to take on, or transfer, financial risk for an appropriate rate of return, this too might damage the functioning of the financial markets.

The use of derivatives might have the effect of reducing the cost of capital for firms, enhancing their real capital investment, and increasing their value. This result might occur because using derivatives to hedge risk reduces the riskiness of the firm's cash flow stream. Again, economists' views on this issue are mixed. Traditional theory took the position that any reduction in risk the firm faced would enhance the value of the firm. In 1958, Franco Modigliani and Merton Miller changed traditional perceptions by demonstrating that any change in the financial capital structure of the firm, (in their case specifically, the mixture of equity and debt financing) in an economic setting with no imperfections, would have no effect on the value of the firm. Later writers have demonstrated that if any of a variety of market imperfections exist, then the value of the firm may very well be affected by the choice of financial structure. This line of reasoning usually posits that although the firm's actions, e.g. implementing a program of futures contracts, do reduce risk, these actions come at a cost. Either the payment to achieve the reduction in risk is just equal in value to the risk reduction, in which case the value of the firm is unchanged, or the owners of the firm could achieve the same risk and return profile through lower cost personal transactions, making them unwilling to admit an increase in the value of the firm due to managerial action.

The limited empirical information available suggests that the use of derivatives is extensive. The EIA's analysis of Securities and Exchange Commission 10K filings for 2002 showed that the use of derivatives was virtually universal among firms included in the study, but the value of derivative holdings varied widely.[13] From this study it also appeared that firms on the marketing level used derivatives far more than producers or refiners, perhaps because producers can control production and refiners have storage and inventory management capabilities. It also appeared that vertically integrated oil companies found less need for derivative use, which again fits in with the earlier explanations of how firms might carry out risk management. Although there is little direct evidence that the use of derivatives increases the value of the firm, the near universality of use by

[13] Energy Information Administration, *Derivatives and Risk Management in the Petroleum, Natural Gas, and Electricity Industries*, October, 2002, pp.27-28.

energy firms, as shown by the EIA, suggests that a wide spectrum of energy managers see value in using derivatives to manage risk. If these firms are efficiently managed, it would be unlikely that they would consistently engage in inefficient activities.

Although little in the way of theory or empirical evidence exists to tie derivatives to either beneficial or injurious market effects, the very size of both the traded market and OTC contracts suggests the possibility of important consequences should problems occur. The openness and innovation in the market suggests that while great success might be registered, large errors might also be made. Also, the critical nature of the underlying commodities suggests the potential for major disruption of both the consumer and producer sectors of the economy if a derivative related financial crisis led to disruption in the physical markets.

Derivatives and Commodity Prices

Since the value of a derivative contract is based on the value of the underlying commodity, when the price of the commodity varies the result is a variation in the price of the derivative. The increasing importance of derivative trading has raised the question of whether price variability that has its origins in the derivative market can affect commodity market prices? While it is generally accepted that price variability in the underlying commodity is a requirement for a successful derivative contract market to exist, does the existence of derivative trading and its practice *cause* price variability in the underlying commodity, independent of market fundamentals?

The futures market is made up of two primary groups of traders; dealers and merchants who have an interest in buying and selling the underlying commodity, and financial investors, sometimes identified as speculators, who trade contracts to obtain financial gains and do not have an interest in buying and selling the underlying commodity. In principle, the market activities of speculators in establishing either a long or a short position, could change the price of futures contracts, and hence the reported price of the underlying commodity. However, since the speculator can neither deliver, nor accept delivery of the commodity, they must resolve their position on the futures market by purchasing a position opposite their original one. If establishing the first part of their futures position raised (lowered) the market price, the resolution of that position in the second part of the transaction would then lower (raise) the market price to an approximately equal amount.

In recent years, a number of studies has attempted to clarify the relationship between derivative and commodity prices as well as the effect of financial traders on market prices. For the most part the studies have investigated the behavior of contracts traded on the NYMEX and similar exchanges. The OTC market has been the subject of less research because, unlike the organized exchanges which accumulate data for regulatory agencies and public use, the OTC has no data reporting requirement.

EIA Study

The EIA study assesses the relationship between natural gas futures and spot market prices over three consecutive winter heating seasons running from 2002 through 2005.[14] Economic theory suggests that futures prices should be related to spot prices, and tend to equalize with spot prices as the expiration of the futures contract approaches. This theory was subjected to empirical analysis in the EIA study.

