Ph.D. Dissertation in Engineering

The evolution of the long-term natural gas contracts in the changing industry environment

변화하는 산업 환경에서의 장기 천연 가스 계약의 진화

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Abstract

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The purpose of the dissertation is to look into the developments in the natural gas industry and markets happening on the global and regional level approaching from the lens of evolution of long-term contracts that are likely to have effects on the country level with regards to natural gas importing and exporting countries.

This dissertation is made up of two essays.

The first essay using instrumental variables methods, such as: two stage least squares (2SLS), generalized method of moments (GMM) and limited information likelihood (LIML) regressions empirically explores the evolution of the long-term contracts via analysis of the effects of market deregulation, technological change, an increase in LNG tanker fleet capacity,

global economic recession to the length of the contracts for the sale and purchase of natural gas. In this context three models has been formulated. The first one analyzes pipeline gas contracts, while the second model looks into the liquefied natural gas contracts and the last one deals with both contracts. To sum up, overall results indicate that the duration of the contracts tended to decrease on average due to occurrence of the aforementioned factors and events. The only point is that LNG contracts concluded during the global economic recession tend to be longer on average, but more flexible at the same time.

In the second essay, using probit model with endogenous covariate we are exploring the LNG market and trade flexibility brought by the ability of liquefied natural gas cargo diversion via analysis of the determinants for the choice of flexible destination clauses in long-term liquefied natural gas sales and purchase agreements. We defined the destination clause as the DES delivery terms stipulated in the contracts concluded between the seller (exporter) and buyer (importer) of the chilled gas. Therefore, we analyze the effect of the factors that are prevalent in the global gas markets - and LNG markets in particular - today for the choice of FOB contracts. To sum up, the findings clearly imply that the most of the factors, developments and unfolding in the current liquefied natural gas markets, industry and value chain links favor or affect the choice of more flexible contractual arrangement. Furthermore, this trend is likely to be persistent in the mid- and long-term further contributing to the overall flexibility of the LNG trade, which in its turn is likely to affect the overall flexibility of the global gas markets.

To sum up, we believe that the results of quantitative analyses can be taken into account during the process of strategy formulation in the gas exporting and importing countries as majority of them use long-term contracts in the natural gas trade.

Keywords: Natural gas; LNG; long-term contracts, destination clause, technological change, transaction cost, gas demand security.

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LIST OF ABBREVIATIONS

2SLS: Two stage least squares

bbl.: barrel

BP: British Petroleum

Bcm/a: Billion cubic meters per annum

CIF: Cost, insurance and freight paid

CFNAI: Chicago Fed National Activity Index

DES: Delivered ex-ship

EIA: Energy Information Administration

FERC: Federal Energy Regulatory Commission

FOB: Free on board

FSRU: Floating Storage Regasification Unit

FLNG: Floating liquefied natural gas

GECF: Gas Exporting Countries' Forum

GIIGNL: Group International des Importateurs de Gaz Naturel Liquefie (International Group of Liquefied Natural Gas Importers)

GMM: Generalized method of moments

HH: Henry Hub

ICC: International Chamber of Commerce

IEA: International Energy Agency

INCOTERMS: International Commercial Terms by International Chamber of Commerce

IV: Instrumental variables

JCC: Japan Crude Cocktail

JKM: Japan Korea Marker

LIML: Limited information maximum likelihood

LNG: Liquefied natural gas

LOP: Law of One Price

MT: million tons

mtpa: million tons per annum

OLS: Ordinary least Squares

OPEC: Organization of Petroleum Exporting Countries

PNG: Pipeline natural gas

REED: Risky Energy Export Demand Index

SPA: Sales and purchase agreement

TPA: Third party access

UK: United Kingdom

US: United States

USD: US Dollar

PART I GENERAL INTRODUCTION

Chapter 1 Introduction

1.1 Rationale for the research

Currently, accounting for about 23% of the world energy demand, natural gas is the cleanest and most hydrogen-rich of all the hydrocarbon energy sources. It is plentiful as there are discovered, but unexploited resources of natural gas all over the globe. (Economides & Wood, 2009)

Presently paradigm shift is observed in the global energy pricing and it very likely the days when crude oil price of 70 USD and higher was the norm are behind, leaving uncertainty about possible rebound to historical trading ranges. At the same time, the dynamics of the gas industry are also changing as new projects come on stream, making significant effect on gas hubs' spot pricing levels and ultimately having profound effects on both natural gas exporting and importing countries.

Shale gas revolution in the US is likely to result in increasing exports of liquefied natural gas to various destinations in accordance with long-term, short-term and spot contracts adding to the flexibility, liquidity as well as spurring further convergence between previously regionally isolated gas markets. Notwithstanding bright picture in the short and medium terms, low prices may hinder capital investments has to be made for the future supplies as demand inevitably is going to pick up in the longer-term under the effect of some factors such as the rise in global population.

Table 1.1 Top ten natural gas producers and consumers[1]

Producers				Consumers			
No	**Country**	**Natural gas production volume (bcm)**	**Share of the total**	**No**	**Country**	**Natural gas consumption volume (bcm)**	**Share of the total**
1	United States	767.3	22%	1	United States	778	22.8%
2	Russian Federation	573.3	16.1%	2	Russian Federation	391.5	11.2%
3	Iran	192.5	5.4%	3	China	197.3	5.7%
4	Qatar	181.4	5.1%	4	Iran	191.2	5.5%
5	Canada	163.5	4.6%	5	Japan	113.4	3.3%
6	China	138	3.9%	6	Saudi Arabia	106.4	3.1%
7	Norway	117.2	3.3%	7	Canada	102.5	2.9%
8	Saudi Arabia	106.4	3%	8	Mexico	83.2	2.4%
9	Algeria	83	2.3%	9	Germany	74.6	2.1%
10	Indonesia	75	2.1%	10	United Arab Emirates	68.3	2.0%

Many of the exporting countries have traditionally resorted to the use of long-term contracts for the sale of their natural gas to be able to share risks related to the sunk investments made for gas production, processing and transportation infrastructure. However, year-on-year increases in supplies thanks to monumental investments made during the period of fairly high oil and gas prices resulted in new discoveries, shale gas development and subsequently many projects (especially LNG terminals) to come on stream in a few years. This is likely to result in the claim for more flexible contractual arrangements from the buyer’s side. Therefore it is of foremost interest to elaborate on the possible evolution path of the contracts by means of analyzing empirically to what extent it has already happened. Current anemic demand and abundant supply equated to low prices in global gas markets may

[1] Source: BP (2016)

induce exporter countries to search for new, probably more flexible business models and innovative ways of natural resources monetization.

Another interesting issue is the flexibility in long-term contracts. Traditionally, natural gas producers have been resorting to the incorporation of various restrictive clauses to the pipeline gas and LNG exports deals. Take-or-pay clauses requiring the offtake of the predetermined annual volumes and destination clauses are the most important of them. While generally destination clauses are prohibited in the Continental Europe with reference to the breach of 1958 Treaty of Rome norms that require free competition, they ceased to be usual business practice in liberalized gas markets of United Kingdom or United States. Nevertheless in the other markets organizational form still resembles traditional monopolistic structure.

The development of liquefied natural gas market has made the resource mobile in terms of reach to different markets in various regions. Common sense tells us that this should have led to price convergence among global gas markets as chilled gas volumes are able to be arbitraged between various markets, moving from cheaper price regions to markets where they are more valuable less transportation costs. But here is the point is that destination restrictions are available in the number of the long-term contracts for the LNG trade too. They are incorporated in the gas trade deals through direct restriction of destination or through resorting to the INCOTERMS rules by International Chamber of Commerce. Traditionally, FOB (free on board) or DES (delivered ex ship) delivery terms have been used in the LNG sale and purchase agreements (SPA) to stipulate which party pays transportation costs, when the title or ownership for the cargo passes on to the buyer etc. In this context DES defines that the title and ownership of the cargo passes on to the buyer in the destination port. As a result, the incorporation of DES delivery term into the LNG trade contract serves as a destination restriction largely affecting the flexibility of liquefied natural gas especially in terms of the reach of the markets where they need it most at the specific time, i.e. limiting arbitraging between markets by the buyer. Therefore we found it interesting to look into the factors that affect the choice of destination flexibility in the long-term LNG contracts as it will be vital for overall flexibility of the global gas markets in the future.

1.2 Research objective

The purpose of the dissertation is to look into the evolution of long-term contracts from the perspective of the effect of changing industry environment on the duration of the long-term natural gas contracts and factors affecting the choice of destination flexibility in the long-term LNG SPAs. We argue that both shortening of the long-term gas contracts duration and the choice of flexible destination contractual provisions is likely to affect the overall flexibility of the regionally disparate gas markets through pushing them towards price convergence. Consequently, it might affect the gas exporters' revenue flow stability, demand security and ex-ante and ex-post transaction costs such as finding new trade partners, negotiation of terms, maladaptation and contract renegotiation. At the same time naturally it is going to open new opportunities for gas importing countries in order to benefit from the gas markets flexibility.

We believe that the results of quantitative analysis would serve as one of the references during elaboration of future gas export and import strategies as a response to the alterations in the global gas markets.

1.3 Research questions

We formulated two main research questions and five sub-questions related to the first research question as follows:

RQ1: What is the effect of changing industry environment on the duration of long-term natural gas contracts?

- RQ 1.1 What is the effect of transition from a monopoly industry to competitive market structures in gas industry on the average contract duration?
- RQ 1.2 What is the effect of global economic recession on the average duration of LTGC's?
- RQ 1.3 What is the effect of absence of the destination clause in the LNG contracts on their average duration?
- RQ 1.4 What is the effect of technological progress on the average duration of LTGC's?
- RQ 1.5 What is the effect of an increase in the LNG carrier fleet size on the average contract duration?

RQ2: What are the determinants for the choice flexible destination long-term liquefied natural gas sale and purchase agreements?

