A Note on Natural Gas Market Evolution in Light of Transaction Cost Theory

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Summary

A liquid spot market does not exist in the international natural gas market for two reasons according to transaction cost theory: small numbers of traders and the need for large relationship-specific investments. Spot markets with small numbers of buyers or sellers can lead to situations with costly and continual bargaining, raising transactions costs. Relationship-specific investments are those specific to a trading relationship that have greater value inside the relationship then outside.

The hold-up problem emerges when opportunistic trading partners, who either did not make a relationship-specific investment or made a relatively inexpensive one, take advantage of the situation by changing the prices they are willing to pay or charge. In both cases contracts are an efficient alternative to spot markets because they can reduce transactions costs and mitigate the hold-up problem from relationship-specific investments.[1] Vertical integration is an alternative to a contract, but access issues and inefficiencies arising from such integration can make contracts more appealing.

This underlying theory suggests there are three factors which will have an important influence on the evolution of the natural gas market. The first is the size of relationship-specific investments. Theory suggests that as the value of these investments falls, so does the duration of contracts. These may fall due to a mature industry where most infrastructure has been built, or the emergence of liquid spot markets. A falling size of relationship-specific investments may also increase the number of buyers (wholesalers, traders, etc.) and sellers (LNG exporters) in the natural gas market.

The number of buyers and sellers in different natural gas markets is also important. More buyers and sellers can reduce the size of relationship-specific investments because the risk of finding a buyer or seller in the future is reduced. This can also lead to lower transactions costs because of less bargaining. Both of these can shorten contract durations. Increased numbers of buyers and sellers may also lead to a more competitive market, reducing the chances for either a buyer or seller to use their market power or engage in collusive behavior.

The regulatory regime is a third factor influencing the evolution of natural gas markets. Any type of regulation which distorts the incentives of buyers of sellers will shorten the duration of contracts in the natural gas industry according to transaction cost theory. This is because such regulation raises the costs of monitoring a contract, and these additional costs reduce the benefits of extending a contract. Well-structured regulations, however, are instrumental in avoiding situations where market power can be exerted, such as in the case of pipeline access.

[1] In the agency-based approach, contracts can exist as a risk transfer mechanism between parties to a transaction. Such a contract is way for either party, who may have large fixed costs and small variable costs, to guarantee a return on investment by transferring some risk to the other party.

Why Do Contracts Exist in the Natural Gas Industry?

Agency theory and transaction cost economics are the two primary approaches to explaining the existence of contracts.[2] In an agency framework, contracts help to overcome difficulties which a principal has when hiring an agent. Because the principal may have divergent goals from the agent, and it is costly to monitor the agent (maybe impossible), actions going against the interests of the principal may be taken by the agent. Even if the principal is able to monitor the agent, the principal and agent may prefer different actions because they differ in their tolerance of risk (Eisenhardt, 1989).

In this situation a contract can emerge to align the interests of the agent with those of the principal. Such an agreement might make it less costly to monitor or verify the actions of the agent, and a contract can also transfer risk between the principal and the agent. This risk-transfer function of contracts is the part of agency theory most relevant to the natural gas industry. Due to large investment costs and uncertainty over future prices and production, there is substantial risk in agreeing to purchase or produce natural gas. According to agency theory a contract can help to transfer some of this risk. This is also true when spot markets exist but are not liquid, as has been historically true in natural gas.[3] Firms may enter into a contract if they have large fixed costs and small variable costs, as is often the case in natural gas, because the contract can transfer some of this risk to the other party.

The agency view of the natural gas industry is unsatisfactory because it cannot explain why spot markets are unable to provide this risk transfer, or how to differentiate between the principal and agent in the buyer-seller relationship. The transaction cost economics approach seems more applicable to the natural gas industry. To understand this theory, it is easiest to begin with spot markets, identify their weaknesses, and then explain how contracts can emerge due to these weaknesses.

