Competition in the German natural gas market?

The impact of oil price fixing and long term take-or-pay contracts.

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Abstract

Will the forthcoming changes in law and institutional arrangements yield a competitive German natural gas market? Until now there are three peculiar features in this market: local monopolies, oil price fixing and long term take-or-pay (TOP) contracts. In this paper we first discuss the likely impact of oil price fixing on the imperfect competition between a monopolistic supplier of natural gas and a group of oil distributors. In a differentiated good oligopoly model we show how oil price fixing can work as a collusive device but may nevertheless yield lower prices and profits for the natural gas supplier if we properly account for the likely asymmetries between oil and gas distributors. In a second step we deal with the situation after liberalization. Here we examine a model with two suppliers of natural gas that compete in a local market. While oil price fixing is no longer feasible in this setting, appropriately constructed TOP contracts may be applied to restrict price competition. We analyze this aspect in a capacity-constraint price duopoly in the spirit of Kreps and Scheinkman and extend this model by introducing the possibility that firms may buy or sell natural gas on a spot market with a bid-ask-spread.

Keywords: Natural gas market, Oligopoly, Oil price fixing, Take-or-pay contracts

JEL–classification: D 43, L 41, L 59

1 Introduction

Due to national implementation of EU regulation and the changing attitude of competition authorities and regulatory agencies, the institutional settings in the European national markets for natural gas are changing. Considering the present situation in the German natural gas market, three peculiar features attract attention: Natural gas is distributed by local monopolies, there exist long term contracts between importing firms and the local distributors as well as between these importing firms and the foreign gas producing countries in the form of long-term take-or-pay (TOP) contracts, and, finally, the prices on all stages of the vertical chain are based on some average of oil prices in the past few month (so called "oil price fixing"). All these features are under scrutiny by competition authorities. However, it is not clear whether the discussed changes in law and institutional arrangements will actually result in a more competitive German natural gas market with lower prices for final consumers. To shed some light on this issue we explore the competitive effects of oil price fixing in the present institutional setting and discuss the impact of TOP contracts and spot markets for natural gas in the emerging situation with (potential) competition between local gas distributors.

In Germany oil price fixing of the natural gas price was introduced in private long term contracts between exporters and importers in the late 1960s (Auer 2003). The natural gas price is usually calculated according to the 6/3/3-rule (BET 2005): The oil price is observed for six months. Then an average oil price is calculated for that time. After a short time lag of three months, the average price will be enforced for the following three months. At the time of introduction, oil price fixing seemed appropriate for a number of reasons: In long-term contracts, there must be rules about the adjustment of prices. It seemed reasonable to peg prices to oil, the major competing energy source. As natural gas only had a very small market share the anti-competitive effect of such a move was negligible. Oil price fixing also insured the investment of local distributors and final consumers against the threat that the few natural gas producing countries would abuse their market power once substantial (specific) investments were made. However, the situation has changed as natural gas has become the dominant energy source for new installations in the heating market and also a major competitor in other sectors of the energy market. Therefore, recently more and more criticism emerged, arguing that oil price fixing is no longer appropriate (Gassmann 2004). Critics point out that nowadays the natural gas market has matured and so oil price fixing is only a distortion of competition. Industry lobbyists counter that liberalization of the natural gas market would jeopardize the security of supply since only the most "attractive" markets would be served (E.ON 2004). In 2005, the German *Bundeskartellamt* (Federal Antitrust Division) started an investigation on oil price fixing. Some of their arguments against oil price fixing were summarized in Beuret (2005): (i) The historic reasons are no longer valid, since more and more applications of oil are substituted through natural gas. (ii) The oil price is mainly driven by political events and therefore very unstable. (iii) As worldwide oil stocks are decreasing, oil prices will increase. Higher oil prices will drive up the price for natural gas although natural gas itself is not short.

As already mentioned, oil price fixing is closely linked to so called take-or-pay contracts (TOPs). TOPs are long-term supply contracts that last from one up to three decades and have typically high unconditional payment obligations (Auer 2003). They are justified by the long-term balance of risk between the natural gas producers and the importers. They guarantee the security of supply, and by also specifying the adjustment of prices they reduce the hold up problem for specific long term investments. While critics argue that there has never been a serious conflict between the natural gas importers and exporters — except for the recent dispute between Russia and Ukraine — there might still be a hold up problem due to the limited number of potential suppliers. However, note that natural gas prices must not necessarily be pegged to the oil price and even if oil price fixing prevails in long-term contracts in the upstream market, this does not necessarily imply that oil price fixing is also appropriate in local downstream markets.

To analyze the impact of oil price fixing and TOP contracts we proceed as follows: Section 2 develops an oligopoly model with differentiated products and shows how differences in intra-oil and gas-oil substitutability as well as the number of competing oil suppliers affect prices and profits of a competing and an oil price fixing gas supplier. In section 3, we consider a liberalized natural gas market with two suppliers, TOP contracts and a spot market. We show how prices in the local market are jointly determined by the exact specification of TOP contracts and the bid and ask prices on the spot market. Finally, section 4 concludes by summarizing the results obtained in the models and deriving implications for the German natural gas market.

2 Oil price fixing in local markets

In our discussion of oil price fixing we want to concentrate on the strategic impact of this strategy. We show how it works as a collusive device and discuss how details of the market structure and asymmetries between oil and natural gas suppliers affect the results on prices, profits and welfare. To highlight these points it is necessary to abstract from other aspects: (i) We do not explicitly consider the dynamic structure of pricing. As explained earlier, in reality the price of natural gas does not depend on today's oil price but on an average of past prices. However, the basic strategic impact would remain as oil suppliers would be still able to determine the price of natural gas by their pricing decision. (ii) In reality consumer switching costs are likely to be the main reason that natural gas and oil are only imperfect substitutes. However, a model with switching costs would have been much more complicated to analyze and it would have been almost impossible to introduce asymmetries in a meaningful way.

