

Globalization of Natural Gas Markets Working Papers

WP-GG-07

**Less Long-Term Gas to Europe?
A Quantitative Analysis of European Long-Term
Gas Supply Contracts**

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Reprint from
Zeitschrift für Energiewirtschaft, Vol. 28, No.3, 175-182 (2004)

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Abstract

Several studies have analyzed the interdependence between liberalization of the gas industry in the US and the UK and long-term take-or-pay contracts between gas producers and large gas consumers, but none so far have examined continental Europe, where liberalization started in 1998 with the first EU Directive. This paper provides the first quantitative analysis of long-term European gas supply, based on a unique dataset of European importers' long-term contracts in the last two decades. We find that the contract length of take-or-pay gas supply contracts to Europe has significantly decreased over the past decades, and that this is probably because of the move towards liberalization in the EU. The country of origin of the gas affects contract length, as does the additional option of LNG import facilities. We conclude that whereas long-term gas contracts will remain important in Europe, their nature is going to evolve significantly.

Introduction

In a milestone analysis of the changing nature of the European gas industry at the dawn of liberalization, entitled "Gas to Europe", Mabro and Wybrew-Bond (1999) discuss the options for long-term European gas supply. They identify a contradiction between rising import demand for natural gas on the one hand, and a reduced role for long-term contracts on the other, concluding that "long-term supply contracts which have been the bedrock of the gas industry will not continue to be accepted without qualifications by the big industrial users of gas" (Mabro and Wybrew-Bond, 1999, 2). Long-term take-or-pay contracts have indeed characterized the European gas supply for decades. However, as liberalization continues to progress throughout Europe, this instrument of maintaining the supply of pipe-

line gas is undergoing fundamental change. Today, in fact, none of the major market players would deny that the time of long-term contracts of bygone days is over. Similar to what happened in the US and UK after liberalization, contract lengths are shrinking, oil-price indexation is diminishing in importance, and flexibility in the terms of the contract (take-or-pay obligations and swing) is increasing; all of which are reported in the recent IEA (2004) study on "Security of Gas Supply in Open Markets". It seems that while European gas imports are steadily increasing, less of this gas will be supplied via traditional long-term contracts.

Long-term take-or-pay (ToP) contracts link sellers and buyers into a bilateral monopoly for a long period, during which both parties have strictly defined obligations. Purchasers are required to pay for a pre-specified minimum quantity of gas whether or not they actually take the gas, and producers are required to deliver this quantity (Masten, 1988). Such contracts constitute a firm basis for investment and financing of capital-intensive infrastructure with a high degree of asset- and relationship-specificity. In the old European gas world of local monopolies and no competition, long-term contracts were seen as ensuring a consistent distribution of market risks along the supply chain: price indexation to oil gave gas buyers long-term protec-

tion against prices exceeding those of the main competing fuels; the buyers bore the volume risk, and the sellers the price risk.

Long-term contracts in the energy sector served as empirical evidence to test transaction cost theory and contract theory back in the 1980s, and they continue to be of interest for economic and regulation theory, and for energy policy makers around the world. The first wave of research began in the 1980s, when new institutional economics (e.g. Williamson, 1975, 1985, Joskow, 1985) met with the post-1970s oil crisis and mounting concern about long-term gas supply security (Adelman, et al., 1986, Golombek et al., 1987). Bolle (1989) pointed out that typical take-or-pay contracts were superior to contracts on the basis of marginal costs in static and dynamic efficiency because they reduced the moral-hazard options on the demand as well as on the supply side. Masten and Crocker (1985) and Crocker and Masten (1988) were the first to empirically test the interdependence between regulatory framework and contract length using 280 long-term contracts in the US gas industry. They concluded that, ce-

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teris paribus, increased regulatory risk tended to shorten the length of long-term contracts. Likewise, Doane and Spulber (1994) showed that changes in the regulatory framework towards more competitive markets decrease transaction costs, thereby enhancing spot trade. Parsons (1989) performed an empirical study to derive monetary estimates of the strategic value of long-term contracts.