Fully developed spot markets are able to determine prices based on the interactions of supply and demand. If there are many buyers and sellers so that these markets are competitive, using spot markets allows for adaptability under changing conditions, cost minimization, and the realization of economies of scale. Because spot markets are continually changing, variations in supply and demand will adjust prices and quantities traded instantaneously, allowing for adaptation. Competitive spot markets also lead to cost minimization by suppliers because they gain any benefits from reducing costs. Economies of scale result in competitive markets because even buyers with a small demand for a good are able to purchase at the minimum of average costs when there are many suppliers all producing at this level (Church and Ware, 2000, Ch. 3). In addition, if there is security of supply, then a competitive futures market might exist which would allow traders to hedge against risk if there is price volatility.

If spot markets work well, why have contracts been prevalent in the natural gas industry? The advantages of using spot markets depend on the ability of either the buyer or seller (or both) to change

[2] Hart and Holmstrom (1987) provide a survey of agency theory and Tadelis and Williamson (Forthcoming) do the same for transaction cost economics. A comparison of how the two theories fit the data is Masten and Saussier (2000).

[3] Spot markets with small numbers of buyers or sellers may increase the risk of either buying or selling because there is no guarantee that a buyer or seller will be available in the future. Contracts can be used to hedge such price or quantity risk.

trading partners relatively inexpensively. Historically, this has been difficult in the natural gas industry because of the small numbers of buyers and sellers and large investment costs. Spot markets with small numbers of buyers or sellers can lead to situations with costly and continual bargaining, raising transactions costs. Contracts are one way to avoid these costs (Church and Ware, 2000, Ch. 3).

Another reason that contracts may exist is that buyers and sellers may make investments specific to the trading relationship that have greater value inside the relationship then outside. Examples of these include pipelines, pipeline extensions, or LNG re-gasification facilities. These relationship-specific investments can make it very costly to find a new trading partner. It is then possible for an opportunistic trading partner, who either did not make the relationship-specific investment or made a relatively inexpensive one, to take advantage of the situation by changing the prices they are willing to pay or charge. This is known as the hold-up problem (Tadelis and Williamson, Forthcoming). Contracts are one way to get around the hold-up problem, as they provide a mechanism for parties to commit to their future behavior (Lafontaine and Slade, Forthcoming).

Why Contracts and Not Vertical Integration?

The importance of hold-up problems can disappear with vertical integration. Either the buyer or seller could purchase their counterparty, thereby eliminating the relationship-specific investment and any potential for hold-up. Vertically integrating in this way by eliminating the use of contracts can allow the newly expanded firm to replicate the efficient adaptation of a liquid spot market. However, there are several reasons why such vertical integration may be problematic.

The main reason, which is not related to theoretical issues, is because of access. Either the buyer or seller may simply be unable to get the rights to purchase their counterparty. Aside from this, it may also be that the costs of vertical integration outweigh its benefits. One potentially large cost is the increasing level of inefficiency which can accompany greater size. Such inefficiency may occur because the newly integrated unit no longer produces as efficiently. Before the firm had to sell its product at a (market) price, but this incentive for cost minimization may no longer be as strong as a division of a larger firm. It might also be the case that the objectives of this division's managers diverge from those of the new owners. These (and likely many other) costs outweigh the benefits of getting rid of the hold-up problem.

Why Have Natural Gas Contracts Traditionally Been Long-Term?

The length of natural gas contracts has generally been between 15 and 25 years (Neuhoff and von Hirschhausen, 2005). From an agency perspective, the duration of a contract is positively related with its level of risk –the greater the risk the longer the contract. There is a large amount of risk taken by both buyers and sellers in the natural gas industry. This is related to the size of investments, but also

uncertainty over the future price and demand for natural gas. Using long-term contracts alleviates some of this risk by providing an insurance device guaranteeing some minimal level of returns.