We start by considering a situation with a single natural gas distributor in a local area. While this firm is therefore a monopolist in the local natural gas market, this might not be the relevant market as there is competition by suppliers of other energy sources: Consumers are not per se interested in natural gas but look for some kind of primary energy to fulfill their energy needs. Given this broader definition of the relevant market, the natural gas distributor competes with suppliers of other forms of energy, namely suppliers of oil. Oil and natural gas are, however, only imperfect substitutes: Different forms of primary energy are more or less suited to perform the various needs of energy consumption for transportation, heating or else. There might also be switching costs which are due to specific investments in devices that are only usable with a specific form of primary energy.

For this reason we think that it is appropriate to discuss oil price fixing in an oligopoly model with differentiated products. For various assumptions about the degree of competitiveness among oil suppliers and about asymmetries between oil and gas we ask how oil price fixing affects the market outcome. As a baseline case we consider the competition between the natural gas distributor and one oil supplier under symmetric product differentiation with zero marginal cost and identical valuation of consumers for both oil and natural gas. Later on we generalize the analysis by considering an inverse demand system with n oil suppliers that allows different degrees of substitutability between oil and natural gas (β) and among oil suppliers (γ) as well as a higher or lower valuation of natural gas (α). For the baseline case the consumption side is given by a representative consumer with linear-quadratic utility

$$U(x_1, x_2; x_0) = \alpha(x_1 + x_2) - \frac{1}{2}(x_1^2 + x_2^2 + 2\beta x_1 x_2) + x_0 \tag{1}$$

with x_1 and x_2 indicating the specific types of the differentiated good produced by firm 1 or 2, respectively, and x_0 a numeraire good which is assumed to be produced in another sector of the economy and has been added linearly to ensure that the marginal utility of income is equal to one. The parameter α is a measure of market size while β describes the degree of substitutability between the products of the two firms: If the products are perfect substitutes $\beta = 1$, if they are independent $\beta = 0$. In the baseline case the market size parameter α will be normalized to 1 for both oil and natural gas (in the general case α may be smaller or greater than one for natural gas).

Given this utility function, the consumer maximization problem leads to linear inverse demand functions

$$p_i = 1 - x_i - \beta x_j \quad \text{with} \quad j \neq i. \tag{2}$$

To analyze the duopoly with price strategies we need demand functions that express quantity demanded as a function of the two prices. Based on the inverse demand functions straightforward calculations yield

$$x_i(p_i, p_j) = \frac{1}{1 - \beta^2}[(1 - \beta) - p_i + \beta p_j]. \tag{3}$$

We do now proceed to the general case with n oil suppliers. Here the utility function is somewhat more complicated,

$$U\left(x_1,\ldots,x_{n+1};x_0\right)=\alpha x_1+\sum_{i=1}x_i-\frac{1}{2}\left(x_1^2+\sum_{i\neq 1}x_i^2+2\beta x_1\sum_{i\neq 1}x_i+2\gamma\sum_{j\neq\{1,i\}}x_ix_j\right)+x_0. \tag{4}$$

As already mentioned $\alpha\neq 1$ refers to cases where consumers value natural gas more ($\alpha>1$) or less ($\alpha<1$) than oil. The interpretation of β remains the same as before. γ describes the degree of substitutability between two oil distributors. We get perfect substitutes if $\gamma=1$, however, γ may be smaller than one if firms supply different qualities of oil or if they may be considered to be different by consumers with respect to other attributes (e. g. location or service).

From (4) we derive (5) and (6),

$$p_1(x_1,\ldots,x_{n+1}) \;=\; \alpha-x_1-\beta\sum_{i\neq 1}x_i \tag{5}$$

$$p_j(x_1,\ldots,x_{n+1}) \;=\; 1-x_j-\beta x_1-\gamma\sum_{i\neq\{1,j\}}x_i \quad j=2,\ldots,n+1. \tag{6}$$

For $n=1$, e. g. one competing oil supplier, solving (5) and (6) for x_1 and x_2 to get demand functions subject to the prices of natural gas and oil, yields

$$x_{1,\,n=1}=\frac{(\alpha-p_1)-\beta\,(1-p_2)}{(1-\beta)\,(1+\beta)} \tag{7}$$

$$x_{2,\,n=1}=\frac{(1-p_2)-\beta\,(\alpha-p_1)}{(1-\beta)\,(1+\beta)} \tag{8}$$

For $p_1>\alpha$ we get $x_{1,\,n=1}=0$ and for $p_2>1$ we get $x_{2,\,n=1}=0$. The maximal demand (α for natural gas and 1 for oil) results if natural gas and oil are independent products and prices are zero. The higher the degree of substitutability between natural gas and oil, the higher is the negative effect of lower prices of the competing energy source on own demand. Assuming price competition in a simultaneous move game we obtain the following equilibrium values:

$$p^*_{1,\,n=1}=\frac{2\alpha-\beta\,(1+\alpha\beta)}{(2-\beta)\,(2+\beta)} \tag{9}$$

$$p^*_{2,\,n=1}=\frac{2-\beta\,(\alpha+\beta)}{(2-\beta)\,(2+\beta)} \tag{10}$$

The highest prices result for $\beta = 0$ were the natural gas supplier charges $\alpha/2$ and the oil supplier $1/2$. The price of the natural gas supplier rises as its valuation increases while at the same time the price of the oil supplier decreases. Both prices decrease with a rising degree of substitutability between the two energy sources. In the extreme case of perfect substitutability $p^*_{1,\, n=1} = (\alpha - 1)/3$ and $p^*_{2,\, n=1} = (1 - \alpha)/3$ and thus only the firm with the higher valuation will remain in the market.