1.4 Methodologies

The scope of methodologies ranges from qualitative to quantitative analysis via utilization of two stage least squares instrumental variable regression (2SLS), generalized method of moments (GMM), limited information likelihood estimation (LIML), probit and probit model with endogenous covariates (IV probit).

1.5 Research Contributions

This study is expected to make several contributions to the research in the field of long-term gas contracts.

Previous literature looked into the issue of long-term contracts from the importer's perspective; however we approach from gas exporter's side, while making brief conclusions for importers too.

To the best of our knowledge it will be the first empirical study that quantitatively analyzes the determinants of the choice of flexible destination LNG contracts. Furthermore, we construct the 'destination clause' variable by means of utilizing the INCOTERMS[2] 2000 to find out whether the availability of so called "destination clause" or DES (ex-ship) delivery basis affects the contract length compared to more flexible delivery on the FOB basis.

Then, we quantify the technological change in the LNG industry and test the hypothesis related to its effect on length of contracts on average. Also

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[2] The International Commercial Terms (INCOTERMS) are a series of predefined terms published by the International Chamber of Commerce (ICC) related to international commercial law. They are widely used in International commercial transactions or procurement processes as their use in international sales is encouraged by trade councils, courts and international lawyers.

we make use of liquefied tanker fleet data to check the effect of growing tanker fleet size on the long-term contracts duration and the effect of economic recession.

Moreover, we approach long-term contracts from the perspective of means and one of options for fostering energy security and gas demand security in particular.

Finally, we believe our research outcomes can serve as a departing point in the situation assessment on the way of taking strategic decisions by the decision-makers in the gas exporting countries.

1.6 Structure of the dissertation

The structure of dissertation is presented in the Table 2.

Table 1.2 Dissertation structure

PART		CHAPTER	RESEARCH OBJECTIVE	RESEARCH QUESTIONS OR HYPOTHESES
I	GENERAL INTRODUCTION	1	Introduction of the research framework.	What is the rationale for the research? What are the research objectives? What are the research questions, methodologies and contributions? What is the structure of the dissertation?
II	LONG-TERM NATURAL GAS CONTRACTS EVOLUTION IN THE CHANGING INDUSTRY	2	Main features of long-term gas contracts for the export of pipeline gas and LNG.	What are the specificities inherent in the long-term pipeline gas and LNG contracts?

	ENVIRONMENT	3	Empirical assessment of the effect of changing gas industry and market environment on the duration of the long-term natural gas contracts.	How do gas market liberalization, global economic recession, technological progress, an increase in the LNG tanker fleet size and availability of FOB shipping terms in contractual provisions affect the length of long-term gas contracts?
III	FLEXIBILITY IN LONG-TERM LNG CONTRACTS	4	An empirical assessment of the determinants for the choice of flexible destination liquefied natural gas contracts.	What are the factors that affect the choice of destination flexible long-term LNG contracts?
IV	CONCLUSION	5	Conclusions and policy implications	What are the findings from the research? What are the possible directions for future research based on the results of the current study? What are the policy implications for gas exporting and im-porting countries?

PART II LONG-TERM NATURAL GAS CONTRACTS EVOLUTION IN THE CHANGING INDUSTRY ENVIRONMENT

Chapter 2 Long-term contracts and natural gas pricing

2.1 Introduction

Long-term take-or-pay (ToP) contracts tie sellers and buyers for a considerable period of time, with strictly defined obligations towards each other. 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 (Crocker & Masten, 1991). Therefore, risk sharing along the gas chain is settled by buyer bearing the volume risk and the seller the price risk. By means of such contracts strong basis for investment in highly asset-specific and capital-intensive infrastructure is established. (Joskow, 1987; Newmann & Hirchhausen, 2004; Ruester, 2009)

Coase (1937) underlines the role of long-term contracts - besides markets and vertically integrated firms - as one of the possible instruments of economic interaction in market economies. There are specific transaction costs that are inherent in each of those mechanisms:

- Markets: the costs related to information acquisition and risks management;

- Vertically integrated firms: depending on the firm size, the costs of a hierarchical organization and control;
- Long-term contracts: the costs of their negotiation and enforcement.

To sum up, high specificity of investment, shipping and storage costs has been among critical factors favoring the creation of marketplaces featuring the gas trade based on long-term contracts. (Newmann & Hirchhausen, 2004)

2.2 Pricing mechanisms in gas industry

Due to disparate nature of regional gas markets, presently there is no common world gas price. Eight different pricing systems were found to be available throughout the world in accordance to International Gas Union (IGU) Survey held in 2009: (Jensen, 2011)

1. *Gas-to-gas competition*. Gas is priced in free-market on a spot basis or under long-term contracts.
2. *Oil price indexation*. Prices are set by formula under long-term contracts, pegged to oil prices with some lag of usually several months.
3. *Bilateral monopoly*. It has been the dominant pricing mechanism in interstate gas dealings of the Former Soviet Union, Central and Eastern Europe.
4. *Netback from final product*. Price received by the gas seller reflects the price received by the buyer.

5. *Regulation (cost of service)*. Prices are approved by a regulatory authority so as to cover supply costs including a reasonable return on investments.
6. *Regulation (social/political)*. Prices are set and adjusted typically on an *ad hoc* irregular basis by the government taking into account buyers' perceived ability to pay, sellers' perceived costs, and the government's revenue needs.
7. *Regulation (below cost)*. The government knowingly sets prices below the sum of production and transportation costs as a form of subsidy to the buyers and usually reimburses the seller from the state budget.
8. *No price*. The extreme form of regulation (below cost).

The most common systems were gas-to-gas competition (33%) and regulation below cost (25%). This is largely because gas-to-gas competition operates in North American market and many governments use international pricing for exports, but subsidize their own consumers. (Jensen, 2011)

Countries exporting natural gas on the basis of long-term contracts tend to focus on markets of countries favorable both in terms of volume and price. In order to prohibit gas re-sale while exporting to "less attractive markets" same netback price is offered and destination clauses are incorporated. Furthermore, exporters will tend to concentrate on the premium segments of the import country. In the case of exporting to non-premium segments, these segments are isolated to avoid a deterioration of average export price. (Energy Charter Secretariat, 2007, p.48)

After the deregulation in the second half of the 1980s, North American gas presently has flexible market with freely traded pipeline capacities. Prices tend to be volatile; participants in the market make use of derivatives such as seventy-two month futures contracts offered by NYMEX to manage price risk in physical spot markets. The North American gas system has developed around a number of ‘hubs’ where pipeline interconnections bring gas flows together from various sources and re-distribute it to different market regions. Henry hub serves as reference point in national gas trading and it has become the focus for the Henry Hub futures market trading on the NYMEX. When investment in new capacity is required, project sponsors will usually hold an ‘open season’ for potential shippers who are prepared to assume ‘ship-or-pay’ obligation so that the debt service on the investment is protected. (Energy Charter Secretariat, 2007, p.119-120)

UK’s transition from a government gas monopoly to liquid and competitive market today was a product of supply and demand conditions and major policy initiatives. On the supply side - reliance on low-cost gas from the Central North Sea domestic gas, discovered in 1965, and, on the demand side - the need to expand the UK’s power sector in an environmentally friendly way by using gas-fired power plants. Policy instruments in The Natural Gas Act of 1986, initiated by the Conservative government of Margaret Thatcher included:

- Privatization of monopoly - British Gas: The original British Gas has now devolved into three separate corporate activities: BG (acquired by Shell recently) – formerly the parent company, now is a major international gas company that is especially active in LNG, Centrica – the former marketing arm, now is a successful independent gas marketer and TransCo – the former transmission company that manages the gas transportation operations and has been acquired by the National Grid, which operates the transmission system that has five terminals (Bacton, Theddlethorp, Easington, Teesside and St. Fergus) where offshore pipelines connect to the grid. Once the gas passes the entry point it is considered to be on the NBP where it can be traded and taken out at any exit points.
- Creation of a regulatory body, Ofgas (later Ofgem) to oversee competition: In 1989 Ofgas limited British Gas's purchase of supply from new fields to 90%, required third-party access [3] on it's transportation system. (Energy Charter Secretariat, 2007, p.126)

Bacton (UK) - Zeebrugge (Belguim) Interconnector is used for forward flow for much of the year but backflow during the UK's seasonal winter peaks allowing UK using storage on the Continent to manage its seasonality.

[3] Note: Onshore, the third-party access works on the basis of entrance and exit charges for each of the receipt and delivery points on the grid plus a fee independent of location. The Article 18 of the EU's 2nd Gas Directive of 2003 prescribes third-party access to LNG terminals as a rule, however, exemptions for new infrastructure, including new LNG terminals may be granted according to Article 22.

To sum up, new gas imports to UK are an interesting mixture of some traditional long-term import contracts (some now linked to the gas spot price of International Petroleum Exchange, instead of fuel oil indicators), gas flows triggered by arbitrage with the Continent via the UK Interconnector and LNG supply subject to arbitrage with the other markets.

Despite gas market reforms in EU since the end of the 1990s, long-term import contracts has been persistent as the dominant import arrangement, now complemented by some imports, on a short-term basis from the UK and spot LNG. Adaptations to changed circumstances happened by modifying the original long-term contracts through changing the price formula to reflect the development in the competitive position of gas, mainly by increasing the share of gas oil, but also by including elements to reflect the changed role of gas in power generation and later the role of gas-to-gas competition, some modifications as to the size of volumes, term and more flexibility regarding the delivery point.