The "second generation" of research on long-term gas contracts, which began emerging early this decade, is driven by similar concerns as the first generation research two decades ago. Hartley and Brito (2001) explain that the length of long-term contracts (in the liquefied natural gas [LNG] industry) is likely to diminish in the near future, as investment and transport costs fall and the number of players in the international gas markets increase; their model suggests that the market structure will change from bilateral trade using long-term contracts towards multilateral trade using other types of contracts (spot, short-run). Using a case study on a large LNG project, Dailami and Hauswald (2000) have shown the crucial role of specific contract design for assuring long-term investment and the efficient distribution of risks. The discussion on whether long-term contracts are compatible with gas market liberalization, and what policy conclusions to draw in this respect, remains vivid: an argument voiced regularly by industry is that liberalization of access to transmission and downstream infrastructure may be incompatible with long-term supply security (Wybrew, 2002, Czernie, 2002): increased price and demand volatility, due to market liberalization, supposedly puts new contracts at risk and thus undermines supply security and the ultimate objective of reforms, i.e. lower prices to customers. On the other hand, it has been argued that these are two separate issues, and that liberalization may even be conducive to supply security: thus, Frisch (1999) suggested that new forms of contracts, based on spot or over-the-

counter markets, are rapidly gaining popularity in liberalized gas markets, such as the US or the UK, and that Europe is likely to follow suit. Finally, Neuhoﬀ and Hirschhausen (2004) have suggested that gas producers benefit from long-term contracts, as opposed to spot market sales at presumably higher prices, if the difference between short-term demand elasticity and long-term demand elasticity is large enough to reduce strategic price hikes on the short-term market in order not to adversely affect the long-term demand. They also point towards the potential adverse effects of a lack of long-term contracts in a situation of tight gas supply, as observed in the US since 2000.

Our paper takes the discussion on the long-term gas supply a step further by providing the first quantitative analysis of developments in European long-term gas supply. It is based on a unique dataset of long-term contracts concluded by European importers in recent decades. We test the conventional wisdom that in Europe, due both to liberalization and the changing structure of how gas is supplied internationally, the nature of long-term gas contracts is indeed undergoing a significant change. We do not doubt that Europe will be importing significantly more gas in the coming decades; but we contend that a smaller portion thereof will be delivered through traditional take-or-pay contracts.

The remainder of the paper is structured as follows. The Section EU Gas Sector Restructuring and International Experience briefly describes the overall situation on European gas markets at the beginning of liberalization. We then describe the current structure of the European gas supply, and discuss the new institutional framework of long-term gas contracts. We also refer to the development of long-term contracts in liberalized countries such as the US and the UK. The Section Data and Methodology describes the data and discusses the potential relationships between the key variables (contract length, contract

volumes, prices of alternative fuels, etc.). Based on this, an estimation equation is derived to explain the contract length of ToP-contracts. The Section Analysis and Interpretation presents the quantitative analysis and results, and indeed demonstrates that in the two decades prior to 2003, contract length has diminished significantly. The Section Conclusions follows.

EU Gas Sector Restructuring and International Experience

Long-term European Gas Supply and the Institutional Framework

Gas plays an increasing role in the EU energy mix. It was identified as a strategic resource in the EU Green Paper on Energy Supply Security (EU, 2001), mainly because of its increased use in power generation, low carbon content and environmental advantages. The share of natural gas in total primary energy demand in the European Union is expected to increase from approximately 23% at present to a projected 27% in 2020. In Europe, natural gas has traditionally been supplied via long-term contracts and indigenous production. In different scenarios, the gas import dependency of the EU-15 is estimated by the World Energy Outlook 2003 (IEA, 2003) to increase from the current 40% (187 bcm in 2002) to 80% (543 bcm) in 2020. Along the same lines, Stern (2001) forecasts the import dependency of the "Euro-33" (EU 27 + Norway, Switzerland, Turkey, and Balkan countries) to grow from the current 33% to about 56% (corresponding to 420 bcm), a scenario which is also compatible with the EUGAS-model of Perner and Seeliger (2004).