Under oil price fixing the oil supplier chooses the profit maximizing price under the assumption that the natural gas supplier will charge the same price. This yields

$$p^{OPF}_{n=1} = \frac{1 - \alpha\beta}{2 - 2\beta}. \tag{11}$$

Note that for $\alpha = 1$ the firms will charge the monopoly price $1/2$ irrespective of the degree of product differentiation. Oil price fixing will therefore have no effect for independent products while it will be highly collusive for perfect substitutes (see also figure 1).

To highlight the effects of asymmetries, we will now also consider the case with $n = 2$, e. g. two competing oil suppliers (raising n further does not affect qualitative results). We apply the same steps as for $n = 1$, e. g. rearrange for demand,

$$x_{1,\, n=2} = \frac{(\alpha - p_1)(1 + \gamma) - \beta \sum\limits_{i \neq \{1,j\}} (1 - p_i)}{1 + \gamma - 2\beta^2} \tag{12}$$

$$x_{i,\, n=2} = \frac{(1 - p_i) - \beta(\alpha - p_1)(1 - \gamma) - \gamma(1 - p_j) + \beta^2(p_i - p_j)}{(1 - \gamma)(1 + \gamma - 2\beta^2)} \tag{13}$$

where $i, j = 1, 2$ and $i \neq j$. It is then straightforward to determine the equilibrium of the non–cooperative price game

$$p^*_{1,\, n=2} = \frac{\alpha\left[2 - \beta^2(3 - \gamma) + \gamma(1 - \gamma)\right] - 2\beta(1 - \beta)(1 + \beta)}{2\left[2(1 - \beta)(1 + \beta) + \gamma(1 - \gamma)\right]} \tag{14}$$

$$p^*_{i,\, n=2} = \frac{2(1 - \gamma)\left[\gamma + (1 - \beta)(1 + \beta)\right] - \alpha\beta(1 - \gamma)(1 + \gamma)}{2\left[2(1 - \beta)(1 + \beta) + \gamma(1 - \gamma)\right]} \tag{15}$$

with i indicating the (identical) prices of the two oil suppliers. Again we compare this result with the equilibrium under oil price fixing. Note that we must now determine a non–cooperative equilibrium with the two oil suppliers as active players who both assume that the price of natural gas will be set equal to the average price of both oil suppliers, e. g. $(p_2 + p_3)/2$. This results in

$$p_{n=2}^{OPF} = \frac{2\,(1-\alpha\beta)\,(1-\gamma)}{4-\beta\,(3-2\beta)+\gamma\,(2-3\beta)}. \tag{16}$$

Comparing (16) with (11) we see that the natural gas price under oil price fixing will decrease with the substitutability parameter γ: If oil suppliers are closer competitors they will set lower prices. It is therefore no longer assured that oil price fixing is beneficial for the natural gas supplier.

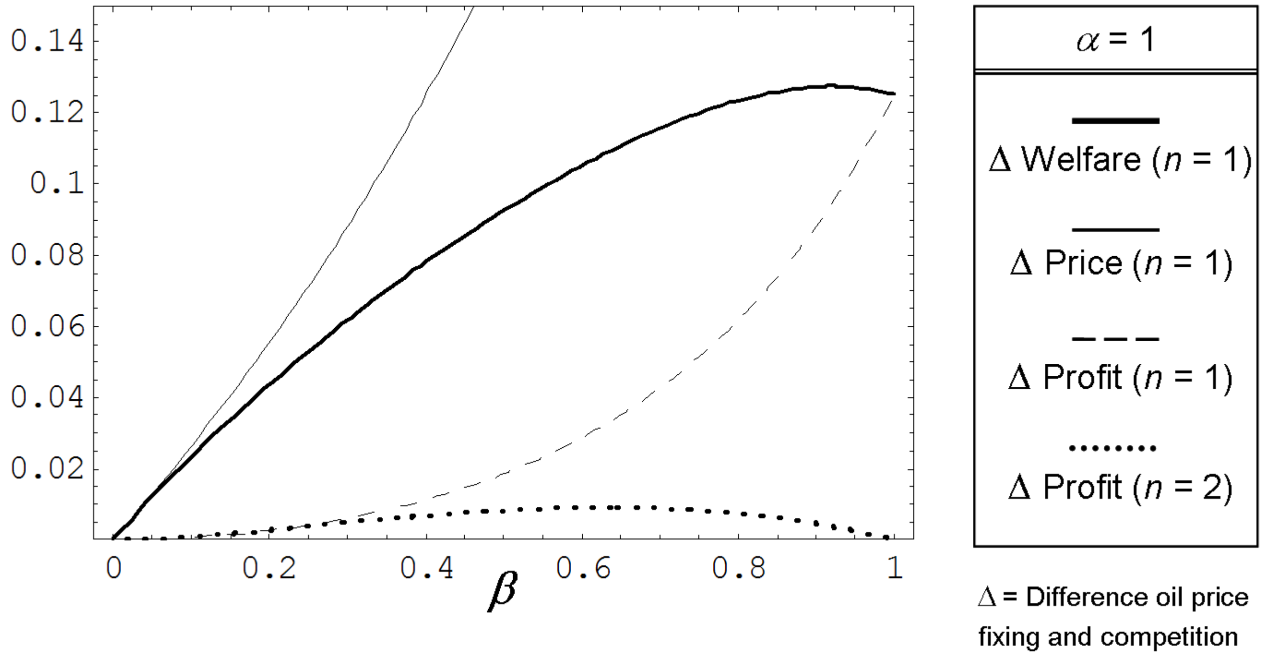
Equipped with these equations we are now able to analyze alternative scenarios that differ with respect to the number of competing oil suppliers, intra-oil and gas-oil substitutability, and the consumer valuation of natural gas relative to oil. How are prices and profits affected by shifting from competition to oil price fixing? We start by considering the symmetric setting: It is assumed that natural gas and oil are equally well suited to fulfill the energy needs of consumers and that intra-oil and gas-oil substitutability are identical.[1] For $\alpha = 1$ and $0 < \beta = \gamma < 1$ it is straightforward to show that prices and profits will be higher under oil price fixing: Oil suppliers internalize the impact of the natural gas price on their profits and will therefore raise prices relative to the competitive equilibrium. As all firms charge identical prices in each of the two symmetric equilibria, the positive effect on profits and the negative impact on welfare is easily established.

