Long-term vs. Short-term Contracts:

A European Perspective on Natural Gas

Karsten Neuhoff and Christian von Hirschhausen

September 2005

CWPE 0539 *and* EPRG 05

Long-Term vs. Short-Term Contracts: A European Perspective on Natural Gas

Karsten Neuhoff[1] and Christian von Hirschhausen[2]

July 2005

This paper analyses the economics of long-term gas contracts under changing institutional conditions, mainly gas sector liberalisation. The paper is motivated by the increasingly tense debate in continental Europe, UK and the US on the security of long-term gas supply. We discuss the main issues regarding long-term contracts, i.e. the changing role of the flexibility clause, the effect of abandoning the destination clause, and the strategic behaviour of producers between long-term sales and spot-sales. The literature suggests consumers and producers benefit from risk hedging through long-term contracts. Furthermore long-term contracts may reduce exercise of market power. This was argued to benefit consumers at the 'expense' of producers' profits. Our analysis shows if the long-run demand elasticity is significantly lower than the short-run elasticity, both strategic producers and consumers benefit from lower prices and larger market volume. Some policy implications of the findings are also discussed.

JEL-code: L22, D 43, L95

Key words : contracts, gas, market power, demand elasticity, liberalisation, Europe

1 Introduction

The theory of (long-term) contracts has been in the core of industrial organization and energy economics for a long time, and it is currently experiencing a "renaissance" in the rising debate on supply security in liberalized electricity and natural gas markets (Helm, 2002, Oren, 2003, Neuhoff and De Vries 2004). The role of long-term contracts is particularly debated in the natural gas industry, where continental Europe is currently pondering liberalization following the policy of the U.S. (1980s) and the UK (1990s). Amid rising demand and increasing prices for natural gas around the world, the European Commission has withdrawn its juridical action against long-term contracts between exporting countries and EU-importers, but remains cautious, as do many member states. It is time to

[1] University of Cambridge, Faculty of Economics, e-mail: karsten.neuhoff@econ.cam.ac.uk
[2] DIW Berlin, and Dresden University of Technology, e-mail: chirschhausen@diw.de
The authors thank Anne Neumann, Aarlon Tussig, Sam VanVactor, and an anonymous referee for comments and suggestions; the usual disclaimer applies.

revive the theoretical and policy debates of the 1980s, when MIT conducted the first large-scale study on international gas trade (Adelman, et al., 1986).

This paper has two objectives: first, we provide a balanced discussion of the role of long-term contracts in natural gas markets, both from a theoretical and an empirical perspective. In particular, we discuss what parallels can be drawn between the developments in the US past liberalisation (1980s) and continental Europe today; second, we carry the theoretical debate a step further by explicitly taking into account the difference between the short-run and the long-run demand elasticities. Our model shows that if the long-run demand elasticity is significantly higher than the short-run elasticity, gas producers prefer for an institutional arrangement that allows for long-term contracting.

The remainder of this paper is structured in the following way: the next section provides a survey of the literature on long-term contracts, with a focus on the natural gas industry. Section 3 provides empirical evidence of the developments of long-term contracts and natural gas prices in the US and in Europe; we also derive a stylized relation between the institutional environment regarding liberalisation and the gas price dynamics. Section 4 then develops the model. Based on work by Allaz and Vila (1993) on the nexus between future contracts and market power, we develop a model where oligopolists have a choice to enter long-term contracts or not, and where arbitrage between the long-term market and short-term sales is possible. Allaz and Vila have suggested that consumers benefit from long-term contracting, because at each contracting stage producers sell additional output. The smaller the quantity producers sell subsequently at the spot market, the lower will be their incentive to reduce production and therefore the price will be lower. This low price is anticipated in all previous contracting stages. We show that not only gas consumers but also gas producers might benefit from signing long-term contracts. As the long-term contracts promise lower prices, consumers will place more investment in gas consuming equipment. This expands the market, and thus, long-term profits. The effect hinges on the difference between high demand elasticity in the long-term versus lower demand elasticity in the short-term. Section 5 concludes and derives some policy conclusions.

2 Long-term Contracts: Theoretical and Empirical Approaches

Long-term take-or-pay contracts (ToP) link sellers and buyers for a long period into a bilateral monopoly, generally 15 to 20 years, during which both of them have strictly defined obligations. In particular take-or-pay contracts require purchasers to pay for a pre-specified minimum quantity of gas whether or not that gas is actually taken, and require the producer to deliver this quantity (Masten, 1988). In some regions, such as Europe and Asia, price indexation to oil as alternative fuel used to protect the buyer of gas on a long-term basis against prices above those for the main competing fuels. Risk sharing along the gas chain is settled by which the buyer bears the volume risk and the seller the price risk. On the other side of the scale, short-term trade and spot trade is carried out anonymously, without specific relations between the seller and the buyer.

The optimal contract portfolio (long-term, short-term, spot) is a topic in all commodity markets. In most of the commodity markets, short-term or spot markets have been implemented in the 1980s, and liquid trading has developed. On the other hand, as Newbery (1984) had observed early on, this trading occurs in an environment which is far from being competitive. This is well known in the OPEC-dominated crude oil market, but oligopolistic producer structures also prevail in natural gas, copper, aluminium, iron ore, and others.

Due to the strategic character of natural gas for the energy supply, long-term contracts in this industry have attracted considerable interest for a long time, both in the U.S. and in Europe (Golombek, Hoel and Vislie, 1987). There are three streams in the literature on long-term contracts that can be distinguished:

- The institutional economics literature interprets long-term contracts as a device to avoid the risks of opportunistic behaviour in deals involving high sunk investments, along the lines of Klein, Crawford and Alchian (1978) and Williamson (1983). A higher asset-specificity of investments leads to more hierarchical contract structures, as opposed to market exchange. This literature is also interested in the repercussions between the contract length and the institutional framework, in particular the regulatory regime. Thus, Joskow (1987) shows, using coal contracts, that relationship-specific investments generally lead to longer term commitments between buyers and sellers. In the natural gas industry, Crocker and Masten (1985) and Masten and Crocker (1988) observe that in an inefficiently regulated commodity market, contract duration will be shorter than in an unregulated, competitive market. Mulherin (1986) tested contractual provisions in long-term natural gas contracts and contended that these were not an expression of market power, but rather resulted from attempts to find an inherent competitive bargaining structure. Neumann and Hirschhausen (2004) show that as liberalisation proceeds in the EU, contract durations tend to become significantly shorter; from an average of 25 years (contracts struck in the 1980s), the average is about 15 years in the beginning of this decade;
- the industrial organisation literature analyzes the role of long-term contracts as compared with shorter-term trading. Using an auction model, Parsons (1989) was the first to quantify the "strategic" value of long-term contracts, i.e. the difference between the value of the gas in the long-term contract and the sale price in a more competitive market. Applying the model to long-term contracts in Russia, Norway, and Canada, Parson showed that the value of these contracts to the producer diminishes as the number of wholesale buyers is increased, an event typical for a liberalising gas sector. Along similar lines, Hartley and Brito (2001) applied a search model to derive that the duration of long-term contracts (here: in the LNG-industry) is likely to diminish with decreasing capital expenditures, with an increasing discount rate, falling transport costs, and a larger number of players in the market (suppliers and buyers). The theoretical industrial organization literature mainly addresses the issue in its relation to

market structure, i.e. whether long-term contracting favours competition or collusion. In a finite-horizon model, Allaz and Vila (1993) suggest that forward trading makes markets more competitive. Consumers benefit from long-term contracting, because at each contracting stage producers sell additional output. The smaller the quantity producers sell subsequently at the spot market, the lower will be their incentive to reduce production and therefore the price will be lower. This low price is anticipated in all previous contracting stages. Moving to collusive behaviour, Le Coq (2004) shows that in a setting of long-term contracts, but subsequent repeated interaction on the spot market, the contract market helps to sustain collusion on the spot market. Along similar lines, Liski and Montero (2004) find that in an infinitely-repeated oligopoly, the possibility of forward trading allows firms to sustain collusive profits that otherwise would not be possible; this result holds both for price and quantity competition;