Indigenous production in Europe, which is concentrated in the UK, the Netherlands and Norway, will not be able to meet the anticipated increase in demand. Thus, imports will be indis-

pensable. In fact, with regard to the traditional suppliers, a number of technical and economic obstacles loom on the horizon: the North Sea (UK and Norway), a traditional supplier of gas to the EU, is running out of gas and has limited prospects of developing new fields. The Groningen field in the Netherlands will probably continue to be used as a swing supplier of gas, and thus will not play a major role in European gas supply. North Africa (Algeria, Libya, Egypt) has made significant efforts to improve its status as a reliable, large-scale supplier to Europe, but the region has yet to conquer a market share in European supply that corresponds to its low-cost reserves. Last but not least, Russia is poised to expand its role as the dominant gas supplier to Europe, with a market share expected to increase from the current 40% of EU imports to two-thirds. However, this forecast ignores the high costs of new gas reserves that are needed to bring this gas on stream, the large investments required to modernize and expand the transport infrastructure, and a certain political cautiousness in the EU not to rely too heavily on gas imports from Russia. At present, it is unclear where the additional gas will come from, at what price, and what institutional barriers have to be overcome to make this happen. The increasing global demand for natural gas, mainly LNG, further contributes to concerns about the security of gas supply. This is not just a matter of European energy policy, but has become a global issue, as pointed out by the International Energy Agency (IEA, 2004). Additional supplies will also have to come from new areas such as the Middle East, which together with the CIS amounts for some 70% of global gas reserves.

The debate on the long-term security of gas supplies occurs at a time when the European Union is pushing liberalization in the gas industry.¹ The recent

Gas Directive 2003/55/EC, the so-called "Acceleration Directive", reflects this issue. On the one hand, it calls for stringent market opening until July 2007 (Art. 23), unbundling of transmission (Art. 9) and distribution system operators (Art. 13), and transparent, non-discriminatory third-party access (TPA) to pipelines and storage facilities (Art. 18, 19). But on the other hand, it also acknowledges the need to maintain take-or-pay contracts (Number 25 of the preamble) and to allow pipeline owners to refuse TPA in case of real or expected financial difficulties (Art. 21). Major new infrastructure such as interconnectors, LNG terminals, and storage facilities may be exempted from the TPA obligation: Member States can apply for a derogation from the TPA obligation in relation to take-or-pay commitments (Art. 27).² The European Commission is committed to watching over the developments of long-term contracts closely. Article 27(6) of the Directive explicitly states that liberalization/TPA and supply security are seen as two sides of the same coin, and that they are key to the success of gas sector reform; the European Commission is obliged to, "within five years of the entry into force of this Directive, submit a review report on the experience gained from the application of this Article [27, on "derogations in relation to take-or-pay commitments"]", so as to allow the European Parliament and the Council to consider, in due course, the need to adjust it."

buyers to resell gas outside their own network thereby further limiting the possibility of competition between operators. At the time of EU gas market liberalization the availability of uncommitted resources for a more transparent and liquid supply scheme was quite limited not exceeding 5-10% of demand.

² This rather favorable interpretation of long-term contracts also marks a change with respect to the attitude of the European Commission during the late 1990s, when these contracts were considered as anti-competitive as such, and attempts were made to restrict their use.

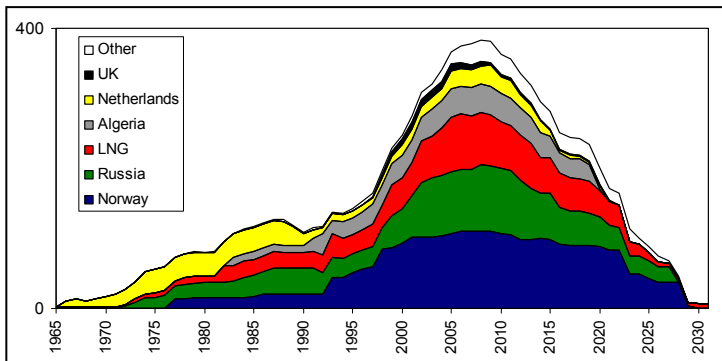
Liberalization and Long-term Gas Contracts: Experience from the US and the UK

What lessons can be drawn from other countries that liberalized their respective gas industries at an earlier stage? In general, the empirical evidence from the US and the UK suggests an inverse relation between gas sector liberalization and contract length, although long-term contracts do not entirely disappear with market liberalization. In both countries, long-term contracts between gas producers and wholesale buyers have lost "market share". Contract length has shortened significantly (to approximately 8-15 years instead of 20-25 years). In both countries, oil price indexation has been partially or totally replaced by spot-price indexation.