In the symmetric setting we obtain the general result that oil price fixing yields higher prices as long as oil and natural gas are imperfect substitutes (there is no collusive effect if the two products are independent and in a setting with at least two oil suppliers oil price fixing would yield marginal cost pricing for perfect substitutes). As is shown in figure 1, with one oil supplier the impact of oil price fixing on prices, profits and welfare is most pronounced for very close substitutes while in settings with at least two oil suppliers the maximum departure from the non–cooperative Nash–equilibrium occurs for an intermediate degree of product differentiation. The

[1] We are aware of the fact that this is a quite unrealistic assumption. However, we use this setting only as a reference point.

reason for the latter result is that oil price fixing is almost ineffective for close substitutes due to the intensive competition between oil producers.

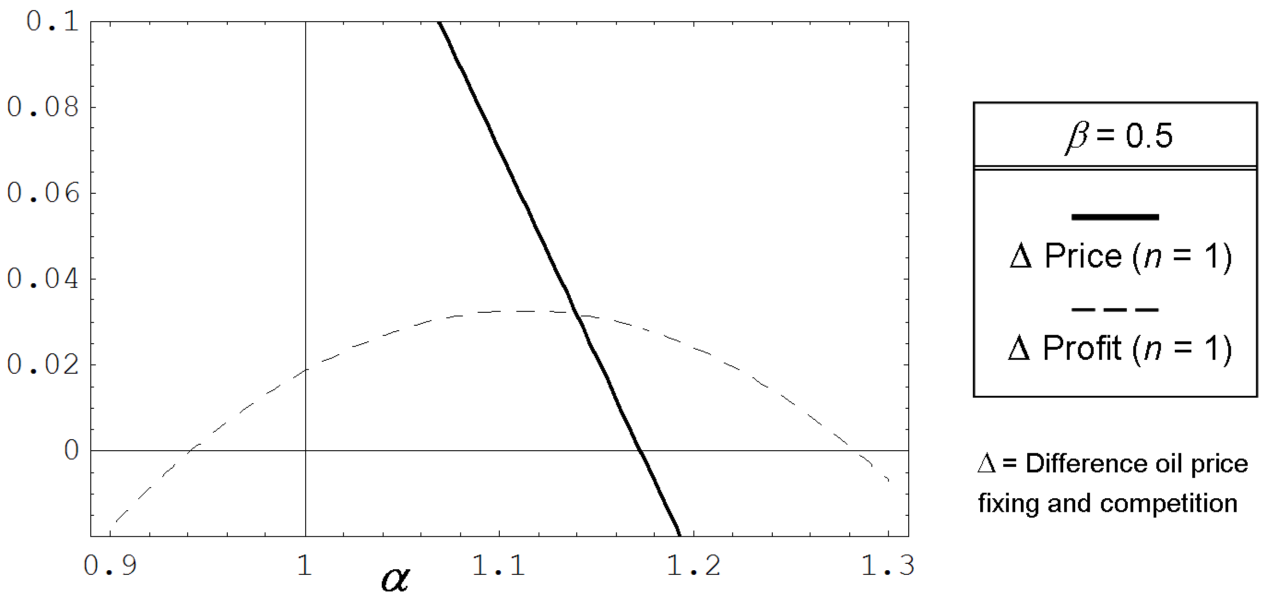
Figure 1: Impact of oil price fixing in the symmetric setting.



It seems to be more realistic to assume (i) that either oil or natural gas are the preferred energy source for the average consumers, i. e. $\alpha \neq 1$ and (ii) that oil from other oil suppliers is a closer substitute to oil than natural gas, i. e. $\gamma > \beta$. Results are less clearcut if such asymmetries are introduced: (i) If $\alpha > 1$ the natural gas supplier will charge a higher price in the oligopoly equilibrium than the oil supplier(s). While the oil distributors still charge higher prices under oil price fixing, the resulting price may be lower than in the competitive equilibrium. (ii) If oil from other suppliers is a closer substitute than natural gas, competition between oil suppliers will be more pronounced and the equilibrium price of the natural gas supplier under oligopoly might be higher than the price under oil price fixing. We discuss whether this is actually the case in markets with at least two oil suppliers and, if though, how much β and γ must differ in order to get this result.