2.3 Long-term take-or-pay export contracts

In Continental Europe current long-term contracts date back to 1959, when Groningen field in the Netherlands was discovered. Nota de Pous presented to the Dutch parliament in 1962 by then Minister of Economic Affairs, established the main principles of the Dutch gas policy. In order to generate maximum revenue for the state, replacement value principle was introduced as the basis for gas marketing as opposed to prevailing cost plus principle. The price of gas was linked to the price of alternative fuels likely to be substituted by the different types of consumers – for instance, gas oil for small-scale users and fuel oil for large-scale users. As a result the major elements incorporated in gas export contracts were the following: (Energy Charter Secretariat, 2007)

- Long-term supply and offtake obligations ensured by the take-or-pay concept: the seller would commit a certain amount of gas reserves as well as gas delivery capacity and the buyer would commit a certain market volume;
- Pricing based on the concept of netback value calculated on the basis of the value of competing energies backed to the border of the buyer's country by deducting buyer's transportation and distribution costs: Under this concept the base price of gas would be re-calculated at regular intervals (monthly or quarterly) in line with the absolute price movements of the competing fuels;
- The possibility of price reviews at regular intervals (typically three years) in order to adapt to changed market circumstances: If the circumstances beyond the control of the Parties change significantly compared to the underlying assumptions in the prevailing price provisions each Party is entitled to an adjustment of the price provisions reflecting such changes;
- The possibility to invoke arbitration in case of disagreement on the price adjustment.

Pm = Po + 0.60 x 0.80 x 0.0078 x (LFOm - LFOo) + 0.40 x 0.90 x 0.0076 x (HFOm - HFOo)

(i) The gas price Pm: applicable during the month m is a function of the starting gas price Po and

- the price development of competing fuels compared to the reference month, in this example: Light Fuel Oil (LFO) and Heavy Fuel Oil (HFO)

(ii) 0.60 and 0.40 are shares of gas market segments competing with respective fuels (no dimension):

- Light Fuel oil/Heavy Fuel Oil
- These shares will be different from the shares of these fuels in total energy use; e.g., the share of heavy fuels used in most European markets is now rather small, however, it remains the best available alternative for most of the gas used for industrial purposes
- ***0.80 and 0.90: Pass through factors (no dimension)**:*
  - Sharing risk and reward of the price development between seller and buyer
  - Most of risk and reward for the seller (0.80/0.90)
  - May be different for different fuels

(iii) 0.0078 and 0.0076: Technical equivalence factors to convert the units of prices for fuel into units of gas price

In this example:
Gas in kWh (GCV), Fuel oil in t,
Dimension: Euro cts / kWh / Euro / t

(iv) Competing Fuels

Quotations reflecting the market
With or without taxes on competing fuels
Time lag and Reference Period to be defined
LFO: Price of Light Fuel oil
LFOo: Price of Light Fuel Oil for starting month o
LFOm: Price of Light Fuel Oil resulting for month m (may refer to an average value of previous months depending on reference period and time lag agreed)
LFO is usually reflecting competition for medium and smaller customers whose alternative is using Light Fuel Oil (typically small industry, commercial, administration, households).
Serving those customers requires also investment into distribution (grid) to medium and small customers, and eventually more instruments to provide the flexibility needed. That would have to be taken into account in the determination of Po.
HFO: Price of Heavy fuel oil
HFOo: Price of Heavy Fuel Oil for starting month o
HFOm: Price of Heavy Fuel Oil for month m
Reflecting competition for larger customers whose alternative is using Heavy Fuel Oil (typically in boilers)

(v) Determination/negotiation of Po (starting price in month 0) reflecting the netback to the point of delivery:

Use of Currency (of the sales market)
Po determined (negotiated) as:
Replacement value minus costs to bring the gas from the delivery point to the customers minus marketing incentives.

Figure 2.1 Stylized Price Formula under the Netback Concept of Long-Term Contracts.[4]

The concept of replacement value results in different netback values at the exporting country's border for different customers due to variation in

[4] Source: Energy Charter Secretariat, 2007, p.154.

transportation costs. For instance in pipeline gas trade export prices at delivery point X for supplies to markets Y and Z are calculated as a price at consumer market less transportation cost from delivery point X. Thus, on the netback basis the longer the distance from the delivery point to the particular market, the lower the price of gas at this point for the supplies to this specific market. Theoretically this creates opportunities for arbitrage by the buyer. Consequently, “destination clauses” prohibit reselling of the gas destined for a market which is more distant from the delivery point at a cheaper price at the closest to the delivery point market to protect exporter position. (Konoplyanik, 2005)

The organisation of Russian gas exports to Europe has been based on Groningen concept with some specificities such as minimum-pay obligation with a high annual load factor in order to ensure a high utilization rate of pipeline system. Since 2005, Gazprom takes the price in the main EU markets at the end of the pipeline (Germany, France and Italy), as a reference point, and then deducts the difference in transportation costs. (Energy Charter Secretariat, 2007, p.167)

Table 2.1 Some of the existing long-term contracts between Gazprom and European customers[5]

Buyer	**Seller**	**Starting date/Date of extension or renewal**	**Ending date**	**Annual Volume in Bcm**
OMV (Austria)	Gazexport (Russia)	2006	2027 (an extension from previous deadline 2017)	7 Bcm/year

[5] Based on the data from Energy Charter Secretariat, 2007, p.158.

ENI (Italy)	Gazprom (Russia)	2006	2035 (an extension from previous deadline in 2017)	3 Bcm/year
E.ON-Ruhrgas (Germany)	Gazprom (Russia)	-	2036 (an extension from previous deadline in 2020)	24 Bcm/year
Gaz de France (France)	Gazprom (Russia)	2006	2030 (an extension of an existing contract)	16 Bcm/year

The main elements of the Norwegian long-term export contract from Troll field included: (Energy Charter Secretariat, 2007, p.160)

- A price review clause;
- A price was in local currency, with 50-60% indexation to light fuel oil, the rest to heavy fuel oil and a special element to reflect competition with electricity in French case;
- National border of the buyer was defined as a delivery point;
- An option to increase original volumes (by 80% or more) was granted to buyers, conditional on an obligation to use it in covering at least a part of incremental demand.
- An annual take-or-pay obligation.

First Algerian LNG deals with the UK and the US were fixed-price deals, and then in mid-1970s Sonatrach concluded LNG contracts with Spain, France and Belgium on a netback basis with an indexation to fuel oils. Presently, Algeria has – unlike the other large exporters to the EU – a substantial part of its price formulas pegged to crude oil instead of to fuel oils. (Energy Charter Secretariat, p.161)

2.4 Long-term contracts in traditional LNG trade

Long-term contracts concluded for the duration of more than 20 years have been serving as traditional contracting pattern in the LNG industry as each element in its value chain is capital-intensive and the investment is usually front-end loaded so that revenue does not begin to flow until the project is complete. FOB or DES was used as delivery terms, determining which party assumes the tanker transportation responsibility. Traditionally tankers were dedicated to the specific project during its lifetime and could be owned by buyer, seller or independent ship-owners. Furthermore, LNG long-term Sale and Purchase Agreements overseeing the logic of 'the buyer takes the volume risk and the seller takes the price risk' had take-or-pay provisions and indexation was principally defined in oil terms. Chilled gas projects have been tied to a specific large field or group of fields and unless the project is developed solely by a national oil company, project developers have usually been joint ventures of several companies. Since traditional LNG contract buyers were usually national companies or regulated utilities with exclusive concessions, such as Gaz de France or Tokyo Electric, they could reasonably foresee and manage market development and thereby handle the market risk implied by the take-or-pay and minimum pricing clauses. Nevertheless, contracting in LNG is becoming much more flexible with introduction of small, but growing short-term market, and development of 'self-contracting'. In a 'short-term' market buyers swap cargoes from time to time as one customer found himself temporarily long on supply while another was temporarily short. Still, long-term contracts have remained as the principal means of sharing risks among venture partners. This is partly due to the supplier's reluctance to proceed with a new project without some degree of long-term contract protection despite substantial pressure to increase flexibility in LNG contracting. On the other hand, buyers are now commonly smaller and much more sensitive to price competition. By seeking to minimize their market risks by relying on gas market indicators, they have effectively transferred more of the project risks to the sellers. The response of the sellers has increasingly been towards 'self-contracting' with their own marketing affiliates, effectively integrating downstream to sell directly to smaller re-sellers or end users. For instance, in traditional contracting, the venture partners usually market as a group directly to specific customers and the contract designates the destination of the cargoes. In self-contracting, one or more of the partners in the venture (or their marketing affiliates) sign the SPA with the venture and assume the marketing risk for the contracted volumes. The resulting volumes commonly become part of the seller's supply portfolio and can be sold under any terms and conditions that he chooses to utilize. Self-contracting is becoming the predominant pattern in liberalized markets of North America and UK where gas-to-gas competition prevails. Cargoes being shifted between Nigeria and Trinidad on the one hand and the US and Spain on the other, the Atlantic Basin has become the major LNG arbitrage market. Some mechanism to share those rents is commonly included in the agreement, in case if arbitrage presents the possibility of added rents.