- a third strand of the literature links long-term contract with infrastructure investments. Thus, when assessing the investment question in electricity generation, Oren (2003) argues that in principle price volatility should be mitigated in a well functioning market by forward contracting and other risk management practices, in order to secure long-term investment. However, vertical disintegration and regulation of some segments may result in improper distribution of risk along the electricity supply chain. Oren (2003, 8) concludes that "consequently some regulatory intervention (e.g. facilitating longer-term contracting for capacity), at least on a temporary basis, might be needed in order to achieve socially efficient risk management." Neuhoff and de Vries (2004) point to the question of competitive electricity supply companies – these are restricted from signing long-term contracts with their final consumers to facilitate switching and retail competition. But even without such constraints the Scandinavian experience shows that consumers prefer short-term contracts. Therefore, retail companies are not credible counter parties for long-term contracts with generation companies, because at times of excess supply and hence low spot prices, new retail companies could offer electricity to final customers at lower rates and existing retail companies would be unable to honour their long-term contracts. With competition in gas supply, a similar evolution might be anticipated in the gas sector.

Clearly the discussion on long-term contracts also has a public policy component. Proponents of liberalisation regularly argue that a market based mainly on shorter-term contractual arrangements is compatible with long-term supply security as long as alternative trading arrangements, e.g. through spot markets, can be established. Hartley (2002) argues that liberalisation (in the UK) will not expose the UK to major supply risks concerning (Russian) gas,[3] an opinion apparently shared by Odell (TISC, 2002). On the other hand, critiques (and many practitioners) argue that liberalisation of access to

transmission and downstream infrastructure is incompatible with long-term supply security and that long-term contracts are put at risk by liberalisation (Wybrew, 2002). Without these contracts between exporters and wholesalers, price volatility would increase (Beckervordersandforth, 2004). The price risk for revenues from new gas field increases capital costs and delays investment until expected prices are higher; hence security of supply would be jeopardised. Furthermore the US experience of unanticipated supply shortages in recent years suggests that without large coverage of long-term contracts, aggregate supply is difficult to predict. This is particularly the case as gas producers - both individually and collectively - face an incentive to overstate future gas production in order to prevent entry, increase demand and then capture higher prices in a market with scarce supply.

One might ask whether sellers or buyers have a higher interest in long-term contracts. From a buyers' perspective, an institutional framework with increasing shares of energy bought at spot prices below the long-term contract price is considered favourable. In such a situation, buyers may not be interested in the "luxury" of expensive long-term contracts. The expectation of the disappearing destination clause leads to further expectation of price falls. On the other hand, buyers have an incentive to sign long-term contracts as a barrier to entry for new market entrants. Also, from the perspective of a gas importing country, long-term contracts struck by private importers include a positive external effect, in that they increase the security of supply. Governments may thus be willing to grant importers with long-term contracts specific advantages. The sellers' view on long-term contracts is ambiguous. They are also concerned about the counter-party risk of contracting with commercial entities that might lose their franchised customer base in the process of liberalisation. In this case gas-importing companies committed to higher long-term contracting prices might not be able to bear the risk of enduring low spot prices.

In this paper we shall build upon the theoretical industrial organization literature, in particular the Allaz and Vila (1983) model of forward contracting. Thus we leave aside other (important) topics, such as the institutional aspects, and contract types. We focus on long-term contracts at fixed prices. Further, we do not differentiate between long-term contracts and forward contracts but only require that either type cover a period exceeding the time required to build new production and transmission facilities. Producers that own the physical assets to deliver the gas can best carry the risk involved in forward contracts for gas imports to Europe for approximately ten years – hence producers would serve as main counter-party both for forward contracts and long-term contracts. The main difficulty with such long-term contracts is the counter-party risk. Frequently, contracting parties are concerned that the counter party will abandon the contract if it is more profitable to sell the gas in the spot market.[4] With the emergence of liberalisation, and of additional liquefied natural gas (LNG) supply,

[3] "There are good sources of gas available from close neighbours. … On the basis of reliable projections, the next 20 years do not look like years of real difficulty for the UK." (Hartley, 2002, 23).

[4] For example, OPEC countries did not honour long-term contracts for oil exports when the spot price significantly exceeded the contracted price in 1979. As oil-exporting countries, the loss of reputation as financial credible counter parties had little implication as they did not need to access credit markets. At the same time they did not worry about punishment strategies as

the number of potential buyers is larger, and hence it is more likely that contractual arrangements will build on a flexible price; this observation is confirmed by traders (Cahagne, 2004).

3 Some Empirical Evidence: the U.S. and Europe

The liberalisation of the gas industries in the U.S. (1980s), the UK (1990s) and in continental European Union (ongoing) definitely impact the role of long-term supply contracts. We therefore analyze the developments of contracts and prices in the U.S., and look for similarities and differences with the current situation in continental Europe. We also derive a stylised relation between the institutional framework of the industry and the natural gas price, and discuss the current price structure prevailing in Europe.

3.1 U.S. experience

The US commenced liberalisation in the 1980s from a position of excess production capacity. Investment was further facilitated by a multi-tier price structure, put in place as a result of the gas shortage in the 1970s, that provided extra rewards for the development of new gas fields. The 1970s and 1980s were characterized by a complex web of field price regulation, fuel use restrictions and allocation rules, etc. Pipelines and gas distribution companies were obliged to rely on long-term contracts. In fact, the federal regulator (FERC) would not approve the construction of new pipelines without long-term gas supply and sales contracts in place.

Liberalisation started with the Natural Gas Policy Act in 1978, which ended Federal control over wellhead prices of "new" gas as of 1985 (but kept in place wellhead price controls for previously contracted gas, IEA, 1998, 71 sq.). In 1985, FERC order 436 paved the way for competition by opening up access to the pipeline system. Subsequent orders continued the path of liberalisation, notably the "final restructuring" FERC order 636 (for a detailed account, see IEA, 1998). Natural gas consumption fell until 1986, but picked up thereafter as prices fell.

In the decade following liberalisation, excess production capacity led to lower spot pricesFigure 1 shows the development of natural gas wellhead prices (real terms) in the U.S. between 1982 and 2004 - the period shortly before and after liberalisation.[5] Falling gas prices also resulted from weak demand for natural gas. Both industrial consumption and utility consumption hit a trough in 1986/87.[6] External supplies furthermore contributed to price reductions: Canadian pipeline gas exports to the U.S. increased in the late 1980s, and peaked only in 2000/01, to decline gradually thereafter. The sustained period of low prices came to an end in 2000, and most notably already before the Californian crisis,

---

they could sell oil on the spot market to various parties. This experience is unlikely to directly translate to gas, as gas transport is cheapest by pipeline, and hence it is easier for importing companies to retaliate if a gas exporting country abandons a long-term contract. The experience with gas imports into Europe confirms that even during crisis times, the gas exporters put in significant efforts to honour their commercial contracts.