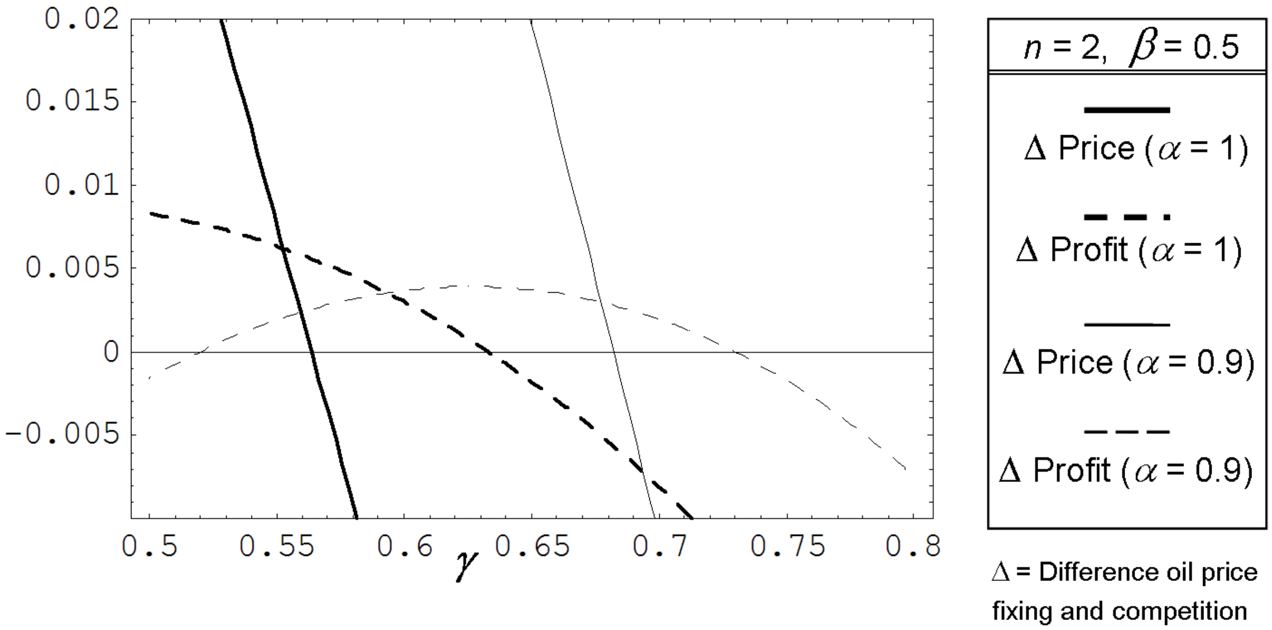
We start by exploring the case with only one oil supplier but $\alpha \neq 1$. If natural gas is an inferior energy source ($\alpha < 1$), the gas price under oil price fixing will always exceed the price under duopoly competition (and thus welfare will be reduced). As can be seen in figure 2 (for $\beta = 0.5$) oil price fixing will also yield lower profits for the natural gas supplier when the inferiority is sufficiently pronounced - the oil supplier chooses a relatively high price because consumers have a higher willingness to pay and this price exceeds the optimal price for the natural gas supplier. If, however, natural gas is a sufficiently superior energy source ($\alpha > 1$), oil price fixing might yield a lower natural gas price than under competition. This might be nevertheless in the interest of the natural gas supplier as the price of oil will be higher under oil price fixing and therefore natural gas will obtain a higher market share. Given the development in the German energy market since the introduction of oil price fixing in the 1960s, it seems most likely that natural gas has become the superior alternative for many purposes and that therefore the case with $\alpha > 1$ seems to be the most relevant.

Figure 2: Impact of oil price fixing for $\alpha \neq 1$



We will now analyze for $n = 2$ how a higher degree of substitutability between oil producers, $\gamma > \beta$, affects the results. The bold lines in figure 3 show the impact for $\alpha = 1$: As the oil firms compete more intensively, the oil price under competition is lower than the natural gas price. Given this, oil price fixing, while still rising the oil price, might yield a lower price for the natural gas supplier. And if the degree of substitutability between oil producers rises further, even the profits for the natural gas supplier will be lower under oil price fixing. The lighter lines in figure 3 visualize a interesting interaction between the two different forms of asymmetry: For symmetrically differentiated products ($\gamma = \beta$) oil price fixing decreases the profits of the natural gas supplier whenever α is substantially below 1 (this will be the case for all values of γ if $\alpha \leq 0.94$) — see also figure 2. If, however, $\gamma > \beta$, oil firms choose lower prices and therefore oil price fixing may increase profits of a natural gas supplier although α is substantially below 1 (in the figure $\alpha = 0.9$).

Figure 3: Impact of oil price fixing for $\gamma > \beta$ and $\alpha = 1$ vs. $\alpha = 0.9$.



3 Competition between natural gas suppliers

In this section we consider a setting where gas markets have been liberalized and natural gas suppliers compete in local markets. Also the strategy of oil price fixing has been abandoned, perhaps because competition authorities do not accept this kind of strategy anymore. Since we want to concentrate on price competition in the local market, we assume that there are no bottlenecks in production and the pipelines are in possession of a non-discriminating government. The only specific feature of natural gas markets that is assumed to remain is the possibility of TOP contracts (however, the importance of these contracts is reduced insofar as there will also exist a spot market).[2]

As there exists a recent paper by Polo/Scarpa (2002) that also deals with competition in local gas markets, we want to highlight how our approach differs. Polo/Scarpa (2002) concentrate their analysis on a separable market where the incumbent enters first and the entrant enters second, both facing inelastic demand. They figured out that the market for natural gas tends to be segmented and each firm becomes a monopolist in a part of the market. No firm has the incentive to enter the competitor's market since the rival would otherwise do the same. The size of the market share is determined by the capacity constraint. The incumbent will serve demand according to his capacity resulting from his TOP contract, the entrant therefore will serve the residual demand and so two (separated) markets emerge. If segmentation is not possible, Bertrand price competition would lead to a natural gas price of zero, since marginal costs within their capacity constraints are zero. In contrast to Polo and Scarpa we consider one local market with elastic demand and capacity constraints due to the appropriate design of TOP contracts.