The findings of the EIA study resulted in mixed support for the theory. It was reported in the study that the prices observed for futures contracts can vary over time. This result is not inconsistent with theory, as fundamental factors that affect expected spot prices may also vary. The study also reported that the difference between futures prices and realized spot prices do not diminish over time in all cases. In some cases, the futures price was a good predictor of spot prices, but in many cases it was not. It was also determined that prices for futures contracts showed a systematic bias, but that price patterns did not evolve in a predictable way, making futures contract prices an unreliable predictor of future spot prices.[15]

NYMEX Study

The NYMEX accumulates trading data as part of its self-regulatory process, in addition to its oversight by the CFTC. In 2005, the NYMEX published a study investigating the behavior of hedge fund participation in energy trading.[16] The report was undertaken by NYMEX staff, to address concerns that hedge funds (large, leveraged investment funds that are largely unregulated) were exercising undue influence on energy futures prices. The data used in the study was from an internal reporting system that NYMEX uses for market surveillance for the period January through November 2004.

The NYMEX found that hedge funds accounted for trading volumes of 2.69% in crude oil and 9.05% in natural gas. When considered in terms of open interest, the number of unliquidated contracts held, the hedge funds constituted 13.4% in the crude oil market and 20.4% in natural gas. According to the NYMEX study, these values suggest that the hedge funds are not disproportionately active traders, tending to hold a larger number of contracts, lending stability to the market. The study also reports that hedge funds held their positions longer, on average, than other groups of traders, suggesting that hedge funds are a non-disruptive source of liquidity on the market rather than a source of price volatility. Specifically with respect to price volatility, the study found that changes in hedge fund positions, in both the crude oil and natural gas markets, tended to reduce price volatility, lending a stabilizing factor to the market.[17]

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[14] Energy Information Administration, *An Assessment of Prices of Natural Gas Futures Contracts As A Predictor of Realized Spot Prices at the Henry Hub*, Office of Oil and Gas, October 2005.

[15] Ibid. pp.4-5.

[16] The New York Mercantile Exchange, *A Review of Recent Hedge Fund Participation in NYMEX Natural Gas and Crude Oil Futures Markets*, March 1, 2005.

[17] Ibid. p.3.

U.S. CFTC Study

Researchers at the CFTC studied whether managed money traders (hedge funds) exerted a disproportionate and destabilizing influence on the workings of derivative markets.[18] The CFTC study was based on data that was reported to the Commission in the course of its regulatory responsibilities. Although it is likely the data set is similar to that used in the NYMEX study, the two data sets are independent. CFTC researchers used advanced econometric techniques, including Vector Autoregressive Models and Innovation Accounting, and Directed Acyclic Graphs to analyze their data set.

The study found that in the natural gas market, dealers and merchants, the participants whose interest in the market was commercial, tended to influence prices, while the activities of managed money traders had no effect on price changes. The study concluded that managed money traders provided liquidity to the market and aided the price discovery process and did not contribute to price volatility through their market activities. Similar results were found to hold in the crude oil market.[19]

The study also concluded that information regarding price changes tended to flow from the commercial sector of the market to the managed money traders, suggesting that the speculator sector tended to react to, rather than generate, price changes.

Cooper Study

Mark N. Cooper undertook a study of energy based derivative trading for the Attorneys General Natural Gas Working Group of the states of Illinois, Iowa, Missouri, and Wisconsin.[20] The Cooper study differs from the NYMEX and CFTC studies because it is limited to the natural gas market, does not use econometric analysis of a recognized data base, relies on anecdotal evidence, and is focused on the over the counter market. Cooper approaches his research trying to determine why a damaging price spiral occurred in natural gas markets and the role of speculative activity in causing those price increases.[21]

Cooper's point of departure for the study is that a description of the natural gas market as being characterized by increasing demand, constrained supply, and efficient price signals that balance demand and supply is a half-truth. He sees the market as inefficient, vulnerable to abuse and volatility, and yet relatively unregulated.[22]

Cooper finds that a correlation exists between increases in the trading of derivatives and both the volatility and level of natural gas prices.[23] In a graph relating the wellhead price of natural gas to

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[18] Haigh, Michael S., Hranaiova, Jana, and Overdahl, James A., *Price Dynamics, Price Discovery and Large Futures Trading Interactions in the Energy Complex*, Office of the Chief Economist, U.S. Commodity Futures Trading Commission, April 28, 2005.

[19] Ibid. pp. 24-28.

[20] Cooper, Mark N., *The Role of Supply, Demand and Financial Commodity Markets in the Natural Gas Price Spira*l, March 2006.

[21] Ibid. p.3.

[22] Ibid. pp.1-3.