The major factor driving contract duration in the transaction cost approach is the size of relationship-specific investments. These investments lead to the hold-up problem, which can be overcome through the use of a longer-term contract. As the size of these investments falls, this theory predicts that the duration of contracts should do so as well.[4]

The level of uncertainty and regulation also play a part in determining optimal contract duration in the transaction cost approach. Because contracts are always incomplete (they cannot contain every possible contingency), greater uncertainty leads to larger transactions costs. These are the specific costs of monitoring a contract, or attempting to renegotiate due to some unforeseen event, or trying to mitigate opportunistic behavior on the part of either the buyer or seller more generally. Thus higher uncertainty will tend to lead to shorter-term contracts according to the transactions cost theory. [5]

This is also true of industries which are highly regulated. Poorly designed regulations misalign the incentives of buyers and sellers to such an extent that submitting to a contract becomes increasingly risky. The misalignment of incentives raises the chances of either the buyer or seller trying to engage in opportunistic behavior. This raises transactions costs, both because it requires additional monitoring and because such contingencies must be written into contracts, which works to reduce contract duration.[6]

Why Have Natural Gas Contracts Traditionally Been Take-or-Pay?

Take-or-pay contracts link buyers and sellers into a bilateral monopoly for a specified period. Purchasers are required to pay for a pre-specified minimum quantity of gas, whether or not they take the gas, and producers are required to deliver this quantity.[7] The basic idea is that the buyer bears the volume risk and the seller the price risk (Creti and Villeneuve, 2005).

Agency theory does not provide any guidance regarding the structure and provision of contracts. Transaction cost economists have taken two different views on the emergence of take-or-pay provisions in natural gas contracts. Both stem from the fact that all contracts are to some extent incomplete, and this incompleteness creates the possibility of opportunistic behavior on the part of either the buyer or seller.

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[4] Several studies have found evidence that contract duration increases with relationship-specific investments. The classic result is due to Joskow (1987), who shows that the duration of contracts in the U.S. coal industry were positively related to the size of relationship-specific investments. Crocker and Masten (1988) found this to be true in the U.S. natural gas industry, while Neumann and von Hirschhausen (2006) show this result holds in the global natural gas industry more generally, but particularly in European natural gas contracts.

[5] Crocker and Masten (1988) find that greater uncertainty after the 1973 Arab oil embargo led to shorter contracts in the U.S. natural gas industry.

[6] Crocker and Masten (1988) find that price regulation lead to shorter contracts in the U.S. natural gas industry.

[7] The prices in such contracts may also be indexed to some marker, for example crude oil.

One view is that take-or-pay provisions are risk-sharing instruments to overcome the hold-up problem.[8] The take-or-pay provision is a way to put price risk on the seller and quantity risk on the buyer. An alternative theory is that take-or-pay provisions have emerged because they minimize transactions costs associated with contract verification. This is because such contracts increase the flexibility of a long-term contract (which usually adds complexity and costs) while making it easy to implement (which can reduce complexity and costs).[9]

Why are Natural Gas Contracts Linked to Other Prices?

Even when natural gas contracts are take-or-pay, the price stipulated in the contract is often linked to competing fuel or crude oil prices (EIA, 2003). If the take-or-pay provision in the contract is viewed as a risk-sharing instrument, this price indexation may be a way to transfer risk. This is the case if the price risk of the seller exceeds the quantity risk of the buyer. The price indexation puts some of the price risk on the buyer as well.

If the take-or-pay provision is viewed as a way to minimize transactions costs, then price indexation may reduce total costs. This is true if the additional costs of price indexing are lower than the monitoring costs a buyer faces without indexation. A final reason that natural gas contracts may be linked to other prices is due to market power. The provision can be a means for the seller to use some of their market power to extract additional revenue from the buyer.

What Might Change Indexation to Henry Hub?

Given existing differentials in natural gas prices across regions, it is possible that contracts could be indexed to Henry Hub prices instead of competing fuel or crude oil prices. If the take-or-pay provision in the contract is viewed as a risk-sharing instrument, this could occur because the distribution of risk has changed. The buyer may be taking on more risk than the seller, given lower natural gas prices in other markets, and indexing to these other prices may distribute the risk more evenly.

If the take-or-pay provision is viewed as a way to minimize transactions costs, then changing price indexation may reduce total costs. In this case, the additional costs of changing the price index for the seller are lower than the monitoring costs they face without indexation. A final reason that the price index in natural gas contracts may be changed is that the market power of sellers has fallen. This might occur because of growth in the global LNG market or due to changes in regulations in consuming countries.