The question we want to answer in this section is, which prices and quantities will result, if we allow optimal choice of TOP contracts and the establishment of a spot market. For this purpose we analyze a simple duopoly model with two natural gas suppliers that is based on the capacity-constraint duopoly competition model by

[2]TOPs are considered to be an appropriate instrument to achieve efficiency. This is shown in a model by Masten/Crocker (1985). Consider the relationship between a natural gas producer and distributor, both assumed to be risk-neutral. The value of the natural gas for the distributor is a random variable depending on exogenous demand shocks. Let $v(\theta)$ denote the value of natural gas to the distributor and y the agreed payment to the producer for a specified quantity. Therefore the net utility for the distributor is $v(\theta) - y$ and y for the producer. If, for whatever reason, $v(\theta) < y$ — the net utility of the distributor is negative — the distributor would willingly quit the contract. But is this efficient? If the producer e. g. can sell the quantity to another supplier he can gain s. So if $s > y > v(\theta)$ the breach of the contract is efficient since the natural gas is sold to the buyer with the highest willingness to pay. However, if $y > s > v(\theta)$ a breach would be inefficient. To ensure efficiency, the producer has to charge a penalty from the distributor in the case when he is willing to breach the contract amounting to $y - s$. The smaller is s the higher is the penalty the distributor has to pay if he wants to breach the contract. If we assume the extreme case when $s = 0$, then the distributor has to pay the producer independently if he takes the natural gas (and sells it to his consumers) or not.

Kreps/Scheinkman (1983). They examined a two-stage model, where the two firms in the first stage decide about capacities and in the second stage choose prices in a Bertrand game. Under specific assumptions this capacity constrained price competition leads to the same results as Cournot competition. A crucial assumption is efficient rationing, i. e. goods are first sold to those consumers who value them most (who have the highest willingness to pay).[3]

In the first stage each of the two suppliers chooses its capacity by signing an appropriate take-or-pay contract (they bind the quantity they are going to receive). In the second stage they compete with each other in the resulting quantity constrained pricing game. For the ease of exposition we assume a linear demand function

$$x = 1 - p, \tag{17}$$

where p is the price of natural gas and x is the resulting demand for natural gas. We have to distinguish three possible cases in the analysis of capacity-constraint price competition:

(a) $p_i < p_j \quad z_i = \min\{\bar{x}_i, 1 - p_i\}$

(b) $p_i = p_j \quad z_i = \min\left\{\bar{x}_i, \max\left\{\frac{1}{2} - \frac{1}{2}p_i, 1 - p_i - \bar{x}_j\right\}\right\}$

(c) $p_i > p_j \quad z_i = \min\{\bar{x}_i, \max\{0, 1 - p_i - \bar{x}_j\}\}$

where i, j indicates the natural gas supplier 1, 2 with $i \neq j$, z_i is the resulting demand for natural gas of i and $\bar{x}_i$ is the available capacity of i. In case (a), firm i is the cheapest supplier and therefore either sells its capacity or total demand (if capacity exceeds total demand). Case (b) is applicable when both firms set the same price. Again firm i may sell its capacity, or either if firm j's capacity is high enough they split the whole market equally or if firm j is not able to fulfill its demand, but firm i is able to do so, firm i will sell the excess demand, too. In case (c), firm i is the expensive supplier and therefore either will sell its capacity or either nothing, if firm j is able to satisfy total demand, or excess demand, if firm j is not able to do so. In all three cases the

[3]While later research, e. g. by Davidson/Deneckere (1986) or Güth (1993), showed that other rationing rules do not yield the Cournot outcome, in all cases the results are less competitive than the Bertrand solution.

minimum is always binding, either because the firms are not able to sell more (capacity constraint) or because consumers want to buy less at the given price (demand constraint). Note first that according to Bertrand price competition the cheapest supplier always serves first and excess demand, if applicable, serves second according to efficient rationing. Second, if firms charge the same price they will each sell half the total quantity demanded at that price (equal sharing, see Gravelle/Rees 1992).

Taking the above stated considerations about the reactions of demand subject to price differences into account, following price(s) will result

$$\underline{p}_i \geq 1 - x_i - x_j \text{ and } \underline{p}_i = \bar{p}_i = 1 - x_i - x_j.$$

The last condition results from $\bar{p}_i = \bar{p}_j$ (see also case (b) above). $\underline{p}$ is the minimal chosen price and $\bar{p}$ the maximal chosen one. The minimal chosen price yields from the situation when both firms are able to sell their total capacities. A further decrease in price will indeed push demand for natural gas, but no firm is able to satisfy this additional demand. The only effect is that they sell the same amount of natural gas — their capacity — but for a lesser price and therefore reduced profit. No rational supplier hence will choose to set a price even slightly below $\underline{p}$. Suppose now w.l.o.g. that $x_i > x_j$ and $p_i = p_j > 1 - x_i - x_j$, here it is better for i to charge a price slightly below j, since i can sell more and increase its profit. The same applies also for j and therefore each firm will always undercut the other. The resulting condition, $\underline{p}_i \geq 1 - x_i - x_j \geq \bar{p}_i$, leads to the above stated condition.