[23] Ibid. p.7.

time, he identifies the natural gas price spike of 2001 as being associated with Enron entering the trading market and the fall in prices in 2002 to be associated with Enron's exit from the market. Cooper identifies the peak natural gas prices of 2003-2006 as related to investment bankers entry in the OTC market to replace Enron, and the increase in hedge fund activity. While there does appear to be a coincidence between the events Cooper describes and natural gas prices, his analysis does not establish a correlation in a statistical sense, or causality. His analysis fails to control for other factors, both fundamental and institutional, that might have contributed to the price spikes in the years in question.[24]

Specific Reform Proposals

In the wake of the Enron bankruptcy, legislative proposals to increase the regulation of OTC energy contracts began to be introduced.[25] In the 107th Congress, proposed legislation concerning OTC trading was considered. Senator Dianne Feinstein proposed derivatives legislation, (S. 1951), in the Senate, while, independently, Representative Peter DeFazio introduced a bill, (H.R. 4038), in the House of Representatives. The 108th Congress rejected amendments (S.Amdt. 876 to S. 14 and S.Amdt. 2083 to S. 2673) to increase the regulatory reach of the CFTC and the Federal Energy Regulatory Commission, as well as proposals for more data reporting and transparency in OTC transactions, although issues of trade manipulation were also addressed. Legislation introduced in the 109th Congress focused on data reporting and the transparency of OTC trades. H.R. 1638 and S. 509 were directed at bringing natural gas transactions under CFTC control and increasing the civil and criminal penalties for market manipulation. H.R. 4473 would have provided the CFTC with authority to expand its data collection and monitoring activities from natural gas traders.[26]

In principle, an OTC contract is between two parties who interact one-on-one because of differing needs, perhaps with a financial institution managing the terms of the agreement. After the Enron bankruptcy, the market appeared to be evolving into a dealer driven market where the dealers were "energy trading" firms. These companies generally had experience in the physical energy market, either because they began their businesses in the field, or because they were set up by energy companies specifically to trade energy derivatives. Energy trading firms served as a counterparty to firms who want to set up an OTC contract. They then hedged the risk that they took on by purchasing market traded derivative contracts with an offsetting risk profile. As a result, they were heavily leveraged relative to their capital base. Both parties in the OTC transaction are then subject to each others' substantial credit risk.

One suggestion that was discussed to address the OTC market proposes that energy trading firms be more related to the core, physical side of the energy market. The theory is that the asset positions and cash flows from the physical side of the business can act as a stabilizing factor for the OTC side of the business. Additionally, if the company's business focus is on the physical market it might be less likely to make the purely speculative financial bets that are possible with highly leveraged derivative positions. Critics contend that firms have moved away from the physical side of the business and into energy trading because that is where they perceive the

[24] Ibid. pp. 53-55.

[25] For an analysis of the history of derivative regulation as well as an analysis of policy proposals, see CRS Report RS21401, *Regulation of Energy Derivatives*, by Mark Jickling.

[26] Ibid. pp. 5-6.

greater return to be. As a result, requiring firms to participate more heavily in the physical business would require them to participate in what they see as a less profitable activity. In any case, if the cash flow from the physical energy business is small relative to the credit risk positions from the derivative contract business, little reduction in credit risk would be attained.

More recently, major financial institutions, especially investment banks, such as Goldman Sachs, Morgan Stanley and Merrill Lynch, have become the major market makers in OTC energy transactions. This was the case early in the development of the market, to the extent that the major investment banks became known as the "Wall Street Refiners," and appears to be the case again. The important issue for market makers, and financial markets as a whole, is the degree of capitalization of the counterparty and the degree of counterparty risk. OTC market participation and the structures and roles of the participating firms ultimately depend on profit incentives. Regulations that alter the least cost, profit maximizing choices of firms might make the OTC contract less desirable, but perhaps safer.

Another reform proposal that has made progress is to establish a clearing house along the lines of the NYMEX and other derivative markets. In fact, the NYMEX is actively offering clearinghouse services for OTC derivative transactions.[27] Some of the potential benefits of establishing a clearing house are important. Counterparty credit and performance risk would be substantially reduced. This is significant because the aversion to credit and performance risk is considered a major factor in reducing activity on OTC transactions. Participant operating capital needed to secure positions might be reduced as the diversification and netting of the clearing house might require lower aggregate capital due to risk spreading. Confidence in OTC transactions has been low, and slow to recover since the collapse of Enron. It is conceivable that the use of a clearing house could restore a part of the faith in the market that has been lost. Whether liquidity would be increased as the result of a clearing house is an open question. Although a centralized location would enhance knowledge concerning buying and selling opportunities, the customized nature and specific risk profiles of the contracts would remain. It is likely that the use of a clearing house could provide a higher degree of price transparency which might contribute to enhanced liquidity.