The US were the first to liberalize their gas sector, starting with the Natural Gas Policy Act of 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 the first few years after liberalization, gas prices indeed fell to the level of long-run marginal costs, and these prices prevailed for about a decade (see Neuhoﬀ and Hirschhausen, 2004). The share of gas supplies through long-term contracts was reduced from about 100% to below 50%. Until 1991, the average contract volume fell from 1.27 bcm/a to 0.24 bcm/a (IEA, 1998). However, as gas demand picked up again in the late 1990s, industry found itself suddenly deprived of (moderately priced) gas supplies. Hence, in the year 2000 (and, notably, before the Californian energy crisis), prices rose significantly, and have remained high until today. It is expected that gas prices will remain high, whereas most large consumers are currently attempting to (re-)conclude long-term contracts, both for pipeline gas and for LNG.

In the UK, one observes a similar trend: a price drop in the first years after liberalization. Today, about 85%

¹ Traditional long-term contracts resulted in a very rigid organization of the markets all the more as the netback pricing system was generally coupled with destination clauses preventing

Figure 1: European gas imports contracted long-term as of 2003 (and historical contract volumes) (in bcm)

of gas delivered at the beach is covered by long-term contracts (IEA, 2004, 110). The most recent contracts contain an indexation to the UK spot gas market, and no more ToP-obligation. A liquid spot market has developed. However, in the UK like in the US, as supply is becoming tighter one also observes a certain renaissance of stronger contractual ties between gas suppliers, wholesale traders, and the electricity industry as a large consumer. The new electricity trading agreements (NETA), which have replaced a large portion of the pool trading in the electricity sector, may emerge as the new “role model” for the gas sector.

Data and Methodology

Data

Our objective is to derive quantitative evidence on the nature of long-term contracts. Since there is no unified source of data on European long-term contracts, we collected this information ourselves from a variety of publicly available sources as well as through expert interviews. At this point, the database contains about 150 long-term contracts between European gas importers and the large exporting countries or traders. The main gas-exporting countries to Europe are: Norway, the Netherlands, the UK, Russia, and Algeria. Having eliminated some outliers and contracts insufficient for this analysis, our sample includes 103 long-term contracts for pipeline and 39 for lique-

gas via spot markets is still negligible (the share of spot trading with the more flexible LNG in OECD Europe was only 1.76% in 2002), the sample can be regarded as representative.

Figure 1 provides an insight into the volumes of natural gas contracted between major European gas-importing companies and their producers (as of 2003). The figure shows an increasing role of LNG in European gas contracts, and a more rapidly decreasing volume contracted with traditional suppliers. The importance of the UK as a long-term gas supplier is clearly diminishing. Algeria's position, too, has weakened. When compared with optimistic forecasts, Russia also seems to have held back its offer of long-term gas, facing uncertainty about future costs, transit routes, and competitiveness. Strangely enough, European gas importers have contracted the highest volumes of gas from Norway, even though Norway is the most expensive supplier. This may be explained by the political stability that gives these contracts a competitive edge in terms of transaction costs.

Overall, Figure 1 suggests an increasing discrepancy between demand forecasts and contracted volumes. European gas supply on a long-term basis seems to be secure only until about 2010. By itself, this trend is not necessarily alarming, as existing contracts can be extended and volumes can be increased quite flexibly. However, when comparing these contracts with contract structures five or ten years ago, the evidence

fied natural gas, concluded between 1980 and 2003. The sample covers 78.5% of total OECD European imports during the period under consideration. As the share of imported

of an increasing gap is confirmed. Given the current uncertainty regarding the regulatory framework and the apparently decreasing willingness of players to sign new long-term contracts, one might expect an impact on prices after 2010.