[5] Source: EIA. Note that price developments before 1982 were characteristic, too, with flat or only slowly rising prices until the early 1970s, which can be attributed to an oversupply of gas and only gradually increasing marginal costs. Gas prices exploded in 1973, parallel to the first oil shock.

[6] We are thankful to a referee for historical details on the U.S. natural gas market.

both driven by increased demand for newly built combined cycle gas turbines and subsequently lower than expected gas production.

Following FERC Order 436 (1985), long-term contracts were no longer administratively required, and were largely abandoned. The share of gas supplies through long-term contacts was reduced from about 100% to below 50%. Until 1991, the average contract volume fell from 1.27 cm/a to 0.24 bcm/a (International Energy Agency, 1998, 83). As gas demand picked up, and the „cheap" gas had been sold, prices rose once again. Prices were volatile, as heating demand varies with climatic conditions. Then, in the first years of this decade, North America was suddenly faced with rising prices, and hence an attempt to assure long-term contracts, both for pipeline gas and for LNG. Compared with the price level of the 1990s, prices have stayed high in the first half of this decade. NYMEX Futures price predictions indicate little change in the coming years: forward prices for 2010 are slightly higher than high prices of spring 2005 (December 2010 forward at about 6.50 USD/MBTU). The U.S. Energy Information Agency (EIA) expects prices in 2025 to be at a similarly level.[7]

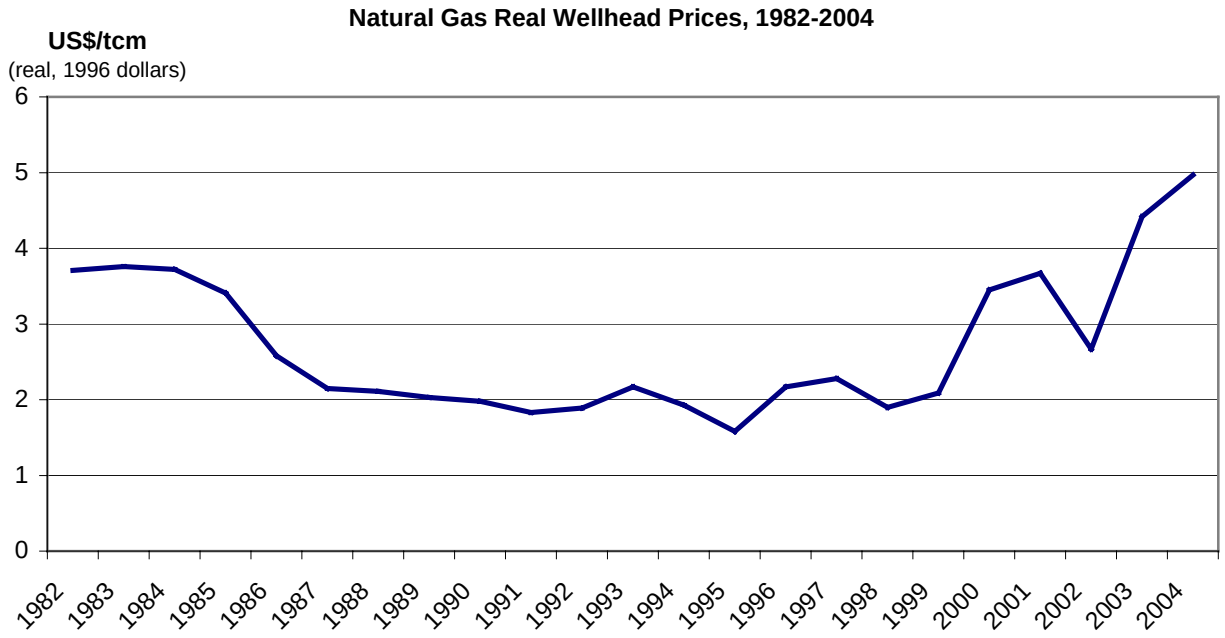

Figure 1: U.S. natural gas wellhead prices, 1982-2004

Source: Energy Information Agency (EIA)

[7] EIA (2005): Petroleum and Natural Gas Forecasts. url http://www.eia.doe.gov/oiaf/petgas.html (called on the 27 May, 2005).

3.2 A stylised model of price dynamics

We now turn to the description of an ideal pattern of price developments from a world of excess supply and (regulated) long-term contracts, to a liberalised world, and moving on to a world of lacking long-term contracts. Figure 2: stylizes such a development: in the "old" world of cost-plus regulation (plus eventually regional monopoly concessions), gas trade was dominated by long-term contracts. Moreover, most contracts contained a flexibility clause, which was an additional driver against competitive entry. Now assume that liberalisation starts. Initially the entire market can be satisfied by the gas contracted in long-term contracts using the flexibility clause option. Sellers collude not to sell additional gas on the spot market, which is facilitated by the contract clause not to resell gas obtained on long-term contracts ("destination clause"). With decreasing contracting volumes and increasing demand, either the gas supplied on the take or pay plus flexibility contract does not satisfy demand, or some producer tries to increase its market share by selling outside of the flexibility clause. As it is observed by competitors, they follow the strategy and hence increasing gas volumes are sold at the spot market at decreasing prices. In the third period we can envisage two scenarios. Either the investment in production and transmission capacity decreases due to low spot prices and lack of new long-term contracting, such that marginal production costs and hence gas prices increase again. Alternatively, sellers sell a sufficiently small fraction of their gas on long-term contracts, to have large shares of their revenue dependent on the gas spot market price. In this scenario they are more likely to reduce output again to increase the spot market price. It is difficult to anticipate which of these two mechanisms will push up prices in period three.[8] The price level will then depend on whether the institutional arrangement facilitates long-term contracts. Should this not be the case, then prices are likely to continue to rise.

[8] In the US with a large share of independent producers the price increase is usually associated with scarcity of production capacity rather than strategic behaviour.