Given the fragile nature of confidence in OTC contracts after the Enron bankruptcy, and the concern with credit and performance risk, some suggested that the answer might lie in structured derivative product companies.[28] These companies were generally subsidiaries of major financial corporations which were specially structured to act as derivative intermediaries while maintaining triple-A credit ratings. The companies accomplished this by the way they managed both market and credit risk. Market risk, in the case of energy derivatives, generally price risk, was cancelled through a set of mirror transactions, collateralized hedges, with the derivative product companies' parent or affiliated company. Credit risk was minimized at a level consistent with a triple-A rating by earmarking capital. This typically resulted in derivative product companies having higher capital costs than other derivative trading companies even though capital costs are explicitly minimized. Finally, these companies usually had a well defined, transparent workout structure in place for situations in which other preventative measures fail to protect against risk, and contracts associated with the derivative product company must be liquidated. Derivative product companies

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[27] See "NYMEX OTC Clearing", presented at the North American Energy Standards Board Annual Meeting, September 25, 2000, Hunt Valley, MD.

[28] An extensive analysis of structured derivative product companies can be found in Eli M. Remolona, William Bassett, and In Sun Geoum, *Risk Management by Structured Derivative Product Companies*, Federal Reserve Bank of NY Economic Policy Review, April, 1996.

worked well in interest rate and currency derivative markets in the 1990s, but never really dominated the market. The higher costs of these firms negated a good part of the rationale for engaging in OTC transactions. The problem for derivative product companies has been that market participants have not appeared to be willing to pay for the specific benefits they can provide. If market participants value the reduced default and credit risk derivative product companies offer at least as highly as the extra cost they impose, then the approach might be workable.

The proposals discussed above all touch on the issue of price transparency. It is worth emphasizing the importance of price transparency in the context of documenting and reporting transactions and derivative holdings. Companies have used derivatives to carry out illegal and deceptive financial strategies. Even though the root problem was the desire to engage in illegal or deceptive activities, it is still true that derivative contracts were the vehicle by which some of these activities were carried out. Many observers agree that anti-fraud and anti-manipulation safeguards would be more effective if pricing and documentation of transactions were more transparent. Also, the complex, largely unobservable, web of transactions created through derivative trading can be opaque to regulators as well as investors and might contribute to unrecognized systemic risk. Some organized form of reporting OTC contracts has been suggested as a way to address this issue. The trade-off is that one of the goals of OTC derivative trading is just this opaqueness. In a market with relatively few large firms, revealing what one believes to be the direction of the market or one's own strategy to competitors might have significant costs. Additionally, if one's strategy is explicitly reacted to by competitors, actual events in the market might be affected.

In summary, the OTC energy derivative market is a young market that is still in the process of finding its place in the larger energy markets. That it serves a need in the energy industry is not in doubt; its growth and dollar value attest to that. It is also clear that it has been misused for illegal and deceptive purposes. Finding the balance between safeguarding participants' interests without unduly damaging the business purposes the market was designed to meet is the challenge facing reform proposals.

Conclusion

Deregulation and the increased volatility of oil demand and supply fundamentals were factors in establishing the need for an energy derivatives market in the 1980s. Those factors continue to influence the market today, and have accounted for the growth of both organized exchange and over-the-counter trading. By adopting hedging strategies, commercial energy firms have been able to reallocate price risk and operate their businesses more efficiently. Since groups of commercial traders, on each side of the market have relatively the same exposure to price risk, they need another group with opposite interests, who are willing to accept risk transfers from the commercial sector. These groups are known as speculators and are composed of financial traders representing hedge funds, investment banks, and others.

While the organized exchanges are regulated by the CFTC, the OTC market remains opaque and unregulated. Legislative proposals have focused on increasing transparency through data reporting and mitigating manipulative practices. Increasing the visibility of OTC transactions would yield benefits, but might so disrupt the market that it could not serve its designed purpose. This result might create incentives for energy industry traders to develop other mechanisms to accomplish the goals currently attained in the OTC market. Market manipulation tends to distort the working of the market and rarely evokes public support.

Energy derivative markets provide benefits to both energy firms and consumers in providing a more efficient market. Regulation and oversight that reduces market distortions and enhances efficiency is likely to provide additional gains for the market, although over regulation can distort the purpose of the derivative markets.

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