(Energy Charter Secretariat, 2007; Crocker & Masten, 1991; Jensen, 2004; Neumann and Hirschhausen, 2004; Ruester, 2009; Talus, 2011)

Northeast Asia, Continental Europe, North America, the UK, China and India are currently six significant regional markets importing LNG. Gas pricing in Northeast Asia and Continental Europe is a product of the price negotiations that buyers have had over the years with their suppliers. North America and the UK have liberalized their gas industries, and their gas pricing has reflected competition among indigenous suppliers for outlet. China and India have a history of local gas pricing that has been heavily influenced by regulation. Japanese, Korean and Taiwanese contracts use Japanese Customs Clearing price for crude oil indexation. In this context, the first new Middle East contracts to Korea and Japan retained the JCC pricing formulas and competition centered on price capping mechanisms. For instance, the first Korean contract from Rasgas 1 project (Qatar) had included a floor price; however, after Oman offered Kogas a contract without a floor price, Rasgas removed the floor price from the first contract as a part of negotiations for expanded deliveries. Moreover, the late 1990s saw the shortening of contract terms (i.e. from 20 to 15 years or less) and some additional off-take flexibility. Furthermore, there were a number of innovative contracts, such as ones signed by Petronas (Malaysia) provided for three tranches of contract commitment. The base load portion of the contract with a group of Japanese buyers operated as a traditional 20-year take-or-pay contract, the second tranche was annual having the same terms as the base load except fixed take obligation and last tranche was simply supply option. Rasgas has a long-term contract with the Daheej terminal in India where they have established a fixed price ($2.53/MMBtu FOB Qatar) to operate for a period of five years before the oil escalation clause kicks in. After the fixed price period expires, the contract is supposedly pegged to $20/bbl oil, with a 0.13 'A' coefficient in a P=A*Oil Price formula. Regarding contracts with Pacific Basin countries, in the most of Algerian SPAs for European buyers some form of oil-indexation remains as the dominant pattern. At the same time the seller was willing to offer indexation terms of a mix of crude oil and products, partial indexation to electricity, coal or to inflation. Nigerian export contracts pricing clauses for the most part reflect competition with pipeline supply in their markets and utilize some mix of fuel oil and gas oil pricing. The exception is the contract with power generator ENEL where price clause is believed to include coal and inflation in addition to oil prices. Starting in 2001, Qatar began contracting with customers in Spain and Italy, presumably utilizing competitive escalation clauses and in the US and the UK primarily contracting with venture partners who will market the LNG on behalf of the venture. (Energy Charter Secretariat, 2007)

2.5 Conclusion

For those markets that have been developed largely on the basis of imported supply, such as the European Continent and Northeast Asia, long-term contracts have been extremely important and are likely to remain so. Pricing clauses in these contracts have commonly been tied to either crude oil or products prices and many contracts allow for a regular review of the pricing formula. However, for markets that have historically been largely self-sufficient and have restructured their gas industries, such as North America and the UK, short-term contracting prevails and oil-linked pricing is a rarity.

At the same time significant volumes of LNG have been contracted by aggregators, some of them selling gas to different companies under long-term contracts based on their global portfolio, others may retain some LNG volumes to feed the markets where they operate and arbitrage between the different import regions. For instance in the event of cold weather and resulting supply shortage in one region aggregators would benefit from higher margins, but during the periods of low demand and a comfortable supply resulting in low spot prices their margins will be eroded.

Destination clauses are of the most important features of the long-term contracts. They do not allow re-export of the cargoes by the importer to benefit from arbitraging opportunities. Such clauses have been gradually eliminated from supply contracts to Europe.

Hartley (2014) outlines the factors that have affected the evolution and increased importance of spot trade in LNG markets:

- Long-term LNG contracts have become more flexible with addition of destination flexibility, allowing quantity adjustments, wider range of pricing options (Weems, 2006);
- Availability of cargo reloading facilities in some of the LNG receiving terminals that enabled re-export of cargoes from buyer's LNG storage tanks;
- Use of swap agreements;

- An increase in the number of “branded” LNG cargoes[6];
- Final investment decisions for some of the recent LNG projects have been made without 100% offtake commitments by buyers creating uncommitted volumes available for spot market trade.
- Many of the suppliers whose early long-term contracts expired retain spare capacity therefore have entered the short-term markets. (Thompson, 2009)

The analysis in Hartley (2014) suggests that potential US LNG export projects featured on a tolling basis[7] should further stimulate the trends toward more spot and short-term trading and greater flexibility in long-term LNG contracts. Furthermore, numerous buyers contract for supply that will go into global portfolios (“branded LNG”) without dedication to any particular customer. Another point is that modular liquefaction units with lower capital costs and capacity utilizing existing infrastructure (port and pipeline facilities), further reducing up-front capital costs. To sum up, lower investment costs in turn might reduce the need for long-term contracts to stabilize cash flows and underwrite debt financing. Furthermore, the reduced up-front capital costs and further development of “branded LNG” should also reduce the benefits of vertical integration between LNG liquefaction capacity and LNG marketing.

[6] Note: sellers of LNG source their supply from multiple locations instead of entering into contracts that tie imports by one customer to a small number of liquefaction plants.
[7] Note: *Tolling contract*: whereby the customers purchase the gas and then pay the liquefaction plant operator a fee to liquefy the gas and load it onto ships for export.

Chapter 3 An empirical assessment of the long-term gas contracts evolution in the changing industry and market environment[8]

3.1 Introduction

Long-term contracts (LTC) have been used as a tool for sharing market risks related to asset-specific and capital-intensive investments through formation of bilateral dependency between the seller and the buyer for a considerable period of time (Crocker and Masten, 1991). Nevertheless, prior research indicates that gas market deregulation processes in the North America, UK and Continental Europe have led to shorter gas sale and purchase deals. (Neumann and Von Hirschhausen, 2004)

The purpose of this chapter is an empirical analysis of the effect of numerous developments happening around global natural gas markets such as market liberalization, global economic recession, technological change, flexibility in contractual provisions and increase in LNG tanker fleet capacity to the duration of long-term contracts. The outcomes of the empirical studies may offer some insights in terms of planning for future cash flows stability, provision of the security of demand for produced gas, minimizing transaction costs and foreseeing proper distribution of market risks during planning for new asset and relationship specific investments. (Niyazmuradov & Heo, 2017a,b)

[8] Note: Some passages in this chapter have been quoted verbatim from the following source: Niyazmuradov S & Heo E. (2017): Long-term natural gas contracts evolution in the changing industry environment, Geosystem Engineering, DOI:10.1080/12269328.2017.1341348.

This chapter is structured as follows:

Section 3.2 provides literature review. Section 3.3 analyzes changing industry environment. Section 3.4 describes the data and methodology. Section 3.5 explains empirical results. Finally, last section provides conclusions.

3.2 Literature review

The trigger of the research on the nature of the long-term contracts dates back to the second half of the 1980s (e.g. Joskow, 1987) when gas market was restructured in North America and followed by the United Kingdom. The subject was brought on the limelight again in 2000s mainly due to gas supply security concerns as possible outcome of the gas and electricity market liberalization trends in Continental Europe.

Careful literature review reveals the existence of three main streams on long-term contracts research: (Niyazmuradov & Heo, 2017a,b; Neumann et al., 2015)

- The institutional economics literature sees long-term contracts as a tool to avoid the risks of opportunistic behavior in deals involving high sunk investments, as in the seminal papers by Klein, Crawford and Alchian (1978) and Williamson (1983). Furthermore, it deals with the repercussions between the contract length and the institutional framework. Joskow (1987, 1988a) shows that the duration of contracts in the American coal industry is positively related to the level of asset-specificity. In the natural gas industry, Crocker and Masten (1985) and Masten and Crocker (1988) observe shorter contract lengths in an inefficiently regulated commodity market in comparison with competitive market. Mulherin (1986) provides evidence that governmental regulation in the US (mainly the Public Utility Holding Company Act of 1935 and the Natural Gas Act of 1936) led to an increasing use of long-term contracts and take-or-pay provisions and price adjustments reducing the hold-up problem. Hubbard and Weiner (1986) analyze take-or-pay provisions of long-term gas supply contracts following deregulation of wellhead prices in the US. The sample of 884 natural gas contracts, collected by the Energy Information Administration in 1982, signed after the 1978 Natural Gas Policy Act reveals minor effects in mean take-or-pay requirements, in line with MacAvoy's (1962) observations. Doane and Spulber (1994) argue that open access to the transportation system reduces the potential for bilateral monopoly between pipeline owners and field producers and the related contractual holdup problem. Neumann and Hirschhausen (2004) utilizing the dataset of long-term contracts concluded by European importers since 1985 show that the length of take-or-pay contracts for gas supply to Europe has significantly decreased over the past two decades, which supposedly is driven largely by the move towards liberalization.

The results do not suggest the disappearance of long-term contracts for European gas supply; rather, they put emphasis on required structural changes of these contracts adapting to a more competitive environment. In a theoretical paper, Neuhoff and Hirschhausen (2005) take the analysis a step further by accounting for different short-run and long-run demand elasticities. The analysis shows that if long-run demand elasticity is significantly higher than short-run elasticity, producers prefer institutional arrangements allowing for long-term contracting.

- The industrial organization literature analyzes the role of long-term contracts in comparison to short-term trading. Using an auction model, Parsons (1989b) shows that an increase in the the number of wholesale buyers decreases the value of contracts to the producer. Brito & Hartley (2002) applying search model found that the length of LNG trade deals is likely to diminish in the near future, as investment and transport costs fall and the number of players in the global 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). The theoretical industrial organization literature mainly addresses the issue in its relation to market structure, i.e. whether long-term contracting favors competition or collusion.

Moving to collusive behaviour, Le Coq (2004) shows that current gas market setting where long-term contracts co-exist with spot markets helps in sustaining collusive behaviour in short-term markets.

- A third strand of the literature links long-term contracts with infrastructure investments. Proponents of liberalization 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. It has been widely recognized that long-term contracts serve as a means of minimizing transaction costs for two parties engaging in a commitment involving significant specific assets. Long-term contracts including requirement clauses, price indexation, liquidated damages, arbitration and other provisions have been identified as a means to overcome the "hold-up" problem without vertical integration. The hold-up problem is likely to arise when transaction-specific investments are required. (Klein et. al., 1978) Indeed, asset-specific investments and uncertainty are the main contributing factors to a high level of transaction costs as defined by Williamson (1975, 1985), all of which explain requirements of alternative institutional arrangements as opposed to "simple" contracting (Williamson, 1983). As a theoretical response to transaction cost economics, the concept

> of incomplete contracts has been developed (Grossmann & Hart, 1986; Hart & Moore, 1988). Both concepts are based on the assumption of opportunistic behavior by the agents whose rationality is bounded. However, as pointed out by Saussier (2000), the main difference of these concepts is the role of contracts: whereas in the incomplete contracting framework contracts minimize ex ante investments distortions, in the setting of transaction cost economics they provide sufficient investment incentives and inexpensive ex-post renegotiation.

