



## Changing Contract Structures in the International Liquefied Natural Gas Markets – A First Empirical Analysis

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## Agenda

1. Introduction
2. Theoretical Framework
  - i. Trade-off between the costs of repeated negotiation and the hazard of being bound to an inflexible agreement
  - ii. Conflicting hypotheses concerning the impact of transaction frequency
3. Data and Methodology
4. First Results and Conclusions

Literature

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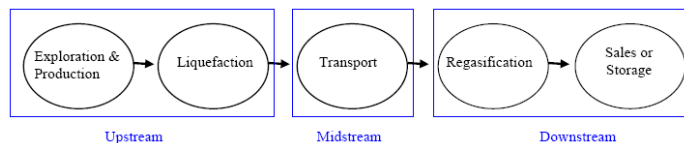
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## Introduction

- Future role of long-term contracts in energy sectors intensively debated
- Changing structure of natural gas markets:
  - Globalization
  - Downstream restructuring
  - Long-term contracts increasingly accompanied by short-term agreements

- Liquefied natural gas (LNG) industry:

- Value added chain:



- Reached maturity during the last decade
- Very dynamic market with global mergers, strategic partnerships, vertical integration, but also non-integrated “tolling facilities” being common practices

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## Introduction II

- How to explain this diversity of governance structures?

**This paper:**

- Trade-off between contracting costs and flexibility discussed in theory and investigated in a number of empirical papers (e.g. Joskow, 1987; Kerkvliet and Shogren, 2001; Neuhoff and Hirschhausen, 2005; ...)
- Contribution to the literature: empirical assessment of LNG supply contracts’ optimal contract duration
- We show that
  - Presence of dedicated asset specificity results in longer contracts whereas
  - Need for flexibility favors shorter contracts
  - With increasing bilateral trading experience contract duration decreases

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Theoretical Framework (I)  
**Optimal Contract Duration – A Trade-Off?**

**Trade-off between the costs of repeated negotiation and the hazard of being bound to an inflexible agreement**

- Optimal CD  $\tau^*$  equates marginal costs  $MC$  and marginal benefits  $MB$  of contracting (Crocker/Masten, 1988)
- $MC$  of being bound in the contract depend mainly on the level of uncertainty  $u$  and increase with CD
- $MB$  of avoiding repeated negotiation depend mainly on the level of specific investments  $s$  and decrease with CD
- Optimization problem:

$$\max_{\tau} G(\tau) \text{ with } G(\tau) = B(\tau) - C(\tau)$$

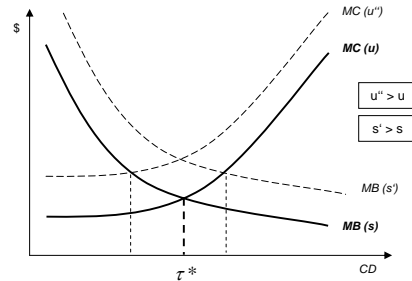
$$G'(\tau) = MB(\tau) - MC(\tau) = 0 \rightarrow MB(\tau^*) = MC(\tau^*)$$

$$MB(\tau^*) = MB(\tau, s, v) = \alpha_0 + \alpha_1\tau + \alpha_2s + v$$

$$MC(\tau^*) = MC(\tau, u, \omega) = \beta_0 + \beta_1\tau + \beta_2u + \omega$$

$$\tau^* = \gamma_0 + \gamma_1s - \gamma_2u + \varepsilon$$

$$\text{with } \gamma_0 = \frac{\alpha_0 - \beta_0}{\beta_1 - \alpha_1}, \gamma_1 = \frac{\alpha_2}{\beta_1 - \alpha_1}, \gamma_2 = \frac{\beta_2}{\beta_1 - \alpha_1}, \varepsilon = \frac{v - \omega}{\beta_1 - \alpha_1}$$



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Theoretical Framework (II)  
**Conflicting Hypotheses on the Impact of Transaction Frequency?**

**High frequency may lead to more “firm-like” governance forms:**

- TCE argues that transaction costs increase with transaction frequency  $f$  due to repeated bargaining and the repeated hazard of opportunistic behavior
- Williamson (1985): High frequency results furthermore in a greater potential for internal specialization and for exploiting scale economies

**High frequency may lead to more “market-like” governance forms:**

- Decreasing transaction costs due to learning processes, developing routines and reputational effects (e.g. Milgrom/Roberts, 1992; Langlois, 1992; Garvey, 1995)

**These are complementary perspectives:**

**“Within” the relationship versus “between” the trading partners**

$$\tau^* = \gamma_0 + \gamma_1s - \gamma_2u + \gamma_3fw - \gamma_4fb + \varepsilon$$

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**Propositions**

**Proposition 1a:** CD should increase with the **level of investments in idiosyncratic assets** to avoid repeated bilateral bargaining and mitigate the ex-post hold-up problem between supplier and buyer.

**Proposition 1b:** Higher **environmental uncertainty** should reduce CD to minimize the inflexibility of being bound in a long-term commitment not reflecting market realities.