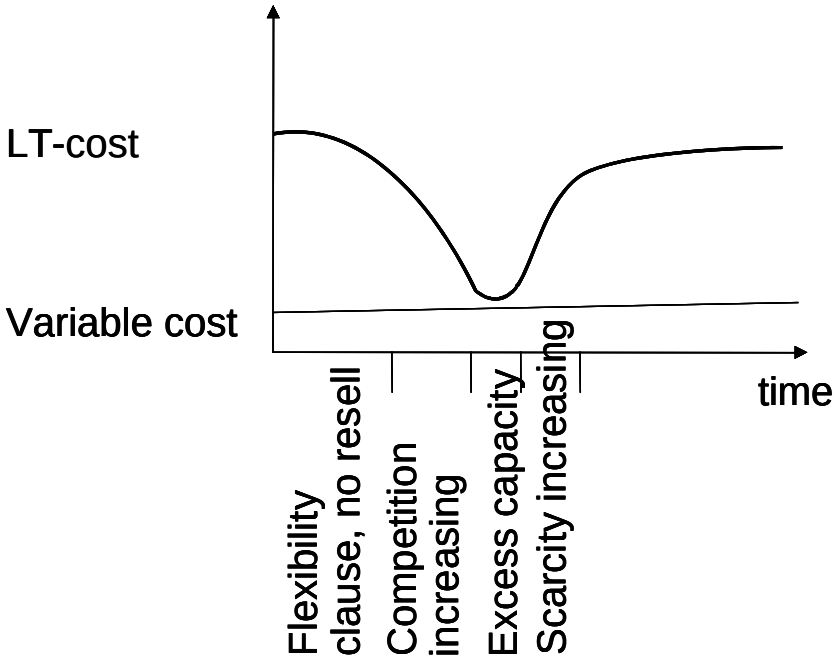

Figure 2: Stylised relation between the institutional context, contract structure, and the gas price

3.3 European experience

We are interested whether the development of long-term contracts in the U.S. is a singular event, or whether there are similarities to be expected in Europe. To some extent, the situation in Europe today resembles the situation in the U.S. one and a half decades ago:

- Until recently, there was an oversupply of gas in Europe ("gas bubble"). Economic growth was lower than expected. Also, the gas prices linked to oil prices, slow liberalisation of gas transmission and balancing made gas generation more expensive, and prevented a full shift from coal to gas, the way observed in the UK. Third, previous regional monopolies had a strong incentive to ensure sufficient supply and might have over-contracted. This was exuberated as no exchange with neighbours was anticipated to resolve unilateral gas shortage;
- a second aspect is the attempt by the European Commission to liberalise the industry following the EU-Directive 98/30/EC (1998), repealed in 2003 by the "Acceleration Directive" 2003/55/EC. The Acceleration Directive advocates third-party access to all essential facilities along the value-added chain (LNG-terminals, pipelines, storage, etc.), but also contains the possibility to grant exemptions, e.g. in cases where TPA would lead to „financial difficulties" of the incumbent, or to distress regarding the security of supply (Art. 21 of the Directive);
- a third similarity is that as in the U.S, in Europe the volume of gas contracted on a long-term basis is shrinking. Given that the average size of the contracts has not changed significantly, the drop in contracted import volume results from a shortening of the average contract length,

from about 25 years in 1985, down to about 15 years (cf. Stern, 2002, and Neumann and von Hirschhausen, 2004, for a quantitative analysis);[9]

- both Europe and the U.S. also have shared characteristics resulting from the emergence of international trade in LNG (liquefied natural gas). LNG is still slightly more expensive than pipeline gas, but costs are coming down. LNG has a much higher flexibility of supply: tanker capacities for transporting LNG is increasing, and an intensification of international trade is expected, eventually even the development of a deep spot market. The current role of LNG for EU imports is small (~ 10%) but rising, and it is important in specific countries, e.g. Spain and France, where LNG accounts for 60% and 25% of total imports, respectively (see IEA 2004, for details);
- another indication for the changing nature of the European market is the evolution of the "flexibility clause", which used to be an integral part of any long-term contract. The flexibility clause covered deliveries above the obligatory take-or-pay element in long-term gas contracts (the latter typically consisted of 80% of the nominal quantity of the contract). The option provided for an increase in delivery by 40%-points of the nominal quantity of the contract (therefore up to 120% of initial quantity) at a similar price level. The flexibility clause was also a method to commit producers to sell output above the long-term contract (80% of nominal level) at the indexed price, because all energy sold within the contract arrangement was sold at the predetermined price. Gas sector liberalisation, coupled with oversupply of gas, weakens the strategic role of the flexibility clause. This was the case in the U.S. in the 1980-90s, and it is now increasingly observed in European long-term contracts. The flexibility clause is increasingly substituted by spot market purchases by the large trading companies. Traders confirm that they have shifted a significant part of their supply to spot markets, besides the National Balancing Point in the UK, on the continent this is Zeebrugge, but also the TTF and others. The proportion of contracts with spot prices is estimated to range from 15 to 20%. Trading companies expect the share of spot sales to increase further.

A comparison of current conditions in Europe with those in the U.S. implies that there is a good chance that Europe is experiencing a similar trend as the U.S. As the liberalisation of the European gas markets started with excess production capacity, we observe that the spot market prices, e.g. at Zeebrugge, were below the long-term contract prices until recently. Figure 3 illustrates that the prices

[9] This might indicate that contracts mainly cover output from existing fields and only very profitable additional investment is funded. In contrast to the US with rather competitive gas production, European gas supplies are imported from regions which still have in place mechanisms to coordinate national export quantity, like the state monopoly on transmission capacity in Russia, Algeria's state-owned gas industry, or even the Norwegian state-controlled gas export cartel (until recently).

deviate particularly during times of low gas demand (i.e. in the summer months).[10] From March 2001 till September 2003, spot prices were significantly below long-term prices as defined by pipe import prices. In particular, since September 2004, Zeebrugge spot prices have skyrocketed, to almost the equivalent of 6-7 USD/mBTU, whereas pipeline import prices, linked to lagged oil prices increases, are climbing only gradually. Also note that given U.S. forward prices of 6.50 USD/mBTU for 2010, there is a strong continuous upward pressure on European prices due to the competition for LNG in the Atlantic basin.[11]