The research since Coase's (1937) article has brought forward many amendments to institutional economics, but all contributors so far agree upon the fact that minimizing transaction costs depends on the degree of asset-specificity, on the level of uncertainty, and the frequency of transactions. Moreover, studies on transaction cost economics - which is a comparative analysis studying governance structures under the target of economizing exchange relationships with respect to the sum of both production and transaction costs - intensified in the mid-1980s. Williamson (1975, 1985, 1993) operationalized transaction cost economics by defining a transaction as "occur[ing] when a good or service is traded across a technologically separable interface" discussing the determinants of (ex-post) transaction costs and contractual difficulties. In this context, economic actors are assumed to be characterized by bounded rationality and may behave opportunistically guided by considerations of self-interest (Williamson, 1985, p. 47). Ex-post bilateral dependencies encourage ex-post hold-up by the non-investing party and provide economic incentives to internalize quasi-rents[9] into the own hierarchy. Two types of opportunistic behavior are distinguished: i) deviations from joint-surplus maximizing within the terms of an existing agreement and ii) enforcement of renegotiations and modification of contractual terms in the case unexpected changes in market conditions evolve (hold-up). At the same time in neoclassical economics contracts are assumed to be complete considering all possible future developments ex-ante in the contracting stage. Consequently, asset specificity without uncertainty allows for the conclusion of complete contingent claim contracts whereas uncertainty without asset specificity can be dealt with in exchanges on competitive markets. Finally, in the eyes of incentive theory the firm is understood as "nexus of a set of contracting relationships" (Klein, 1999, p. 466) with the central question being the optimal design of ex-ante incentive compatible contracts suited to mitigate agency costs in the face of potential adverse selection and moral hazard.

3.3 Theoretical background

We approach the issue of long-term contracts from institutional economics, transaction economics and energy security perspectives.

The institutional economics views long-term contracts as an organizational form situated somewhere between vertical integration and free markets. (Coarse, 1937; Ruester, 2009; Niyazmuradov & Heo, 2017a,b) It is true that in 2000s along with the increase in the dynamics of LNG markets

[9] The excess value of an asset over its salvage value is termed 'quasi-rent'.

thanks to the new discoveries of natural gas and tapping into unconventional resources spot and short-term markets started to gain higher importance. The start of liberalization processes led to the emergence of gas hubs such as Henry Hub or NBP. However, a bulk of other hubs still remains relatively illiquid and most of the regions of the world still don't have one. As a result most of the producers, especially those from landlocked regions still need to be bound with the long-term contracts in the gas trade. Therefore, the fate of the long-term contracts, their evolution in accordance with the changing industry and global economic environment has been closely tracked by them.

Another important point from the lens of gas producers is the demand security for gas produced. Usually most of the gas exporting countries are dependent on the revenues from gas exports and use them for the domestic development purposes such as investment in infrastructure, capacity building and education. Therefore, the provision of gas demand security is of foremost importance for gas exporting countries in terms of long-term revenue flow and subsequent investment planning.

While demand security[10] concerns date back to 1980s when European consumers significantly reduced energy consumption as a result of the two oil crises of the 1970s. However, those concerns were limited to oil until late 1990s when gas market liberalization trends have led to inclusion of natural gas into the agenda of discussions on demand security. Producers' worries were related to unbundling in importing countries which undermined their

[10] Note: Demand security was defined by then Saudi Minister for Petroleum and Mineral Resources as 'continued access into the markets of oil importing countries, the steady share of oil in total energy consumption over the long term, and fair and stable prices that allow for their sustainable development over the lifetime of the resource' (Fattouh and van der Linde 2011, p. 61).

ownership of some pipelines beyond their territory. On the other hand, gas demand security debates remained fairly tacit until the turn of the millennium because initial liberalization meant only information transparency. Nevertheless, in the turn of the new millennium demand security debates 'were given more content' because they included 'issues of policy uncertainty, data transparency, human capital shortages, the IOC-NOC relationship and the role of technology' (Fattouh and van der Linde 2011, p. 116). For instance, producers have argued that revenues from the sale of hydrocarbons are crucial for their development, for social inclusion and stable employment. Therefore, it led to the most tangible development in the concept of demand security due to deepening liberalization in the form of legal and ownership separation of upstream, midstream and downstream businesses and drastic decrease in the costs of chilled gas. It implied that gas suppliers may be progressively stripped of the guaranteed consumption that underlined the very development of the industry and may lead to redundancy of costly pipeline infrastructure and convergence between previously disparate regional gas markets. (Romanova, 2013)

Table 3.1 Instruments suppliers use for the enhancement of the security of demand

	Economic	**Political**
1	Storage facilities	An attempt to use international legislation to limit the freedom of consumers to change their internal legislation
2	Long-term contracts	Cooperation among producers
3	Control of transportation routes	Dialogue between consumers and producers
4	Regular trials to offset or correct the changes in regulation of consuming countries	Investment in the improvement of stable supplier reputation
5	Strategy of diversification	

a)	*Diversification of export markets*	
b)	*Diversification of energy production*	
c)	*Export of value added, processed final goods*	
d)	*Diversification away from energy goods*	

When we talk about the means that producers use to further demand security they can be structured in two groups: economic and political: (Romanova, 2013)

i) Economic Means: At least five economic leverages are used by suppliers to defend their interests:

- Storage facilities for natural gas and spare capacities: These instruments are helpful to offset short term (daily and seasonal) fluctuations in demand, sharp hikes and falls in prices and so on.
- Long-term contracts: The attractiveness of long-term contracts lies in the fact that they guarantee certain consumption for a period of about 20 + years. If an importing country does not need that amount of gas, it still has to pay for it (take-or-pay obligation). As a result long-term contracts guarantee a predictable cash-flow (revenues and credits), which is essential to make costly investments in upstream business and transportation.
- Control of transportation routes: For example, denial of third-party access to its gas pipelines (both in bilateral negotiations and in the talks on the Energy Charter Treaty and on its accession to the WTO) has been allowing Russia to regulate Central Asian resources access to European market.

- Producers' attempts to offset or correct disadvantageous changes in the regulation of consuming countries: Examples include: defending interests of relevant national companies in the new legal environment, bidding for distribution networks, inviting energy companies of importing countries to participate in the development of new gas fields on their territory in exchange for their share in the distribution market.
- The strategy of diversification: Producers actively apply the strategy of diversification to hedge their stakes and to balance the desire of consumers to decrease their dependence on oil and natural gas.
    - Geographical diversification of export markets: The idea is to return to the situation when consumers compete for resources as opposed to the competition among exporters.
    - Diversification of energy production: Fashionable trend is the oil and gas producers' interest in renewable sources of energy.
    - Export of value-added, processed final goods: It is a move away from the export of raw energy materials to oil- and gas-processing on the national territory and to the export of the production of refineries and gas factories.
    - Diversification away from energy goods: It manifests itself at the national and corporate level. This approach allows them to remove superior oil and gas revenues (and therefore fight inflation), cushion external shocks (like 2008 financial crises) with the help of this money, set aside, and use them to finance

modernization of the country (Austvik, 2009). Similarly big oil and gas companies moved to other (energy-intensive) sectors (like metal or chemical production) to secure the demand and at the same time gain profit from alternative sources.

ii) Political Means: They mostly perform an auxiliary function and five types of exporters activities are differentiated in this regard:

- An attempt to use international legislation to limit the freedom of consumers to change their internal legislation.
- Cooperation among producers: OPEC and GECF are the examples of forums where oil and gas exporting countries meet.
- Dialogue between producers and consumers: There are both global initiatives (like the International Energy Forum (IEF)) and regional ones (i.e. between the EU and its suppliers like Norway, Russia and the Gulf Countries).
- Investment in the improvement of stable supplier reputation: Producing countries have used various measures to calm their partners such as speeches of political leaders and business representatives, increased transparency, hiring western PR agencies to present their strategies and so on.

"Transaction cost economics predicts that investments in idiosyncratic assets result in ex-post bilateral dependency and lead to a lock-in situation where the investor faces the hazard of post-contractual opportunism and strategic bargaining by the counterparty. In such settings longer-term agreements attenuate those costs by stipulating the terms of trade over the life of the contract." (Ruester, 2009, p.141)

One distinguishes ex-ante costs (e.g., discovering potential trading partners and relevant prices, negotiating and writing contracts) from ex-post costs (e.g., costs from maladaptation, renegotiation, monitoring, and breach of contract). The focus of transaction cost economics typically is on ex-post transaction costs which become especially relevant under long-term contracting and might exceed ex-ante costs by far. (Ruester, 2009) However, our approach is based on both ex-ante and ex-post costs. We argue that as soon as the contract duration ends there is a likelihood of emergence of ex-ante costs related to finding new trade partner(s), negotiating and writing contracts in case if importer from the expired contract decides not to prolong the relationship. Even in the case when the previous partner decides to prolong the gas import contract it is highly likely he will be insisting on reflection of the market changes (that may be disadvantageous to the exporter) in the renewed contract or on an amendment to the old one. Summarizing, it is essential to "[o]rganize transactions so as to economize on bounded rationality while simultaneously safeguarding them against the hazards of opportunism"[11] due to the fact that parties to the contract are motivationally more complex due to opportunism in the sense of self-interest and cognitively less competent due to bounded rationality from the transaction cost economics perspective. (Ruester, 2009)

[11] Williamson, O. E. (1986). The Economics of Governance: Framework and Implications. In: *Economics as a Process – Essays in the New Institutional Economics*, Langlois, Richard N. (eds.), Cambridge University Press, Cambridge, UK, p.177

To sum up we approach the long-term contracts as an organizational form situated between vertical integration and free market. Furthermore, we accept that longer contract duration tend to lessen transaction costs related to renegotiation sort of opportunistic behavior of non-investing party, which is usually the buyer or ex-ante costs regarding the discovery of the new potential gas trade partner. Lastly in terms of security of demand we see long-term gas export contracts as a tool to ensure gas demand stability and subsequently stable revenue flow to gas exporting countries for the period when the contract is in force.