[8] This is the approach behind the model in Hubbard and Weiner (1986).
[9] This approach is put forth in Masten and Crocker (1985).

Can the Global Natural Gas Industry Be Characterized as an Oligopoly?

There is no mention of market power or collusive behavior in the agency or transaction cost theories discussed to this point. Contracts are an efficient response of buyers and seller to their environment. However, contracts between firms can exist for anticompetitive reasons as well. Contracts can be used to deny competitors' access to either suppliers or buyers, forestall market entry, or diminish competition in the long run (Hauteclocque and Glachant, 2009). Given the varying motives for firms to use long-term contracts, distinguishing the motives of buyers or sellers can be difficult.[10]

The theoretical literature on market power and long-term contracts gives inconclusive results, and has focused primarily on the producer.[11] One possibility is that long-term contracts reduce the ability of large sellers to use their market power. Because the use of such power would only be profitable on the un-contracted portion of their supplies, long-term contracts lead to greater production then would have occurred in their absence. However, sellers can exert market power in stipulating a higher price then would prevail in competitive conditions into the contract itself (Neuhoff and von Hirschhausen, 2005). The different results depend on whether the producer chooses quantity produced or price.

Models that consider the sustainability of collusion also give mixed results. Some theoretical models show that long-term contracts make markets more competitive because additional output is produced then would otherwise be the case. Other models show that long-term contracts help to sustain collusion by buyers and sellers (Neuhoff and von Hirschhausen, 2005). The different results depend on whether long-term contracts are repeatedly negotiated and followed by a spot market, or if these contracts can only be negotiated in one period and are then followed by repeated interactions on spot markets.

There seems to be no theoretical analysis regarding the strategic motives of national companies and market power in the natural gas industry.[12]

What are the Key Theoretical Factors in the Evolution of the Natural Gas Market?

1. *The size of relationship-specific investments*

According to the transaction cost theory, relationship-specific investments are a key factor in the existence and duration of long-term contracts. As the size of these investments falls, the theory predicts

[10] Hubbard and Weiner (1991) evaluate the importance of market power in long-term U.S. natural gas contracting as opposed to efficient contracting in response to market structure. They find some evidence that a small number of buyers exert market power vis-à-vis a larger number of natural gas sellers (monopsony) in setting initial contract prices.

[11] These are almost exclusively game-theoretic models. Shapiro (1989) provides a comprehensive survey of this literature.

[12] Creti and Villeneuve (2005) have a discussion of this topic relevant to the European natural gas market.

that contract duration will do so as well.[13] The size of relationship-specific investments can fall due to industry maturity or the emergence of a liquid spot market.

Industry maturity decreases the size of relationship-specific investments because many of the necessary facilities for the sale and distribution of natural gas have already been built. This reduces the costs of switching trading partners. The emergence of a liquid spot market reduces the size of relationship-specific investments because it can reduce the transactions costs associated with bargaining when there are small numbers of buyers or sellers (or both).

In addition to shortening the duration of long-term contracts, a reduced size of relationship-specific investments should increase the size of the natural gas market in terms of the number of buyers and sellers. Because start-up costs are lower, additional buyers can enter and use the spot market. This might include wholesalers or traders. In the short-term this may not have an impact on the number of producers, but LNG market maturation may provide additional producers for the spot market as well.

2. The number of buyers and sellers

Both agency theory and transaction cost theory predict that additional buyers and sellers will work to reduce the length of contracts. From an agency perspective, additional buyers or sellers reduce the risk of investing and not being able to find a buyer or seller in the future. These additional buyers and sellers also reduce the transactions costs of negotiating contracts, which will reduce their duration as well. Standard microeconomic theory predicts that such additions of buyers and sellers also work to make the natural gas market more competitive.

It seems that regulation plays a big role in the number of buyers and sellers in the natural gas market, while the LNG market can potentially play a large role in influencing the number of sellers in the market.