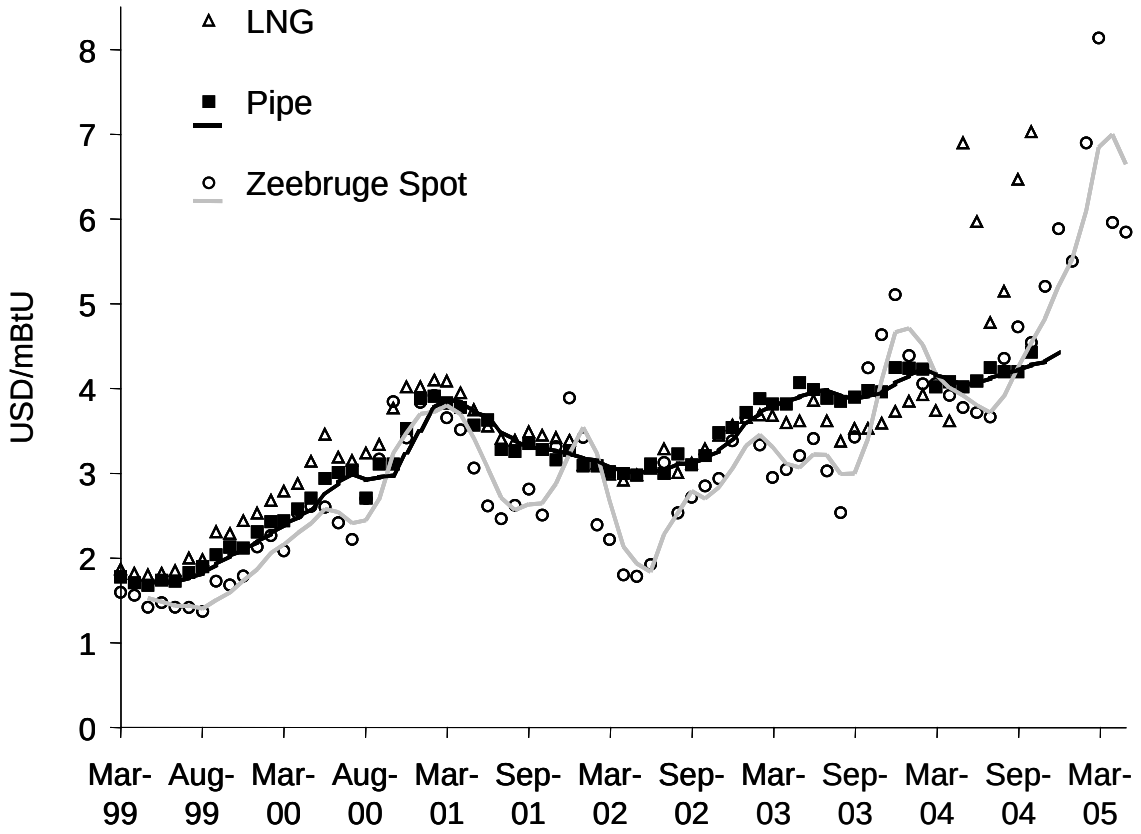

Figure 3: European gas prices: long-term gas imports and spot prices

Source: Heren Report

[10] We also observe that prices for imports via pipeline and LNG largely resembled each other until recently; whereas LNG import prices used to be slightly higher than pipeline gas imports, they were at par since 2001, indicating the increasing role of LNG in the European market. It is not clear what caused the high LNG import prices since summer 2004.

[11] An important companion issue that we have not treated in this paper, is the future price indexation of gas contracts. The current long-term contracts in Europe link the gas price to the oil price. The linkage increases incentives for large producers of both oil and gas to reduce oil production as they will benefit not only on the oil but also on the gas sales. The linkage furthermore facilitates negotiations for all gas producers, as it establishes a gas price on which to coordinate. However, the linkage has the disadvantage, both for exporting countries and most buyers, of producing volatile revenue and cost streams. It is expected that reduction of short-term substitutionopportunities between oil and gas that partially motivated the linkage, will result in a gradual or even a sudden shift away from the explicit oil-gas linkage. We could envisage that future long-term contracts will phase out the linkage, by either setting tighter upper and lower bounds up to which the gas price follows the oil price or by increasing the gas price only by a fraction of an oil price increase. In fact, this decoupling can be observed in recent long-term contracts, both for pipeline gas (Centrica-Statoil contract of 2002, indexed to the NBP), and for LNG (2004 Rasgas contracts, indexed to the Zeebrugge spot price).

Given the concentration of gas supply companies one might have expected that they withhold output during these times to retain higher spot market prices. As argued above the flexibility clause of the existing long-term contracts might have served initially as a commitment device not to sell outside of these long-term contracts and hence could have facilitated retaining high spot market prices until 2001. As less long-term contract volumes are signed, gas exporters have less incentive to keep spot prices high to increase long-term contract prices. At the same time a large fraction of sales are covered withexisting take or pay contracts. Exporting countries only sell a small fraction of their output in the short-term market and hence face little incentives to keep spot prices high and hence spot prices dropped towards competitive levels at short-run marginal costs.

3.4 Scenarios for Europe, short-run and long-run

As argued in the last section, the volume of long-term contracts in Europe has fallen and is likely to continue to fall. Assume that for some time total production capacity will suffice to satisfy gas demand at short-run marginal production costs below today's price level.[12] Several changes could increase competition in the European gas market. If LNG prices continue to fall and LNG import capacities increase, then this could result in additional competition. Alternatively, if the Energy Charter or other developments induce Russia to grant free access to pipeline transmission capacity, then competition among Russian gas producers and exporters could increase. If Algeria goes ahead with privatisation of its oil and gas industry, then large foreign investments could increase its production capacity, and several exporting companies may emerge. Finally, new pipelines could allow gas producers from the Persian Gulf or the Caspian Sea to enter the European market.

While the previous list considers the impact of changes outside of the European gas market on the competition between gas exporters, one can expect that the structure within the European gas market also influence how gas producers compete in supplying to the European market. One of the current obstacles for competition in the European market is the destination clause. Most long-term contracts between gas-exporters and European gas utilities bar buyers from reselling the gas to third parties other than final private and industrial consumers within their territory. In the appendix, we illustrate how the destination clause allowed gas producers to profitable price discriminate. The destination clause impacts competitiveness not only through prices, but also through a second channel, in that it reduces liquidity in the European gas market.[13]

The impact of some or all of these evolutions implies that – ceteris paribus – short-term prices will settle below the equilibrium price observed if all long-term contracts were abandoned. Strategic

---

[12] If this assumption is not satisfied, then we will directly move to the scenario where prices increase, as described above.

[13] If liquidity is lower, then it will be easier to identify individual transactions and also deviations from the collusive equilibrium. It is possible that the collusion takes the form of an (implicit) agreement among gas producers to serve distinct

producers reduce output from the competitive level until the marginal revenue loss of additional output reductions equals the gains on price increase of the remaining output. If some of the output is sold on long-term contracts, then the gains of a price increase on the remaining output is smaller, and the strategic producers are less prepared to accept losses on his output and will sell more output at lower prices. Hence the increase of competition can result in a larger price decrease if some of the output is still sold on long-term contracts than if all output were to be sold in spot sales. If however gas-spot prices fall significantly below long-term contract prices in a liberalised European natural gas market, and if the owners of the long-term contracts do not have long-term contracted or captive customers, then the gas producers will have to renegotiate their long-term contracts to a lower price. In such a situation the gas producers would be exposed to the price reduction on their entire output and, hence, be more inclined to retain high prices as they anticipate that price changes not only impact short-term sales but might also feed through to long-term sales.

We now turn to the discussion of the long-term perspectives for Europe. We envisage that with limited long-term contracting, investment in gas production and import capacity will stay low and hence marginal production costs will increase, pushing up spot prices. International gas supply with a large fraction of the supply not covered by long-term contracts will create the following difficulties. First, with fewer long-term contracts there is a lack of long-term information about future production capabilities and costs.[14] As much of European gas is imported from countries with far less openness in the information policy, uncertainty about predictions of future gas supplies is likely to be even higher. In addition if countries like Russia sell large fractions of their output on short-term contracts, then they have an incentive to overstate future gas production capacity to ensure high gas demand and low investment by competitors.[15]

Second, going beyond the commercial to the political framework, experience shows that gas producer countries were so far eager to honour their contractual arrangements and hence long-term contracts are of importance in ensuring that energy delivery, even from instable regions, is not interrupted.[16] If we assume that gas producers within some of the producer countries can cooperate and hence individual companies can contribute significant shares to the overall production quantity, then long-term contracting can help to reduce this market power. If contracts are signed sufficient years before the

---

regional sub-markets. Such an agreement only is useful in the context of the destination clause. Hence, to the extent that relaxing the destination clause could be seen to reduce the likelihood of a collusion, all consumers will benefit.

[14] In that respect, it is worth noting that even in countries which publish a lot of information, like the UK and USA, the predictions about medium and long-term gas supply have changed within the period of only one or two years, eg Kemp (2002) for forecasts on UK gas production, and EIA (2004) for the U.S.; Costello, Huntington, and Wilson (2005) report changes of demand projections of similar magnitude for the U.S.