3.4 Changing natural gas industry environment and long-term contracts

The empirical evidence from the US and the UK gas market liberalization experience suggests that while long-term contracts haven't entirely disappeared their length shortened significantly (to approximately 8-15 years instead of 20-25 years) leading to the market share loss by wholesale buyers. Furthermore, in both markets, oil price indexation has been partially or totally replaced by gas spot-price indexation. In the first few years after market liberalization, gas prices indeed had fallen to the level of long-run marginal costs and this situation prevailed for about a decade (Neuhoff and Hirschhausen, 2004). The share of gas supplies through long-term contracts went down from about 100% to below 50%. Until 1991, the average contract volume fell from 1.27 bcm/a to 0.24 bcm/a.[12] Nevertheless, EU long-term import contracts have been able to keep their dominance, complemented by some spot market supplies. At the same time they went through some adaptation process to new market realities for instance by inclusion of flexibility elements to the size of volumes, term and delivery point etc. (Niyazmuradov & Heo, 2017b)

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 mainly because of its increased use in power generation, low carbon content and environmental advantages. (EU, 2001) At the same time it is clear there will be a need for imports as indigenous supply from UK, the Netherlands and Norway will not be able to meet anticipated increase in demand due to technical and economic hurdles. Gas production in the The North Sea is on decline and the Netherlands will continue to play the role of swing supplier. Despite huge efforts by North African suppliers (Algeria, Libya and Egypt) they have yet to conquer a market share in European supply that corresponds to their low-cost reserves. Finally, Russia is eager to expand its market share from current 40% of EU imports to two-thirds. (Neumann & Hirschhausen, 2004, pp.176-77)

Regarding the discussion on whether long-term contracts are compatible with gas market liberalization, industry's argument was that third party access to transmission and downstream infrastructure will lead to price

[12] Neumann, A. & von Hirschhausen, C. (2004). Less long-term gas to Europe? A Quantitative Analysis of European Long-Term Gas Supply Contracts, *Zeitschrift für Energiewirtschaft*, Vol. 28 (3), p. 177.

and demand volatility undermining long-term supply security (Wybrew, 2002, Czernie, 2002) On the other hand, proponents of deregulation 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. In this context, if we glance at the Gas Directive 2003/55/EC on the one hand called 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 derogation from the TPA obligation in relation to take-or-pay commitments (Art. 27)."[13]

Hypothesis 1: Transition from a monopoly industry to competitive market structures shortens length of long-term contracts.

The decline in economic activity has a negative impact on the oil and gas sector as it leads to a steep decline in oil and gas prices resulting in falling revenues for oil and gas companies and tight credit conditions. For instance in early 2009, oil prices fell to 33 USD from a 147 USD in July 2008 and gas prices over the same period went down from USD14 to USD4. Decline in

[13] Neumann, A. & von Hirschhausen, C. (2004). Less long-term gas to Europe? A Quantitative Analysis of European Long-Term Gas Supply Contracts, *Zeitschrift für Energiewirtschaft*, Vol. 28 (3), p. 177.

demand due to deceleration in activity was the major factor.[14] On October 21, 2008, the Federal Reserve Bank of Chicago released the data showing that the three-month moving average of this CFNAI index[15] had fallen below - 0.70, which was a typical indication of a recession. A recession could affect the amount of natural gas consumed by the power generation sector. As demand for electricity in other sectors plunges generation segment most likely to see the immediate effects of a demand reduction. In many countries natural gas tends to be the marginal generation source. Natural gas prices tend to follow crude oil price trends however, the relationship can be disrupted by more local events, such as weather conditions and heating demand. In a recession scenario with reduced demand, putting more natural gas into the market would likely further suppress prices.[16] Then, oil prices recovered to levels above USD100/bbl. (Brent) by early 2011 and remained (on a monthly average basis) around that level until September 2014. In Asia by mid-2014 LNG spot prices were in free-fall. Initially this was attributed to a mild 2013-2014 winter in some Asian importing countries but a growing concern appeared to be the reduced pace of Asian LNG demand growth.[17]

Killian (2009) using the data for the period of 1970-2007 decomposed oil prices into three components: oil supply shocks; global demand shocks; and oil-specific demand shocks which reflect “precautionary

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[14] www.investopedia.com.

[15] Note: Chicago Fed National Activity Index (CFNAI): is a monthly index to gauge overall economic activity and related inflationary pressure. CFNAI measures the change in activity across 85 economic indicators in the United States.

[16] Gulick, C. (2008). Natural gas prices in a recession, *Natural gas and Electricity*, Wiley Periodicals, Inc., December 2008, pp.13-18.

[17] Rogers, H.V. (2015). The Impact of Lower Gas and Oil Prices on Global Gas and LNG Markets , Oxford Institute of Energy Studies, Oxford University, OIES PAPER: NG 99, pp.1-55.

demand" associated with market concerns about the availability of future oil supplies. He found that oil price shocks historically have been driven mainly by a combination of global aggregate demand shocks and precautionary demand shocks rather than oil supply shocks as it is commonly believed. On the other hand the evidence suggests that the impact of oil prices on activity and vice versa has significantly declined since the mid-1980s as a result of the falling oil-intensity of GDP. A sharp decline in oil prices was associated mostly with weakening demand as a result of the 1997 Asian crisis. A severe contraction in global demand sent all commodity prices tumbling during the Great Recession of 2008-09. [18]

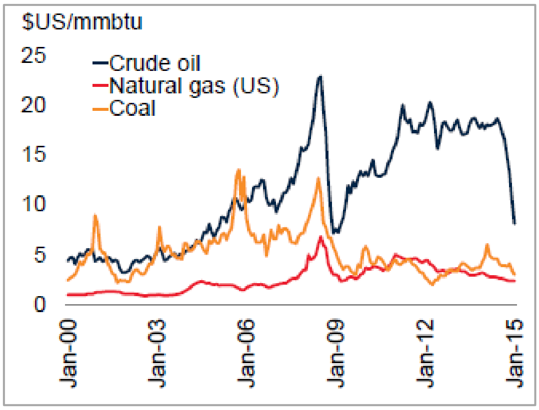

Figure 3.1 Energy prices.[19]

Therefore, due to the decline in overall economic activity, importers and exporters may want to conclude shorter-term gas sale and purchase contracts as buyers are not clear about the volumes of gas they will need in the mid- and long-term and sellers are not satisfied with prevailing low natural

[18] Baffes et al. (2015). The Great Plunge in Oil Prices: Causes, Consequences, and Policy Responses, *World Bank Group Policy Research Note*, PRN/15/01, pp.1-60.
[19] Source: Baffles et al. (2015). The Great Plunge in Oil Prices: Causes, Consequences, and Policy Responses, *World Bank Group Policy Research Note*, PRN/15/01, p.37.

gas and oil prices. Generally, the prices for oil might be of more relevance as the bulk of the long-term contracts retain oil-indexed formulas along with base price.

Hypothesis 2: Global economic recession has affected the duration of the long-term contracts negatively.

Availability of flexible LNG cargoes

Pipeline gas has more rigid infrastructure link that locks the exporter to a particular region, therefore vulnerable to structural changes in end-use markets, upstream risks or transit developments. In contrast, LNG is also vulnerable to upstream issues, but its ability to react more swiftly to changes on the end-user market is increasingly appreciated. Transit issues have not affected LNG so far, despite the existence of some choke points. Another important advantage of the LNG's business model is the flexibility of how it is transported to the buyer. The delivery modalities defined in long-term contracts are either free on board (FOB) or delivered ex-ship (DES):

- With FOB deliveries, the transfer of risks and ownership from seller to buyer occurs when cargo passes the ship's rail at the port of shipment. This allows the buyer greater flexibility with regard to destination; however, the buyer must pay for shipping, insurance, regasification capacity and other costs.
- Delivery ex-ship (DES) usually provides less room for reselling, as the seller is supposed to liquefy and deliver the cargo to the import terminal. DES contracts with a destination clause therefore limit the flexibility to resell or redirect LNG.

> In order to be able to redirect a cargo, the buyer must engage in negotiation with the seller or has to own reloading facilities.

Initially, LNG seemed to be a product relatively similar to pipeline gas as trade relationships were point-to-point and bilateral. However, in the late 1990s, driven by deregulation in some of key markets (US and UK) the model of LNG projects based on long-term contracts and fixed destinations started to be challenged by investors looking for ways to benefit from the flexibility of LNG volumes. The real change began with Trinidad and Tobago when companies such as BG started arbitraging between the United States and Spain. At that time, the US market was the residual market. This gave the opportunity to companies involved in the LNG business to optimize their portfolios, with cargoes actually going to a great variety of Asian, European and Latin American countries. The commercial structure of the different LNG trains (the liquefaction and purification facilities of LNG plants) of Trinidad and Tobago evolved: the first train was based on a merchant model, the other three on a tolling model, with gas producers acting as merchants and sometimes shippers, and buyers acting as shippers. Increasing flexibility in shipping assisted to this transformation: around 14 of the 101 ships delivered over the period 2002-07 were not committed to long-term agreements. At the same time, gas producers acquired shares in the LNG regasification terminals, notably in Europe, reinforcing the possibility for arbitrage. (Corbeau et al., 2014)

Meanwhile, the capital costs of gas liquefaction started to decline from 1990 to 2003, before increasing again. This created a surge of interest in the LNG business and would eventually lead to the emergence of new LNG plants in the early 2000s. The inflexible business model also began to weaken as some merchant companies emerged willing to take the advantage of price arbitrage opportunities. In the years following, some LNG projects continued to diverge from the point-to-point model. Meanwhile, some also offered HH-indexed prices. Some of examples are presented below: (Corbeau et al., 2014)

- Yemen LNG: Yemen LNG submitted and won a competitive bid to supply Kogas, launched in August 2004. A sales and purchase agreement (SPA) was then signed with Suez LNG Trading for the US market, and it secured an additional LNG purchase commitment from its main foreign shareholder, Total. The deal with Total was on a DES basis, with LNG to be delivered at specific ports in the United States while the others were on an FOB basis. The deal to supply gas to the US market was renegotiated in 2009 to allow for the redirection of LNG to more lucrative Asian markets.
- Sabine Pass and the other US projects can be considered the ultimate move away from a point to-point model with oil indexation, as they offer both HH-based indexation as well as FOB deliveries. In practice, Cheniere is not concerned about the destination or utilisation of the LNG plant since the capacity has been booked on a long-term basis. This means that it will always receive the tolling fee even if LNG remains undelivered because the buyer opts to not take it.