Methodology and Variables

We are interested in the length of long-term contracts, and in other structural variables. The contract length (LENGTH) agreed upon initially is a good proxy for the intensity of the relationship in which the seller and the buyer engage, even though most contracts are re-negotiated every three years or so (cf. Crocker and Masten, 1988). Our hypothesis is that the changing market structure of gas, including the process of liberalization, leads to shorter lengths of contracts. Thus, contract length should be inversely related to the year of signature (YoS) of the respective contract.

The relation between contract length and yearly contracted volumes (Yvol) is not clear ex-ante. If two contracts have the same volume of gas but one is longer than the other, an inverse relation between contracted volume and contract length would be expected. If, on the other hand, a gas producer wants to ensure a reasonable long-term rent to cover the high up-front investment costs, this would be reflected in a positive relationship of yearly contracted volumes and the length of contracts.

Some European countries have the opportunity to import LNG, in addition to importing pipeline gas; we express this by the dummy variable LNGDum. This opportunity may have two opposing effects on contract length: on the one hand, LNG can be considered as a substitute for pipeline gas, in which case one would expect contract length to be negatively correlated with the existence of LNG import facilities. On the other hand, imports of pipeline gas and LNG could also be considered as complements: countries particularly dependent on gas imports would seek to

have both options available; one would then expect contract length to be higher than for non-LNG-importing countries. Along these lines, one might also expect a relation between contract length and the share of gas in total primary energy supply (TPES). Countries with a higher share of gas in TPES might be more dependent on gas, and thus contract longer-term.

One might expect the length of contracts also to depend on the institutional framework, mainly on whether the EU Gas Directive on liberalization is in force or not (i.e. in the year 1998 or thereafter). Although talks about gas sector liberalization started as early as the mid-1980s, the year 1998 marked the point of no return for the liberalization process. We therefore introduce a dummy variable (LibDum) for contracts signed in or after 1998 and expect a negative sign.

The raw data also suggested that contract length might be related to the technical and institutional specifics of the exporting country. This issue also relates to the recent debate on the security of gas supplies in Europe and the increasing level of import dependency from certain countries. Therefore, dummy variables for the main gas exporting countries are included in the analysis: Russia (RUSDum), Algeria (ALGDum), Norway (NORDum), the Netherlands (NLDum), and the United Kingdom (UKDum).

We also check whether there is a structural difference between the contracts of UK importers, who clearly operate in a liberalized framework, and continental European importers. We therefore introduce two additional dummy variables, one for UK imports (SVUK), and one for German imports (SVGer, representing continental Europe). We expect a negative coefficient for the UK and a positive coefficient for Germany, implying a shorter contract length in markets with a mature liberalized framework.

In order to test the differences in contract length between pipeline and LNG deliveries, we introduce a dummy

Table 1: Variables and Descriptive Statistics

	Mean	Min	Max	Std. Deviation
LENGTH = contract length	18.77	2	39	8.36
YoS = year in which the contract was signed	1994.986	1980	2003	6.40
YVol = yearly contracted volume (bcm per year)	2.84	0.15	16	2.84
LNGDum = 1 for gas importing countries with LNG facilities = 0 otherwise	0.54	0	1	0.50
TPES = share of natural gas in national total primary energy supply (in %)*	19.72	0	51.4	12.41
LibDum = 1 for contracts signed during or after 1998 = 0 otherwise	0.42	0	1	0.495
RUSDum = 1 for Russia being the exporting part of the contract = 0 otherwise	0.12	0	1	0.326
ALGDum = 1 for Algeria being the exporting part of the contract = 0 otherwise	0.17	0	1	0.376
NORDum = 1 for Norway being the exporting part of the contract = 0 otherwise	0.27	0	1	0.448
NLDum = 1 for Netherlands being the exporting part of the contract = 0 otherwise	0.07	0	1	0.257
UKDum = 1 for UK being the exporting part of the contract = 0 otherwise	0.09	0	1	0.289
SVUK = 1 for British buyer = 0 otherwise	0.05	0	1	0.217
SVGer = 1 for German buyer = 0 otherwise	0.14	0	1	0.349
TypeDum = 1 for Pipeline gas = 0 for LNG	0.73	0	1	0.448
Oil = Average price for Brent during the year the contract was signed (in USD/bbl.)	21.85	13.11	36.83	5.83
DiffOil = Average price for Brent during the year before the contract was signed	22.41	13.11	36.83	5.29