[15] If subsequent production is below the announced level, then Russian gas producers benefit from the higher gas prices. In contrast, if Russian production were fully covered by long-term contracts, then Russian producers would have a strong incentive to produce the contracted amounts, otherwise they might have to acquire replacement gas in a short market to honour their contracts.

[16] If gas would be sold in short term contracts, then political developments would be more likely to induce governments to interrupt gas exports or pipeline transit. Without long-term contracts such activity would not constitute a breach of international agreements, and impact the credit ratings of the respective country or jeopardise future gas trade with the limited number of importing countries that are accessible via pipeline.

delivery date then the number of competitors is larger. Gas projects in third countries either with pipeline or LNG delivery could offer viable alternatives. Likewise small producers could offer to expand their production if long-term prices make such projects viable.

4 The Model: Long-term and Short-term Demand

Our model builds on Allaz and Vila (1993) who suggested an additional reason why contracting might reduce market power. Allaz and Vila show that in a Cournot setting, oligopoly producers with the opportunity to sell future output during several contracting stages will sell some of this output at each stage to pre-empt competitors. Hence to pre-empt the market they will sign long-term contracts, even though in their model the aggregate impact is that the volume of output traded in the final spot market is low and hence the incentive to withhold output is likewise low. The resulting low spot prices are anticipated and hence even the long-term contracts are signed at lower prices. If producers could collude not to sign long-term contracts, then they would be better off while it is individually rational to sign some long-term contracts at every contracting stage.

While the previous argumentation pointed to benefits for consumer countries from long-term gas contracts, it is likely that producer countries, too, can benefit from long-term contracts. One assumption inherent in the Allaz and Villa argumentation is that long-term and short-term demand elasticities coincide. However, in the long-term both industry and consumers invest in new production facilities and renovate heating installations. This typically determines the fuel type. Thus, the expected long-term energy price of gas has a large impact on the future gas demand. By contrast, in the short run only few electricity generators and industrial installations can switch between different fuel types and most of production and consumption decisions are only influenced by the energy price to a small degree. Hence short run gas demand is rather price inelastic.

The following model assesses the impact of differing long and short run demand elasticity. It will show that oligopoly producers benefit from long-term contracts. Without long-term contracts all gas will be sold in the short-term market and given the low short-term demand elasticity the oligopoly producers will charge high prices. In expectation of these high prices consumers will not choose gas as their fuel and hence oligopoly producers will sell low quantities. With the opportunity to sell gas with long-term contracts producers already commit some of their output. Hence they will sell less output in the short-term market and face smaller incentives to withhold output in the short-term market. Accordingly the short-term price is lower. The lower short-term price feeds back to the long-term market. As prices are lower more consumers choose gas as fuel and oligopoly producers serve a larger market. If the difference between short-term and long-term demand elasticity is large enough, then profits of oligopoly producers increase with long-term contracting.

We use a two-stage model (Figure 4). Oligopoly producers decide on the quantity x_i they sell forward. Consumers determine their investment in long-term equipment and thus set the expected demand Q_e. In the short term market producers sell output q_i-x_i and the market clearing price p_s is established. We assume complete information, perfect foresight and no uncertainty.

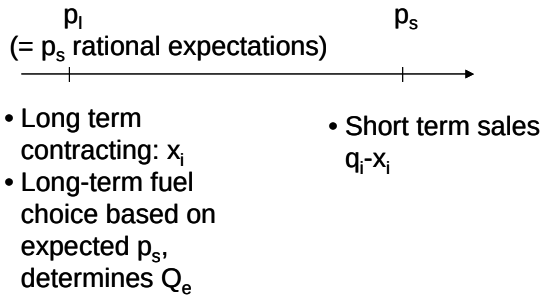

Figure 4 Time line of two stage contracting game

Assuming that total production and consumption is Q, then the inverse long-term demand curve is given by demand intercept A and demand slope b:

$$p_l = \frac{A-Q}{b}. \qquad (1)$$

Short-term demand is more price responsive and hence demand slope scaled by $\gamma > 1$ and demand intercept shifted to A':

$$p_s = \gamma \frac{A'-Q}{b}. \qquad (2)$$

We assume rational expectations and hence require that the long-term price (1) coincides with the short-term price (2) at the expected production Q_e. Hence it follows that $A' = \frac{A+(\gamma-1)Q_e}{\gamma}$ and (2) turns into

$$p_s = \frac{A+(\gamma-1)Q_e}{b} - \gamma\frac{Q}{b}. \qquad (3)$$

To facilitate the calculations, we assume constant marginal costs, which we can normalise to zero, and *n* symmetric producers with production q_i of which x_i is long-term contracted. We solve the model using backward induction and start with profit function of each of the producers in the spot market. At this stage the contract volume x_i and the expected production Q_e are fixed:

$$\pi(q_i) = (q_i - x_i)p_s.$$

Substituting from (3) and using the first order condition to identify the profit maximising output quantity we obtain:

$$0 \equiv \frac{\partial\pi(q_i)}{\partial q_i} = -\gamma\frac{2q_i - x_i + (n-1)q_j}{b} + \frac{A+(\gamma-1)Q_e}{b}. \qquad (4)$$

Producers anticipate in the long-term market their impact of contracting on their own output q_i and others' output q_j. We calculate both by substituting $Q_e=(n-1)q_j+q_i$ in (4). A similar calculation also gives q_j:

$$q_i = \frac{A+\gamma x_i-(n-1)q_j}{1+\gamma} \qquad q_j = \frac{A+\gamma x_j-q_i}{\gamma+n-1}.$$

Solving these two equations for the q_i, q_j gives:

$$q_i = \frac{A+(x_i-x_j)(n-1)+\gamma x_i}{n+\gamma} \qquad q_j = \frac{A-x_i+x_j+\gamma x_i}{n+\gamma}. \tag{5}$$

The expressions for the short-term equilibrium allows us to calculate the long-term contracting decisions x_i of producers in the first stage, using (1) for p:

$$\pi(x_i) = q_i(x_i)p = q_i(x_i)\frac{A-(n-1)q_j(x_i)-q_i(x_i)}{b}. \tag{6}$$

Substituting (5) in (6), differentiating with respect to x_i to obtain the profit maximising long-term contract volume and then using the symmetry among all producers gives:

$$x_i = \frac{n+\gamma-2}{(n+1)\gamma+n^2-n}A. \tag{7}$$

And the corresponding equilibrium output quantity, price and profits are:

$$\begin{aligned} q_i &= \frac{n+\gamma-1}{(n+1)\gamma+n^2-n}A \qquad p = \frac{A}{b}\frac{\gamma}{(n+1)\gamma+n^2-n}. \\ \pi &= \frac{A^2}{b}\gamma\frac{n+\gamma-1}{\left((n+1)\gamma+n^2-n\right)^2} \end{aligned} \tag{8}$$

Alternatively, if no long-term contracts are signed, the equilibrium output quantity and prices can be obtained by setting $x_i=0$ in (5).

$$q_i = \frac{A}{n+\gamma} \qquad p = \frac{\gamma A}{b(n+\gamma)} \qquad \pi = \frac{A^2}{b}\frac{\gamma}{(n+\gamma)^2}. \tag{9}$$

Figure 5 compares profits in both cases as relationship between long-term and short-term demand elasticity γ changes for fixed A = 10, b=1 and n = 2. For small γ the market power mitigating effect of long-term contracting dominates and producers benefit from pure spot market trading. If γ exceeds 4.8, then the benefits of the larger market dominate and oligopolists benefits from long-term contracting.