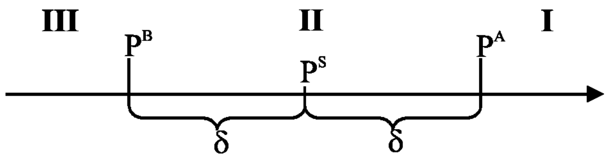
Backward induction now yields optimal reactions to their competitor's decision in the first stage for both suppliers. This is expressed in the (Cournot-) best response function

$$r(x_j) = \frac{1 - x_j}{2}. \tag{18}$$

Inserting of (17) should yield the following Cournot outcomes,

$$x_i^C = x_j^C = 1/3 \text{ and } p^C = 1/3, \tag{19}$$

Figure 4: Bid–Ask spread



where x_i^C and x_j^C are the Cournot-quantities for i and j and p^C is the Cournot-price resulting from the inverse demand function.

Now a spot market is established. For simplicity we assume a small country, so that (domestic) demand is small enough to have no effects on the (international) spot market price, P^S, at all. The spot market is operated by an intermediary who buys the natural gas on the world market and sells it, if required, to domestic natural gas suppliers. Or he buys (excess) capacities from local natural gas suppliers and sells it on the world market. Therefore, both suppliers may buy additional natural gas for the ask price, P^A, and sell excess natural gas for the bid price, P^B. The intermediary sets the ask and bid prices in a profit maximizing manner, and so we get

$$P^B + \delta_1 = P^S = P^A - \delta_2, \tag{20}$$

were δ_1 is the buying margin and δ_2 is the selling margin. For simplicity assume that $\delta_1 = \delta_2 = \delta$.

Figure 4 now identifies three areas of the possible location of the Cournot-price P^C, **I**, **II** and **III**. In the first stage of the game the true value of P^S is not known to any supplier, therefore they have to make a guess on it, respectively use the expected value of P^S, $E\left(P^S\right)$ [4], for their decisions. Actually the spot market price is not the relevant price for the suppliers to base their decisions on. The relevant prices are $E\left(P^A\right)$ and $E\left(P^B\right)$, since δ is common knowledge, however, both expectation values can be constructed from $E\left(P^S\right)$ by simply adding or subtracting δ according to (20).

In the first step of our analysis we start with the decisions of the suppliers before P^S is realized — i. e. in the

[4]We make no further assumptions on the exact probability distribution.

first stage, when the firms make their capacity decisions at zero costs — and in the second step we analyze how both firms react when the true state of the world is revealed. In both stages we have to distinguish three cases.

Case I, $P^C > E\left(P^A\right)$. Should both suppliers choose the Cournot-price and therefore the Cournot-quantity as capacity? No, this would not turn out to be a stable equilibrium, since each supplier has the incentive to undercut the other slightly to get the whole market. If both choose the Cournot-quantity in the first stage, both are able to buy additional natural gas in the second stage and hence the capacity-constraint is not binding. More formally, profit from undercutting yields

$$\left(P^C - \varepsilon\right) D\left(P^C - \varepsilon\right) - P^A \left[D\left(P^C - \varepsilon\right) - \frac{1}{2} D\left(P^C\right)\right] \geq \frac{1}{2} P^C D\left(P^C\right),$$

where the left hand side describes the profit resulting from undercutting and the right hand side is the profit from Cournot-competition (and no supplier deviates). $P^C - \varepsilon$, where ε is very small, describes the undercutting price. If one firm undercuts the other it can get the whole market but has to increase its capacity to fulfill demand. While the consumer price, $P^C - \varepsilon$ is above the ask price it is profitable for the firm. Formally the first term on the left hand side is larger than the second one. Rearranging yields

$$\left(P^C - \varepsilon - P^A\right) D\left(P^C - \varepsilon\right) \geq \frac{1}{2}\left(P^C - P^A\right) D\left(P^C\right),$$

where $P^A \leq P^C - \varepsilon$ — no undercutting below the ask price — and $D\left(P^C - \varepsilon\right) > D\left(P^C\right)$ — demand is decreasing in price. Using (17) we obtain

$$P^A \leq \frac{\frac{1}{2}\left(1 - P^C\right) - \varepsilon\left(1 + \varepsilon - 2P^C\right)}{\frac{1}{2} - \frac{1}{2}P^C + \varepsilon}.$$

With (19) rearranging yields

$$P^A \leq \frac{1}{3} - \varepsilon - \frac{\frac{1}{3}\varepsilon}{\frac{1}{3} + \varepsilon}$$

If $\varepsilon \to 0$ the above derived condition is satisfied for all values of $P^A < \frac{1}{3}$. Therefore undercutting is a (strictly) dominant strategy for both suppliers if $P^C = \frac{1}{3} > E\left(P^A\right)$. But undercutting below P^A is strictly dominated, since in this case the ask price exceeds the consumer price and marginal profit would turn negative.

To conclude, if P^A is below P^C, the ex ante constituted capacity constraint is not binding, since both suppliers are able to buy enough additional natural gas to satisfy the whole market. The optimal strategy is to choose the price $E\left(P^A\right)$ and the capacity $\frac{1}{2}D\left(E\left(P^A\right)\right) = \frac{1}{2} - \frac{1}{2}E\left(P^A\right)$. Hence the maximal price for consumers is the ask price of the spot market.