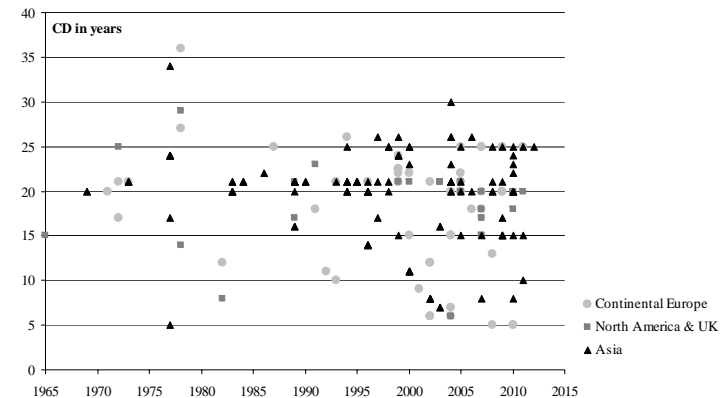
**Proposition 2a:** CD should increase with the level of **frequency** of the transactions **within** the trading relationship to avoid the repeated hazard of post-contractual opportunism by the non-investing party.

**Proposition 2b:** CD should decrease with the **frequency** of transactions **between** the same trading parties due to learning and reputational effects.

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**Dataset**

- Global dataset, compiled from various publicly available information
- Unit of analysis: LNG supply contract concluded between upstream seller and downstream buyer (216 observations)
- Transactions are defined as cargo deliveries of LNG



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## Exogenous Variables

Characteristic	Proxy	Denotation	Exp. Sign
Propositions 1a and 1b			
Dedicated asset specificity	Ratio to which the contract exploits the nominal capacity of the import terminal [%]	RCAPSHARE	+
External uncertainty and need for flexibility	Political instability in the supplying country	UNCERT	-
	Standard deviation of WTI crude oil spot price in the year before contract signature	STDEVOIL	-
	Dummy [D=1 for start-up after 1999]	D2000	-
Propositions 2a and 2b			
Within frequency	Annual contracted volume [bcm/a]	VOL	+
Between frequency	Bilateral trading experience: count index, cumulative number of contracts negotiated between the two parties	BILEXP	-
Control variable			
Dependence on LNG	LNG share in total natural gas imports [%]	LNGSHARE	+
Instruments			
Import terminal capacity	Nominal capacity of the import terminal [bcm/a]	CAP	
Self-sufficiency	Domestic production/total consumption [%]	SELSUFF	
Number of import terminals	Number of import terminals in the country	TERMINALS	

## Methodology

- CD as dependent variable:

$$CD_i = \phi_0 + \phi_1 RCAPSHARE_i + \phi_2 UNCERT_i + \phi_3 STDEVOIL_i + \phi_4 VOL_i + \phi_5 \log(BILEXP)_i + \phi_6 LNGSHARE_i + \phi_7 D2000_i + \zeta_i \quad (1)$$

- However, contracted VOLUME and CD are determined simultaneously, therefore we estimate the model applying system two-stage least squares (S2SLS)

$$VOL_i = \theta_0 + \theta_1 CD_i + \theta_2 SELFSUFF_i + \theta_3 CAP_i + \theta_4 TERMINALS_i + \xi_i \quad (2)$$

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## Estimation Results

Specification		System 2SLS		System GMM	
		Parameter	Corrected standard errors	Parameter	Corrected standard errors
CD = dep. var.	CONSTANT	17.905 ***	1.463	15.423 ***	1.305
	RCAPSHARE	3.998 *	2.463	4.117 **	2.205
	UNCERT	0.579	0.945	0.916	0.859
	STDEVOIL	-1.178	2.427	-0.200	2.139
	D2000	-2.534 ***	0.720	-1.933 ***	0.629
	VOL	0.201	0.533	0.458	0.467
	LOG(BILEXP)	-2.723 ***	0.673	-2.421 ***	0.627
	LNGSHARE	2.701 ***	1.034	4.264 ***	1.020
	Adjusted R <sup>2</sup>	0.185		0.177	
	p-value F-stat. N	0.000 216		0.000 216	
VOL = dep. var.	CONSTANT	-0.873	0.861	-0.807	0.763
	CD	0.149 ***	0.044	0.144 ***	0.038
	SELSUFF	1.103 ***	0.363	1.066 ***	0.358
	CAP	0.021 ***	0.007	0.013 ***	0.008
	TERMINALS	-0.040 ***	0.010	-0.041 ***	0.009
	Adjusted R <sup>2</sup>	0.103		0.091	
	p-value F-stat. N	0.000 216		0.000 216	

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## Conclusions

- This paper provides an empirical study investigating the optimal contract duration of LNG supply contracts
  - Presence of high dedicated asset specificity results in longer contracts
  - Increasing need for flexibility in today's "2nd generation" LNG industry reduces contract duration
  - "Within" versus "between" perspective concerning transaction frequency
- Limitations:
  - Ambiguous and non-significant results for uncertainty variables → external uncertainty should be split into different components
  - Contractual provisions interact → but: very limited data availability
- Future research need:
  - Alternative theories should be tested against each other and/or combined
  - Empirical studies investigating the simultaneous choice of contract provisions

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Thank you very much for your attention!  
Any questions or comments?

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