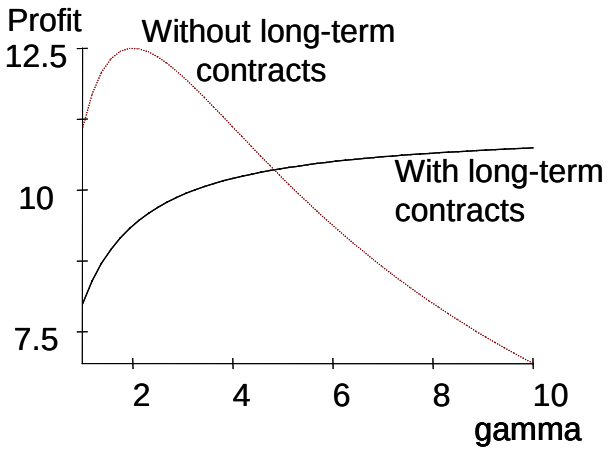

Figure 5 Total profits of oligopolists in market with and without long-term contracting

Consumers continue to benefit from long-term contracting for all γ, as prices are lower under long-term contracting (8) than with pure spot sales (9). Likewise well-fare is always higher with long-term contracts, as the deadweight loss of market power increases monotonously in the excess of market price over production costs.

Comparing the profits of producers in the scenario with and without long-term contracts shows that the ratio γ of short-term to long-term demand elasticity required to ensure producers benefit from long-term contracting is only a function of the number of producers n. As the analytic expression is too complex, Figure 6 shows the numeric result. With an increasing number of players long-term demand hast to be increasingly more elastic relative to short-term demand.

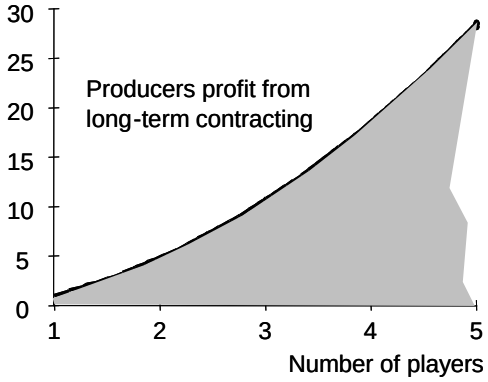

Figure 6 Critical ratio of long-term to short-term demand elasticity

The empirical evidence on demand elasticity is scattered. Al-Sahlawi (1989) reports that the ratio of long-run price elasticity to short-run price elasticity is in the range of 4-5 for industrial gas demand, and in the range of 5-10 for residential and commercial natural gas demand. Estrada and Fugleberg (1989) report similar ratios in a comparative study on natural gas price elasticities in France and in Germany. Overall, the long-term perspective suggests that in markets with a duopoly structure consumers and producers benefit from the strategic function of long-term contracts.

5 Conclusion

In this paper we have discussed the economics of long-term gas contracts both from a theoretical point of view, and with particular emphasis on the situation in Europe. Lessons from the U.S. suggest that the scope for long-term contracts is reduced in the aftermath of liberalisation. However, as time passes on, supply may become shorter, prices may rise, and large consumers and wholesale traders may become weary of the situation, and are then more willing to re-engage in long-term contracts. Our model shows that producers also have a strategic incentive to engage in long-term contracts if long-run price elasticity of demand is significantly higher than the short-run demand elasticity.

Given the structural changes that the European natural gas industry is currently undergoing, one can conclude that long-term contracts will remain an important element of the European natural gas industry, but that in the short term, their role in the supply mix is likely to diminish. The relevant policy question to which our paper hints is: what institutional arrangement would be most appropriate to ensure that one can sign long-term contracts with producers in gas-exporting countries, while at the same time reaping the benefits from gas sector liberalisation?

6 References

Adelman, M.A., C. Blitzer, L. Cox, M. Lynch, J. Parsons, D. White, and A. Wright (1986): Western Europe Natural Gas Trade. MIT, Center for Energy Policy Research (International Natural Gas Trade Project Report).

Allaz, Blaise and Jean-Luc Vila (1993): Cournot Competition, Forward Markets and Efficiency, Journal of Economic Theory, Vol. 59, 1-16.

Al-Sahlawi, Mohammed A. (1989): The Demand for Natural Gas: A Survey of Price and Income Elasticities. Energy Journal, Vol. 10, No. 1, 77-90.

Beckervordersandforth, Christian (2004): Demand and Gas Supply in Europe. Berlin, Presentation at the 3rd ASPO Conference.

Cahagne, Francois (2004): LNG Regional Markets vs. OPEC Gas. Berlin, Presentation at the 3rd ASPO Conference.

Costello, Ken, Hillard G. Huntingon, and James F. Wilson (2005): After the Natural Gas Bubble: An Economic Evaluation of the Recent U.S. National Petroleum Council Stud. The Energy Journal, Vol. 26, No. 2, 89-110.

Crocker, Keith J., and Scott E. Masten (1988): Mitigating Contractual Hazards: Unilateral Options and Contract Length. RAND Journal of Economics, Vol.19, No.3, 327-343.

Energy Information Administration (2004): Annual Energy Outlook 2004 with Projections to 2025. Washington, D.C.

Estrada, Javier, and Ole Fugleberg (1989): Price Elasticities of Natural Gas Demand in France and West Germany. Energy Journal, Vol. 10, No. 3, 77-90.

Golombek, Rolf, Michael Hoel, and Jon Vislie (eds.) (1987): Natural Gas Markets and Contracts. North-Holland, Elsevier Science.

Hartley, Nick (2002): The Performance and Innovation Unit Energy Review. in Helm, Dieter (ed.): Towards an Energy Policy. Oxford, Oxera Press.

Helm, Dieter (ed.) (2002): Towards an Energy Policy. Oxford, Oxera Press.

International Energy Agency (1998): Natural Gas Pricing in Competitive Markets. Paris, IEA/OECD.

International Energy Agency (2004): Security of Gas Supply in Open Markets: LNG and Power at a Turning Point. Paris, IEA/OECD.

Joskow, Paul L. (1987): Contract Duration and Relationship-specific Investments: Empirical Evidence from Coal Markets. American Economic Review, Vol. 77, No. 1, 168-185

Kemp, Alex, and Linda Stephen (2002): Gas Production, Imports and Networks. in: Helm, Dieter (ed.): Towards an Energy Policy. Oxford, Oxera Press.

Le Coq, Chloé (2004): Long-Term Supply Contracts and Collusion in the Electricity Market. Stockholm, SSE/EFI Working Paper Series in Economics and Finance No 552

Liski, Matti, and Juan-Pablo Montero (2004): Forward trading and collusion in oligopoly. University of Helsinki, mimeo, and SESSA Working Paper No. 11.Masten, Scott E. (1988): Minimum Bill Contracts: Theory and Policy. The Journal of Industrial Economics, Vol. 37, 85-97.

Masten, Scott E. (1988): Minimum Bill Contracts: Theory and Policy. The Journal of Industrial Economics, Vol. 37, 85-97.