*With no data being available for 2003 we assume the share of natural gas in TPES to grow with an annual rate of 0,5% for this one year

variable for the type of delivery (TYPEDum). Last but not least, we ask how contract length could be linked with the oil price prevailing in the year of signature or the year before (Oil and DiffOil respectively). Given the traditional oil price indexation of long-term gas contracts, a higher oil price might provide disincentives for the buyer to enter into a long-term contract.

Table 1 provides a summary of all variables, including descriptive statistics. The model our estimations are based on is specified as follows:

$$\begin{aligned} \text{Length} = & \alpha + \beta_1 \text{YoS} + \beta_2 \text{LNGDum} + \beta_3 \text{LibDum} \\ & + \beta_4 \text{YVol} + \beta_5 \text{RUSDum} + \beta_6 \text{ALGDum} \\ & + \beta_7 \text{NLDum} + \beta_8 \text{NORDum} + \beta_9 \text{UKDum} \\ & + \beta_{10} \text{Oil} + \beta_{11} \text{DiffOil} + \beta_{12} \text{TPES} \\ & + \beta_{13} \text{TypeDum} + \beta_{14} \text{SVGer} + \beta_{15} \text{SVUK} + \epsilon \end{aligned}$$

Analysis and Interpretation

The data was analyzed using the standard OLS-estimates (ordinary least squares); the results are reported in Table 2. Columns 1-10 successively include possible exogenous variables influencing the length of traditional long-term contracts, whereas columns 11-15 present selected evidence from more runs with selected additional variables. Column 14 represents the reference case. As residuals are normally distributed, we use standard F-Tests to control for the inclusion of further explanatory variables. All in all, the regression statistics are satisfactory, with an adjusted R^2 in the upper 40%.

Table2: Estimation Results (dependent variable: contract length)