3. Regulation

Any type of regulation which distorts the incentives of buyers of sellers will shorten the duration of contracts in the natural gas industry according to transaction cost theory. From an agency perspective this increased risk will lead to longer contracts. The impact of poorly-structured regulations on contract duration is uncertain from a theoretical perspective.

Well-structured regulations, however, are instrumental in avoiding situations where market power can be exerted. This may occur in the context of pipelines, but also in terms of the development and functioning of liquid spot markets.

[13] As was mentioned above Crocker and Masten (1988) and Neumann and von Hirschhausen (2006) find evidence for this in the U.S. and global natural gas industries.

4. Strategic national behavior

There is little theory to understand how strategic national behavior will impact the global natural gas market. But one can expect that the structure of contracts, size of relationship-specific investments, numbers of buyers and sellers, development of spot markets, and expansion of LNG trade will all be influenced by national objectives.

References

Church, Jeffrey and Roger Ware, *Industrial Organization: A Strategic Approach*, 2000, 1st ed., Irwin McGraw-Hill.

Creti, Anna and Bertrand Villeneuve, "Long-Term Contracts and Take-or-Pay Clauses in Natural Gas Markets," *Energy Studies Review*, 2005, 13(1), 75-94.

Crocker, Keith J. and Scott E. Masten, "Mitigating Contractual Hazard: Unilateral Options and Contract Length," *Rand Journal of Economics*, 1988, 19(3), 327-343.

Eisenhardt, Kathleen M., "Agency Theory: An Assessment and Review," *The Academy of Management Review*, 1989, 14(1), 57-74.

Energy Information Administration, "The Global Liquefied Natural Gas Market: Status and Outlook," DOE/EIA Report 0637, 2003.

Hart, Oliver and Bengt Holmstrom, "The Theory of Contracts", in T. Bewley, eds., *Advances in Economic Theory,* 1st ed., Cambridge University Press, 1987, 294-351.

Hauteclocque, Adrien and Jean-Michel Glachant, "Long-Term Energy Supply Contracts in European Competition Policy: Fuzzy not Crazy", 2009, 37(12), Energy Policy, 399-407.

Hubbard, R. Glen and Robert J. Weiner, "Regulation and Long-Term Contracting in U.S. Natural Gas Markets," *Journal of Industrial Economics*, 1986, 35, 31-79.

Hubbard, R. Glen and Robert J. Weiner, "Efficient Contracting and Market Power: Evidence from the U.S. Natural Gas Industry," *Journal of Law and Economics*, 1991, 34(1), 25-67.

Joskow, Paul L., "Contract Duration and Relationship-Specific Investment: Empirical Evidence from Coal Markets," *American Economic Review*, 1987, 77(1), 168-185.

Lafontaine, Francine and Margaret E. Slade, "Inter-Firm Contracts: Evidence." Forthcoming in R. Gibbons and J. Roberts eds., *The Handbook of Organizational Economics*.

Masten, Scott E. and Keith J. Crocker, "Efficient Adaptation in Long Term Contracts: Take-or-Pay Provisions for Natural Gas," *American Economic Review*, 1985, 75(5), 1083-1093.

Masten, Scott E. and Stephanie Saussier "Econometrics of Contracts: An Assessment of Developments in the Empirical Literature on Contracting," *Revue d'économie industrielle*, 2000, 92, 215-236.

Neuhoff, Karsten and Christian von Hirschhausen, "Long-Term vs. Short-Term Contracts: A European Perspective on Natural Gas," Cambridge EPRG Working Paper 05/05, 2008.

Neumann, Anne and Christian von Hirschhausen, "Long-Term Contracts and Asset Specificity Revisited– An Empirical Analysis of Producer-Importer Relations in the Natural Gas Industry," CEEPR Working Paper 06-010, 2006.

Shapiro, Carl, "Theories of Oligopoly Behavior," in R. Schmalensee and R. Willig, eds., *Handbook of Industrial Organization,* 1st ed., Vol 1, Elsevier, 1989, Chapter 6.

Tadelis, Steven and Oliver Williamson, "Transaction Cost Economics." Forthcoming in R. Gibbons and J. Roberts eds., *The Handbook of Organizational Economics*.