Masten, Scott E., and Keith J. Crocker (1985): Efficient Adaptation in Long-Term Contracts: Take-or-Pay Provisions for Natural Gas. American Economic Review, Vol.75, No.5, 1093-1093.

Mulherin, J. Harold (1986): Complexity in Long-term Contracts: An Analysis of Natural Gas Contractual Provisions. Journal of Law, Economics, and Organization, Vol. 2, 105-117.

Neuhoff, Karsten, and Laurens de Vries (2004): The Development of Generation Capacity in Liberalized Electricity Markets. Utilities Policy, Vol. 13, No. 3.

Newbery, David (1984): Manipulation of Futures Markets by a Dominant Producer. in: Anderson, Richard (ed.): The Industrial Organization of Futures Markets. Lexington, MA, Lexington Books.

Neumann, Anne, and Christian von Hirschhausen (2004): Less Gas to Europe? An Empirical Assessment of Long-term Contracts for European Energy Supply. Zeitschrift für Energiewirtschaft, Vol. 28, No.3, 175-182.

Oren, Shmuel (2003): Ensuring Generation Adequacy in Competitive Electricity Markets. Berkeley, University of California Energy Institute WP 007.

Parsons, John E. (1989): Estimating the Strategic Value of Long-Term Forward Purchase Contracts Using Auction Models. Journal of Finance, Vol. 44, No. 4 (Sept.), 981-1010.

Stern, Jonathan (2002): Security of European Natural Gas Supplies. London, the Royal Institute of International Affairs.

TISC (2002): Security of Energy Supply. Annex "The UK Gas Industry in the Long-Term and the Liberalisation of European Markets: An Alternative Analysis by Professor P R Odell". London, Second Report of Session 2001-02, HC 361-I, House of Commons Trade and Industry Select Committee, February.

Williamson, Oliver E. (1983): Credible Commitments: Using Hostages to Support Exchange. American Economic Review, Vol. 73, No. 4 (Sept.), 519-540.

Wybrew, John (2002): The Security of Future Gas Supplies for the British Market: The Need for Adequate Gas Infrastructure. in: Helm, Dieter (ed.) (2002): Towards an Energy Policy. Oxford, Oxera Press, 199-214.

Appendix

We will assess how the destination clause allows producers to profit from price discrimination, and a potential consequence of abandoning the destination clause.

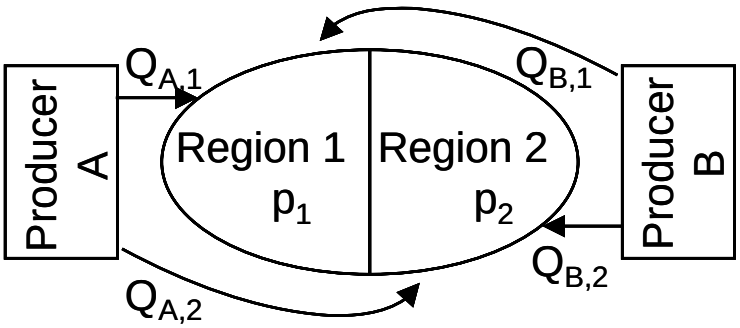

Figure 7: A model to assess the impact of the destination clause

We assume that Europe consists of two regions *i=1,2*, (see Figure 7), each with demand D_i which is for algebraic simplicity assumed to be a linear function of the regional price p_i.

$$D_i(p_i) = A_i - b_i p_i \qquad (1)$$

Two gas producers with constant and identical marginal costs, c, deliver energy to both markets (see Figure 7). Producer A incurs unit costs t_i to deliver to region i. Producer B incurs costs t_1 to deliver to region 2 and t_2 to deliver to region 1.The profits of producer 1 are therefore:

$$\pi_A=(p_1-t_1-c)Q_{A,1}+(p_2-t_2-c)D_AQ_{A,2}. \quad (2)$$

Using $D_i=Q_{A,i}+Q_{B,i,}$ in (1) substituting in (2) and differentiating with respect to p_i gives the optimal output quantities conditional on the production of producer B:

$$Q_{A,1}=\frac{A_1-Q_{B,1}-b_1(t_1+c)}{2} \qquad Q_{A,2}=\frac{A_2-Q_{B,2}-b_2(t_2+c)}{2}. \quad (3)$$

Using the symmetric equations for producer B and substituting $Q_{B,i}$ in (3) gives:

$$Q_{A,1}=\frac{A_1-b_1(2t_1-t_2+c)}{3}, \quad Q_{B,1}=\frac{A_1-b_1(2t_2-t_1+c)}{3}, \quad p_1=\frac{A_1}{3b_1}+\frac{t_1+t_2+2c}{3} \quad (4)$$

Equation (4) and symmetric equations for sales to region 2 can be used to calculate the equilibrium profits for producer A:

$$\pi_A=\frac{1}{b_1}\left(\frac{A_1-b_1(2t_1-t_2+c)}{3}\right)^2+\frac{1}{b_2}\left(\frac{A_2-b_2(2t_2-t_1+c}{3}\right)^2. \quad (5)$$

If we now relax the destination clause, then producers face the aggregate demand:

$$D=A_1+A_2-(b_1+b_2)p. \quad (6)$$

and identical transmission costs for export to both countries. A similar calculation as before gives for the profit of producer A:

$$\pi_{A,R}=\frac{1}{b_1+b_2}\left(\frac{A_1+A_2-(b_1+b_2)(t+c)}{3}\right)^2. \quad (7)$$

First, assume regions and transmission costs are symmetric. $A_1=A_2$, $b_1=b_2$, $t_1=t_2$. In this case we obtain that $\pi_{A,R}=\pi_A$, therefore relaxing the destination clause has no impact on profits and, as can be shown, on output and consumption.

Second, assume transportation costs are symmetric $t_1=t_2$, but region 2 is half the size of region 1 with similar composition of customers and, thus, elasticities: $A_1=2A_2$, $b_1=2b_2$. We again obtain that $\pi_{A,R}=\pi_A$.

Third, assume that demand is more elastic in region 2. $A_1=A_2$, $t_1=t_2$, $b_1=\gamma b_2$ and $\gamma>1$. We obtain from (5) and (7) that the profits for each of the producers are higher with the destination clause than if it is relaxed:

$$\pi_A - \pi_{A,R} = \frac{\pi_A}{2}\left(\frac{A_1}{A_1 - b_1(t+c)}\right)^2 \frac{(\gamma-1)^2}{\gamma(1+\gamma)}. \tag{8}$$

The difference in profits is increasing in $\gamma>1$ and hence the more demand elasticity differs between the regions, the more profitable is the opportunity to price differentiate between regions for the oligopolists using the destination clause.

Finally assume that transport costs differ and $t_1=\delta t_2$. Assuming otherwise symmetric countries and almost symmetric flows we set in first approximation $t=(t_1+t_2)/2$, and obtain for the duopolist that he can profit from the destination clause as follows:

$$\pi_A - \pi_{A,R} = \frac{\pi_A}{4}\left(\frac{3b_1t_1}{A_1 - b_1c - b_1t_1(2-\gamma)}\right)^2 (\gamma-1)^2. \tag{9}$$

The analysis shows, that the destination clause allows producers to profitable price discriminate in the gas industry if transport costs to or demand elasticities in the regions are asymmetric. This would explain the interest of producers in retaining destination clauses.