Most projects over the past decade had been relatively cheap to develop. The source of these projects was production from conventional gas fields, limiting project complexity. In contrast, newer projects are more expensive: Angola LNG and Russia's Sakhalin are respectively 50% and 75% more expensive than Qatar. Norway's Snøhvit is almost twice as expensive as Qatar's LNG projects, and Australia's LNG projects are even more expensive. For instance, Pluto project reached FID in 2007 and was initially planned to be completed by late 2010, but the first train was completed only in May 2012. As a consequence, the project costs increased from USD 11 billion to USD 15 billion, or about USD 5.4/MBtu. The higher costs can be attributed to the greenfield nature of the projects and the environmental and regulatory difficulties. (Corbeau et al., 2014)

On the basis of the aforementioned we found it rational to add a dummy variable - delivery terms FOB in accordance with INCOTERMS 2000 in order to control for the effect of more flexibility in terms of destination and emanating possible arbitrage opportunities on the duration of the long-term LNG sale and purchase agreements. (Niyazmuradov & Heo, 2017a,b)

Hypothesis 3: Availability of FOB delivery terms can have an effect on the length of the LNG contracts.

Technological progress

Technological innovation enables exploration and production of natural gas in more efficient, safe and environmentally friendly manner. While technological change and innovation is observed along all links of the gas value chain we focus on the expansion of LNG carrier capacity. The difference in vessel size was chosen as a proxy for technological change as bigger tankers lead to economies of scale and more significant effect while LNG cargoes are re-directed. (Niyazmuradov & Heo, 2017a,b)

LNG carriers vary in size and recent additions indicate a bias towards larger vessels. Forty five Q-Class tankers: Q-Flex (210,000-217,000 cm) and Q-Max (261,700-266,000 cm), which make up 11% of the active fleet are LNG vessels with largest capacities. Before the introduction of Q-Class vessels the average capacity of LNG tankers was in the range between 125,000 cm and 150,000 cm. In the beginning of 2017 only half of the fleet had a capacity within this range, while 36% of the active global fleet was in the 150,000 to 180,000 cm range. At the same time carriers delivered in 2016 had an average capacity of 173,600 cm and average capacity in the orderbook 172,000 cm at the end of 2016. Furthermore, tanker storage capacity continues to grow as charterers prefer larger tankers that reduce the unit cost of transported LNG. (IGU, 2017, pp. 35-44)

Technological progress is likely to result in increased gas supply which can result in the shorter duration of the long-term contracts. (Niyazmuradov & Heo, 2017a,b)

Hypothesis 4: Technological progress will result in shorter length of LNG contracts.

An increase in fleet size

The LNG shipping sector is cyclical in nature. Shipping companies have dramatically increased their fleet sizes in expectation of high demand in the aftermath of the Fukushima nuclear crisis. It outpaced the incremental growth in globally traded LNG during this period. In 2016 average estimated spot charter rates for steam vessels averaged at ~$20,500/day and for dual fuel diesel electric (DFDE)/ tri-fuel diesel electric (TFDE) to ~$33,500/day. The continuous wave of newbuilds hitting the market in 2017 is likely to further push the LNG shipping market deeper into a period of oversupply. In the beginning of the 2017 LNG carrier fleet consisted of 439 LNG tankers of which 23 vessels were chartered as FSRUs and three as floating storage units. At the same time liquefaction capacity planned to come online during 2017 can potentially absorb some of the excess capacity. Furthermore, a bulk of newbuild vessels were ordered on a speculative basis, not tied to any specific project. Moreover, as of end of 2016, the order book included 121 tankers expected to be delivered through 2022 of which the only 66% currently booked to be tied to the specific charterer. Finally, LNG fleet's age is quite young as 56% of the fleet is under 10 years. (IGU, 2017, pp. 35-44)

FSRUs are in high demand at the moment as project developers are starting to look towards emerging markets. They are ideal for markets that have stagnant or dwindling domestic gas production, or looking to switch from expensive liquid fuels to gas in a relatively short period of time with limited capital expenditures. The relief to oversupplied tonnage can come from ship owners interest in conversion of some of their existing vessels into FSRUs.

To sum up, the increase in fleet size creates an opportunity for spot trading growth beyond the long-term contractual obligations. Therefore the following hypothesis has been stated:

Hypothesis 5: An increase in LNG fleet size will be inversely related to the contract duration.

To sum up we believe aforementioned factors will contribute to flexibility of gas trade. The gas market liberalization allows third party access to the gas transportation infrastructure leading to increase the number of players, fosters the development of spot markets and allows the use of financial derivatives in order to hedge the volume and price risks. Economic recession pushes down the demand for commodities, including the natural gas due to anemic state of the economic activity during that period. Technological change allows shipping higher volumes of gas between regional gas markets and increase in the fleet size raises the number of uncommitted ships (subsequently decreases charter rates) to be used in the case of lucrative price differentials among regional markets or when the buyer is not in the need for specific LNG cargo. In the same vein FOB contracts have a potential to foster cargo diversion among markets which can push regional price markets toward convergence. As a result, these changes may largely affect the market share of traditional exporters in different regional gas markets due to increase in competition and downward slope in price as more volumes become technically available between different markets, gas moving to the places where it is needed the most.

We have constructed three models: Pipeline Gas Contracts Model, LNG Contracts Model and All Gas Contracts Model. The reason behind it is the fact that pipeline gas has rigid export infrastructure that usually ties single exporter and importer or limited number of them. On the contrary, liquefied natural gas is more mobile. Therefore, while it also requires specific infrastructure, it can be delivered to various markets. The second point is that the LNG industry is quite young and just started evolving rigorously in the recent two decades basically thanks to the high oil prices in the 2011–2014. The third point is that the significant players can be different in pipeline gas and LNG markets. For instance, the biggest LNG importer is Japan – the country that has no access to pipeline gas. [20]

3.5 Data and Methodology

The dataset comprises 573 long-term contracts (for pipe gas – 124 and 449 for LNG) concluded between 1963 and 2015. The data has been collected from various publicly available sources: The data documentation by Newmann A., Ruester S. and von Hirchhausen C. (2015): Long-Term Contracts in the Natural Gas Industry – Literature Survey and Data on 426 Contracts (1965-2014)[21], Annual LNG Industry Reports by International Group of Liquefied Natural Gas Importers (GIIGNL) and Annual IGU World LNG Reports by International Gas Union (IGU). The dataset represents around 80% of all gas export contracts. Furthermore, the data from BP Statistical Review of World Energy 2016 was used for quantification of some variables.

Contract duration and contracted volume are determined simultaneously when an LNG seller and buyer agree for a supply arrangement,

[20] Niyazmuradov S. & Heo E. (2017). Long-term gas contracts evolution in the changing industry environment, Geosystem Engineering, pp.3-4, available at https://doi.org/10.1080/12269328.2017.1341348.
[21] Note: Available at: https://www.diw.de/documents/publikationen/73/diw_01.c.498163.de/diw_datadoc_2015-077.pdf.

both represent endogenous variables. (Ruester, 2009; Niyazmuradov & Heo, 2017a,b) Therefore, the error distributions cannot be considered independent of these regressors' distributions. Furthermore, OLS results may be biased as the values of the variable -contract duration- are limited to a lower bound of zero, affecting distribution of errors and over-presentation of longer-term agreements (Masten and Saussier, 2002; Maddala 1983). Joskow (1987) and Crocker and Masten (1988) accounted for those problems using maximum likelihood estimation methods. Moreover, long-term contracts usually occur in clusters at discrete intervals, which may cause heteroscedasticity. (Newmann et al., 2015) Therefore, the models are estimated by two-stage least squares (2SLS) method. The right-hand side endogenous variable (LN_T_VOL) is regressed on all system exogenous variables as well as on the instrumental variable(s) in the first stage. The fitted values are used as instrument in the second stage. Furthermore, we verify the results via use of generalized method of moments (GMM) estimation, which accounts for heteroscedasticity of error distributions and limited information maximum likelihood (LIML) instrumental variable regression, which may lead to less bias and confidence intervals with better coverage rates than 2SLS estimator. (Poi, 2006; Stock et al., 2002)

We consider the following structural model:

$$\gamma_1 = \beta_0 + \beta_1\gamma_2 + \beta_2 z_1 +_{\dots} + \beta_k z_{k-1} + u_1 \qquad (1)$$

γ_2 is clearly endogenous as it is correlated with u_1, z_{k-1} and z_1 indicates the set of exogenous variables uncorrelated with u_1 and γ_2 is suspected of being correlated with u_1. Therefore, we need an instrumental variable z_k for γ_2. The variable z_k must be uncorrelated with error term and correlated with endogenous variable to become valid IV. The second condition can be checked through estimation of the reduced form equation:

$$\gamma_2 = \Pi_0 + \Pi_1 z_1 + \Pi_2 z_k + \vartheta_2 \quad (2)$$

where, E (ϑ_2)=0, Cov (z_1, ϑ_1)=0 and Cov $(z_k, \vartheta_2) = 0$. Additional assumptions for statistical inference are that there are no perfect linear relationships among the exogenous variables and homoscedasticity of error term. (Wooldridge, 2009) In order to control for heteroscedasticity we use robust standard errors.

We define long-term contracts as concluded between gas exporter and importer for the duration of more than four years as in Newmann and von Hirschhausen (2004). The contract length (CD) is a good proxy for the intensity of the relationship between the seller and the buyer (Crocker and Masten, 1988). In order to check the first two hypotheses we introduce (LIB_DUM) and (POST2008). (LIB_DUM) identifies all long-term contracts that have been signed after 1998, when the First Natural Gas Directive 1998/30/EC came into effect. This variable enables us to check the effect of transition to more competitive market arrangements. Intuitively we expect that the duration of the long-term agreements may have shortened due to global economic recession of 2008. This is the logic for inclusion of the (POST2008) dummy variable.