Speci- fication	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Con- stant	1278.85*** (6.63)	1385.08*** (7.10)	880.27*** (3.10)	906.87*** (3.41)	905.73*** (3.38)	957.91*** (3.58)	1082.48*** (4.19)	903.48*** (3.55)	941.74*** (3.72)	1052.08*** (4.06)	1125.63*** (3.73)	1087.06*** (4.16)	1048.30*** (4.03)	1084.92*** (4.20)	1084.54*** (4.18)
YoS	-0.63*** (-6.54)	-0.68*** (-7.01)	-0.43*** (-3.03)	-0.44*** (-3.34)	-0.44*** (-3.31)	-0.47*** (-3.51)	-0.53*** (-4.12)	-0.44*** (-3.49)	-0.46*** (-3.65)	-0.51*** (-3.99)	-0.55*** (-3.67)	-0.53*** (-4.09)	-0.51*** (-3.95)	-0.53*** (-4.13)	-0.53*** (-4.11)
LNG Dum		2.94** (2.35)	2.98** (2.43)	2.82** (2.45)	2.83** (2.43)	3.59*** (2.91)	3.90*** (3.29)	4.51*** (3.90)	3.94*** (3.30)	4.12*** (3.46)	4.14*** (3.47)	4.21*** (3.53)	3.90*** (2.89)	4.13*** (3.50)	4.12*** (3.46)
Lib Dum			-4.40** (-2.42)	-3.82** (-2.23)	-3.83** (-2.22)	-3.80** (-2.21)	-3.26** (-1.98)	-3.70** (-2.32)	-3.45** (-2.17)	-2.24 (-1.30)	-1.90 (-1.0)	-2.39 (-1.38)	-2.28 (-1.32)	-1.61 (-0.92)	-1.64 (-0.93)
YVol				0.88*** (4.49)	0.88*** (3.96)	0.90*** (4.07)	0.99*** (4.63)	0.81*** (3.83)	0.78*** (3.73)	0.77*** (3.70)	0.77*** (3.67)	0.77*** (3.70)	0.78*** (3.70)	0.75*** (3.62)	0.76*** (3.61)
Rus- Dum					0.09 (0.04)	-0.44 (-0.23)	-1.54 (-0.80)	1.178 (0.58)	0.58 (0.29)	0.81 (0.40)	0.63 (0.31)	0.72 (0.36)	1.00 (0.48)	0.83 (0.42)	0.85 (0.42)
Alg Dum						-2.81* (-1.74)	-3.40** (-1.22)	-1.90 (-1.35)	-2.11 (-1.34)	-2.07 (-1.40)	-2.21 (-1.40)	-2.10 (-1.36)	-2.06 (-1.33)	-2.09 (-1.36)	-2.09 (-1.36)
NL Dum							-7.70*** (-3.61)	-6.18*** (-2.94)	-6.33*** (-3.03)	-6.13*** (-2.95)	-6.063*** (-2.90)	-6.00*** (-2.89)	-5.96*** (-2.78)	-6.35*** (-3.07)	-6.32*** (-3.04)
Nor Dum								4.59*** (3.42)	3.98*** (2.88)	3.85*** (2.80)	3.89*** (2.82)	3.64*** (2.62)	4.00*** (2.76)	3.60*** (2.62)	3.62*** (2.61)
UK Dum									-3.30* (-1.72)	-3.94** (-2.02)	-4.10** (-2.07)	-3.96** (-2.03)	-3.85* (-1.953)	-3.87** (-2.00)	-3.87** (-1.99)
Oil										-0.17 (-1.75)*	-0.14 (-1.29)	-0.16 (-1.61)	-0.17* (-1.75)	-0.16* (-1.72)	-0.16** (-1.71)
Diffoil											-0.06 (-0.47)				
TPES												0.04 (1.03)			
Type Dum													-0.52 (-0.34)		
SV Ger														2.48 (1.61)	2.48 (1.60)
SV UK															0.38 (0.15)
adj. R ²	0.22	0.25	0.27	0.36	0.36	0.37	0.42	0.46	0.47	0.48	0.47	0.48	0.47	0.48	0.48
DW d Stat.	1.51	1.57	1.62	1.78	1.78	1.83	1.85	1.86	1.87	1.90	1.91	1.89	1.91	2.00	2.00
F value						3.05	13.16	11.82	2.97	3.1	0.23	1.07	0.1	2.57	0.02

t-ratio in parentheses

*, **, *** marks significance at the 10%, 5%, and 1%-level, respectively

Overall, our results seem to confirm some of the predicted effects of the changing nature of long-term gas contracts on Europe. Our main hypothesis of decreasing contract length over time, in particular after liberalization in 1998, is confirmed. The coefficients for the year of contract signature (YoS) are negative in all equations and significant in a two-tailed t-test at the 1% level in all cases. European gas importers seem to emulate their US and UK counterparts by reducing contract length as regulatory reform and liberalization proceed. The coefficient of the liberalization dummy (LibDum, i.e. year 1998 or after) is systematically negative, ranging between -1.6 and -4.4. This would suggest that contracts closed in 1998 or thereafter tend to be between 1.5 and four years shorter than those closed before, which is a plausible result. Note, however, that the coefficients of LibDum are not significant throughout, i.e. it is not certain that they are different from zero (columns 10-15). Figure 2 provides a snapshot of the relation:

each cross represents a long-term contract for pipeline gas, whereas the circles depict LNG-contracts. The horizontal axis shows the year of signature of the contract, whereas the vertical axis shows the contract length.³ Although there is quite a diversity of contracts, the reduction of the average contract length is evident.