Case II, $E\left(P^A\right) \geq P^C \geq E\left(P^B\right)$. According to our previous analysis this case is straightforward. Both suppliers would choose the Cournot-price, since no firm has an incentive to deviate. The firms would neither buy — the ask price is higher than the consumer price — nor sell — the consumer price is higher than the bid price — natural gas on the spot market, therefore the capacity constraint is fully binding. In this case the spot market has no influence on the Kreps/Scheinkman outcome as both suppliers will choose the Cournot-quantities.

Case III, $E\left(P^B\right) > P^C$. This case is unlikely to happen, since any rational supplier would then try to get infinite capacity in the first stage to sell it completely on the spot market. So either the cost for capacity will increase or the spot market price will decrease.

Now we turn to the second stage, when the realization of the spot market price is revealed. From our analysis so far we know, that only two cases are plausible and therefore only two capacity constellations may appear, namely **I** and **II**. First we have a look at case **I**. Again we may distinguish three cases as before.[5]

Case I-i, $E\left(P^A\right) = p > P^A$. As was argued in case **I** above, both suppliers can cheaply increase their capacities on the spot market to expand their market shares. Hence both firms will buy additional natural gas units and undercut each other until the consumer price is the same as the ask price on the spot market. Further purchases lead to negative marginal profits. Both firms again will serve half of the market and sell each $\frac{1}{2} - \frac{1}{2}P^A$. Contracts between the suppliers and the consumers are made before the firms buy natural gas to prevent the situation in which both firms buy the quantity needed to decrease the consumer price to the ask price level and so "overshoot" the target price, P^A.

[5] Notation: the small letter indicates the same areas as the corresponding capital letter in figure 4 after realization of P^S.

Case I-ii, $P^A \geq E\left(P^A\right) = p \geq P^B$. In this case both firms have no incentive to change their prices or capacities. Additional units of natural gas are to expensive, while the sale on the spot market yields lesser profit than the sale to consumers. So both split the market among them and sell each $\frac{1}{2}D\left(E\left(P^A\right)\right) = \frac{1}{2} - \frac{1}{2}E\left(P^A\right)$.

Case I-iii, $P^B > E\left(P^A\right) = p$. Now both firms sell natural gas on the spot market — decrease their capacities — until the consumer price equals the higher — and therefore more profitable — bid price on the spot market. Then they divide the market and sell each $\frac{1}{2} - \frac{1}{2}P^B$.

The analysis for case **II** is the same as for case **I**. Here, too, we have to distinguish three cases:

Case II-i, $P^C = p > P^A$. In this situation the same arguments as in case **I-i** apply. Both firms will undercut each other until the ask price is reached.

Case II-ii, $P^A > P^C = p > P^B$. The expectations made in the first stage are fulfilled, therefore no firm has an incentive to deviate.

Case II-iii, $P^B > P^C = p$. Analog to case **I-iii** both firms will run short their capacities — sell it on the spot market — until the bid price is reached.

To sum up, we saw, that the consumer price is determined by the spot market price and the bid-ask-spread of the intermediary. The resulting price in stage two is somewhere in the range between ask price — as the upper bound — and bid price — as the lower bound —, depending on the expectations in the first stage, when both firms choose their capacities. If expectations are fulfilled or the outcome is located within the bid-ask-spread, no rational firm has the incentive to deviate. Only in the cases when the expected price is too high — then the competition will force it down to the spot market ask price — or when the expected price is too low — then profit maximizing will push the price to the spot market bid price — firms will change their capacities, i. e. deviate from their previous determined strategy. Formally total sales are within $\left[1 - P^A; 1 - P^B\right]$ or $\left[\left(1 - P^S\right) + \delta, \left(1 - P^S\right) - \delta\right]$.

4 Conclusion

Whether the liberalization of natural gas markets will actually yield more competition and lower prices for consumers is an open question. To shed light on this issue we analyzed a local market for natural gas in a setting that focused on the competitive interactions in such markets. To highlight this point, it was necessary to concentrate on some specific features of the relevant markets (oil price fixing and TOP contracts) while abstracting from other equally important aspects (e. g. market dynamics or vertical structure). When trying to derive conclusions for the German natural gas market it is necessary to be aware of these restrictions of our analysis.

With respect to the current situation in the natural gas market in Germany we pointed out that the strategy of oil price fixing can serve as a collusive device whenever oil and natural gas are imperfect substitutes and the oil market is not perfectly competitive. That does not mean that oil price fixing will not serve other purposes as well – e. g. insuring market participants against absolute and/or relative price changes or enabling a system of long term contract. We only want to stress that this strategy is not likely to be innocuous in the competitive interaction between oil and natural gas suppliers. As has been shown the negative impact on competition will be small as long as oil markets are highly competitive. However, there exists evidence that collusive behavior among oil suppliers is not uncommon. Oil price fixing will then have significant effects on competition and welfare, while not necessarily benefiting the natural gas supplier in the most likely case with asymmetries.

What will happen if after liberalization competition between different natural gas suppliers in one local market becomes feasible? As TOP contracts are an efficient form to deal with the bilateral hold up problem in the long term relationship between resource owners and consuming countries, they are likely to prevail even after liberalization. If the TOP obligation is fixed without considering market interaction, it is quite likely that firms would compete in an extremely competitive environment with perceived marginal costs of zero. As pointed out in the literature this might yield a situation were no firm has an incentive to enter the local market of another natural gas supplier because competition would drive prices down and both firms must incur losses. We show that this can be avoided if TOP obligations are set strategically in a way that appropriately restricts capacities of the competing firms. However, this possibility may disappear if firms have the opportunity to buy or sell natural gas on a spot market with a low bid-ask-spread. Therefore introducing such a spot market may actually be detrimental to competition in the local natural gas market.

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