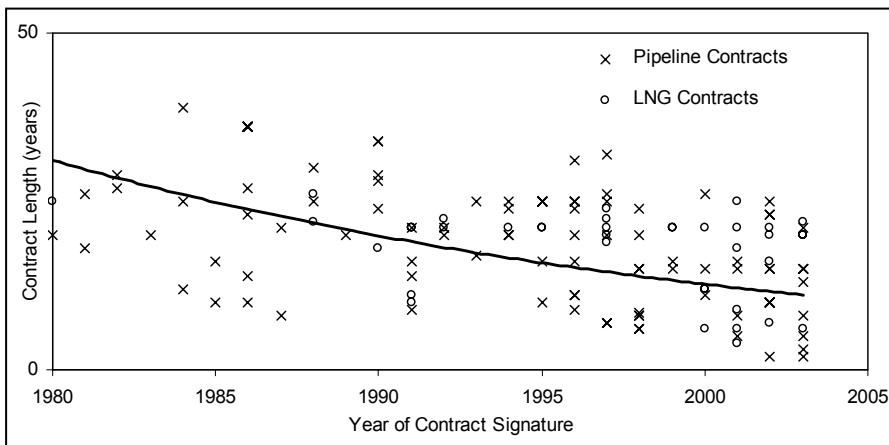
The coefficients for yearly contracted volume (Yvol) have a positive sign, and they are significant at the 1% level in all model specifications. This implies that contract length is positively related to contracted volumes. Thus, higher yearly volumes are insured through contract length. As the contract length is decreasing over time, this relation may reflect a critical issue regarding the long-term security of gas supplies to Europe. Note that the total volume of long-term contracts, i.e. the product of

³ Note that one observation point may represent several contracts: thus, the 1986/36 year combination represents not one, but six different contracts, i.e. the Norwegian Troll contracts struck with several European importers.

contract length and average annual delivery, is definitely diminishing.

Countries capable of importing LNG seem to contract gas for longer periods than their non-LNG-importing counterparts. The LNG-dummy variable is positive and significant throughout, and points at a difference of contract length between 3 and 4 years. It is not certain whether this result speaks against more spot trade in the European markets due to increased imports of LNG. In addition to long-term contracting of LNG, short-term imports could play a significantly higher role in the near future.

The data suggests significant differences in contract length between different exporting countries. The Norwegian contract is on average about four years longer than the others. This may reflect the key role of Norway as a reliable (albeit expensive) exporter. On the contrary, UK gas producers' contracts are about four years shorter than the average. This may be linked to the decreasing reserves and the UK's expected turn from a net exporting to a net importing

Figure 2: Distribution of Contracts struck in OECD Europe since 1980

country after 2010. Contracts with the Netherlands are on average six years shorter. Algerian contracts are about two years shorter than the average (although the values are not significant throughout). Nothing conclusive can be said on Russia.

We find that the oil price prevailing in the year of contract signature leads to shorter contract length. The lagged price for oil does not seem to influence contract length. It also appears neither that contract length is related to the share of natural gas in total primary energy supply (TPES), nor that a difference exists between the contract length of the pipeline and LNG deliveries.

German import contracts are on average two years longer than the average (though the result is not fully significant). This result corresponds with our expectation: Germany is a continental European country that depends heavily on imports, which is to a certain extent reflected in the contract structure. By contrast, the positive sign of the SVUK dummy is less plausible (and it is still less significant than the SVGer dummy; insignificance may be explained with the small number of (eight) UK contracts in the database).

Conclusions

Will Europe have less long-term gas contracts in the future? This paper has provided the first quantitative analysis

of a phenomenon that has been widely observed, but as yet not proven by hard facts. We have shown that the length of take-or-pay contracts for gas supply to Europe has significantly decreased over the past two decades. We suppose that this is driven in large part by the move towards liberalization in the European Union. The country of origin of the gas affects contract length, as does the additional option of LNG-import facilities. Our results do not suggest the disappearance of long-term contracts for European gas supply; rather, long-term contracts will remain necessary to help finance major new gas supply projects. However, long-term contracts will have to evolve further and adapt to the new gas market environment. Further research needs to place the developments in Europe in a global perspective, comparing them with the current dynamics in the other large gas-consuming regions (North America, Asia), in particular with regard to LNG. We also need a better understanding of what the diminishing role of long-term contracts means for long-term price developments.

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