Table 3.2 Summary statistics for Pipeline Gas Contracts Model variables.

Variables	Mean	Std. Dev.	Min	Max
DEPENDENT VARIABLE				
CD: Contract duration	19.44758	8.116734	5	39
INDEPENDENT VARIABLES				
YoS: Year in which the contract was signed	1994.387	10.98092	1965	2012
IMP_INDIA: = 1 if the importer is India = 0 otherwise	.0080645	.0898027	0	1
IMP_CHINA: = 1 if the importer is China = 0 otherwise	.0080645	.0898027	0	1
TKM_DUM: =1 if the exporter is Turkmenistan =0 otherwise	.0241935	.154273	0	1
NED_DUM: =1 if the exporter is Netherlands =0 otherwise	.0645161	.2466667	0	1
NOR_DUM: =1 if the exporter is Norway =0 otherwise	.2983871	.4594065	0	1
RUS_DUM: =1 if the exporter is Russia =0 otherwise	.2741935	.4479168	0	1
BUY_UK: =1 for UK buyer; =0 otherwise	.0725806	.2604994	0	1
BUY_GER: =1 for German buyer; =0 otherwise	.2419355	.4299928	0	1
LNOIL: Average price for Brent during the year the contract was signed (USD/bbl.)	3.664326	.5595649	2.396075	4.764138
LNDIFFOIL: Average price for Brent during the year the contract was signed (USD/bbl.)	3.683191	.5527986	2.396075	4.764138
POST2008: =1 for contracts signed after 2008 =0 otherwise	.0564516	.231728	0	1
LIB_DUM: =1 for contracts signed during or after 1998, =0 otherwise	.4435484	.4988184	0	1
UK_DUM: =1 if the exporter is UK =0 otherwise	.0645161	.2466667	0	1
LN_T_Vol: Total contracted volume	3.609086	1.408428	.6931472	6.802395
INSTRUMENTAL VARIABLES				
LN_W_VOL: Weekly gas offtake volume	-3.1963	1.151436	-5.8511	-.55278
EXP_MIDDLEEAST: =1 if the seller is located in Middle East =0 otherwise	.016129	.1264828	0	1

For the purpose of verification of the last three hypotheses regarding the LNG Contracts Model the following variables were introduced. In order to differentiate the effect of flexible destination contracts (FOB_DUM) variable is included. The variable (FLEETCAP) is proxy for the effect of the change in

LNG tanker fleet on the length of the LTC's. (TECH_PROG) enables us to test our fifth hypothesis.

Now let's overview the control variables used in three models. (3RD_ENER_PKG) dummy variable assists in observing whether the length of the contracts has become even shorter after adoption of Third Energy Package on 3 September 2009. Core elements of the package include: ownership unbundling, establishment of a National regulatory authority in each Member State.

We expect that contract length should be inversely related to the year of signature (YoS) and positive relation between contract length and total contracted volumes (LN_T_Vol) implying that higher volumes agreed upon in the contract mean a foresight with respect to income streams for investing parties. (LNG_DUM) is used to account for countries possessing infrastructure to import both pipe gas and LNG.

Table 3.3 Summary statistics for All Contracts Model variables.

Variables	Mean	Std. Dev.	Min	Max
DEPENDENT VARIABLE				
CD: Contract duration	21.77105	84.58586	4	2032
INDEPENDENT VARIABLES				
LN_T_Vol: Total contracted volume	3.138305	1.291205	-3.827135	6.802395
GASTYPE: =1 for pipeline gas =0 otherwise	.2181501	.4133507	0	1
YoS: The year in which the contract was signed	2001.195	11.54197	1963	2015
LNG_DUM: =1 if the importer possesses both pipeline and LNG import infrastructure =0 otherwise	.4108818	.492456	0	1
EXP_CONT_EUR: =1 if the exporter is located in Continental Europe =0 otherwise	.1409774	.3483258	0	1

EXP_N_AMERICA: =1 if the exporter is located in North America =0 otherwise	.0625	.2422842	0	1
EXP_S_AMERICA: =1 if the exporter is located in South America =0 otherwise	.0349265	.1837626	0	1
EXP_MIDDLEEAST: =1 if the exporter is located in Middle East =0 otherwise	.1433824	.3507849	0	1
EXP_AFRICA: =1 if the exporter is located in Africa =0 otherwise	.1636029	.3702553	0	1
EXP_SE_ASIA: =1 if the exporter is located in Southeast Asia =0 otherwise	.1783088	.3831248	0	1
IMP_NE_ASIA: =1 if the importer is located in Continental Europe =0 otherwise	.4363002	.496359	0	1
EXP_AUS: =1 if the exporter is Australia =0 otherwise	.125	.3310233	0	1
IMP_INDIA: =1 if the importer is India =0 otherwise	.061296	.2400827	0	1
IMP_CHINA: =1 if the importer is China =0 otherwise	.0700525	.2554593	0	1
FSU_DUM: =1 if the exporter is one of the Former Soviet Union countries =0 otherwise	.106814	.3091614	0	1
TKM_DUM: =1 if the exporter is Turkmenistan =0 otherwise	.0055249	.0741921	0	1
BUY_UK: =1 for UK buyer; =0 otherwise	.0394973	.19495	0	1
BUY_GER: =1 for German buyer; =0 otherwise	.05386	.2259441	0	1
LNOIL: Average price for Brent during the year the contract was signed (USD/bbl.)	3.9646	.5870999	2.396075	4.764138
LNDIFFOIL: Average price for Brent during the year the contract was signed (USD/bbl.)	3.968492	.5994631	2.396075	4.764138
POST2008: =1 for contracts signed after 2008 =0 otherwise	.3176265	.4659601	0	1
LIB_DUM: =1 for contracts signed during or after 1998 =0 otherwise	.6963351	.4602415	0	1
3RD_EN_PKG	.2792321	.4490138	0	1
INSTRUMENTAL VARIABLE				
LN_W_VOL: Weekly gas offtake	-3.620752	1.045856	-8.428129	-.5527898

volume

In order to look into the relation between contract length and technical and institutional specifics of exporting and importing countries or region(s); continental, regional and country dummies have been incorporated in all models. For importers we check China, India and Northeast Asia who have been the most eager consumer markets. (BUY_UK) is liable for contracts of UK importers, who clearly operate in a liberalized framework while (BUY_GER) represents German importer, functioning on Continental European markets. (GASTYPE) looks into differences in contract length between pipeline and LNG deliveries.

Given the traditional oil price indexation of LTC’s (usually with several months lag) higher oil price might provide disincentives for the buyer to enter into a long-term contract. Therefore, we include (LNOIL) and (LNDIFFOIL) representing oil prices prevailing in the year of signature and during the year before.

For the second model we introduce additional variables specific to LNG markets. The dummy variable (BUY_US_UK) is the proxy for liberalized gas markets, while (BUY_J_K_T) indicates the Asia-Pacific importers who solely rely on LNG imports. Furthermore, we add the (BUY_CHN) to look into the case of buyer who owns a pipeline and LNG gas import facilities. (SEL_QAT) looks into the contracts of the biggest LNG exporter - Qatar. Moreover, the variable (GAS_CONS_GROWTH) is added in order to check the effect of global gas consumption growth on the length of the newly concluded liquefied natural gas SPAs.

Table 3.4 Summary statistics for LNG Contracts Model variables

Variable	Mean	Std. Dev.	Min	Max
DEPENDENT VARIABLE				
CD: Contract duration	22.47178	95.86102	4	2032
INDEPENDENT VARIABLES				
POST2008: =1 for contracts signed after 2008 =0 otherwise	.3878924	.487817	0	1
LIB_DUM: =1 for contracts signed during or after 1998 =0 otherwise	.7511211	.432849	0	1
GAS_CONS_GROWTH: Annual gas consumption growth	.0235556	.0248888	-.026	.078
FOB_DUM : =1 if the FOB delivery terms are stipulated in the contract; =0 otherwise	.343949	.4757825	0	1
BUY_US_UK: =1 if the buyer is located in the competitive markets of US or UK =0 otherwise	.0956938	.2945233	0	1
BUY_CHN: =1 if the buyer is China =0 otherwise	.0421836	.2012577	0	1
BUY_J_K_T: =1 if the buyer is located in the Pacific basin =0 otherwise	.5693069	.4957872	0	1
SEL_QAT: =1 if the seller is Qatar =0 otherwise	.1358025	.3430024	0	1
LN_TECH_PROG: measured as the difference between the tanker with biggest LNG transport capacity less average tanker capacity in each year observed	10.78188	.8642614	9.711613	11.76837
LN_T_VOL: Total Contracted Volume	3.002043	1.236136	-4.661293	5.574053
LN_FLEETCAP: LNG fleet total capacity in the specific year	16.81298	1.368425	.0094542	17.99697
INSTRUMENTAL VARIABLES				
LN_W_VOL: Weekly gas offtake volume	-3.7427	.9814	-8.4281	-1.5125
SELF_SUFF_p: Self-sufficiency of the importing country (domestic gas production/domestic consumption)	27.6639	102.9555	0	1686.372

To account for endogeneity in the (LN_T_VOL) variable we define three instrumental variables: (LN_W_VOL), which represents weekly gas offtake volume by the importer; (SELF_SUFF_p) indicating the gas self-sufficiency ratio of the importer and (EXP_MIDDLEEAST) is a dummy variable which is equal to one when the exporter is located in the Middle East. In our opinion LN_W_VOL unlike yearly contracted volumes neither agreed upon simultaneously with contract length on the course of negotiations nor stipulated in the contract.

3.6 Empirical results

First of all, comparison of results for ordinary least squares regression and instrumental variable regression indicates that coefficients are different. It was confirmed by Hausman test chi2 statistic of 66.86 (p=0.0000) for Model 1, 30.29 (p=0.0000) for the second model and 88.60 (0.0000) for last one, clearly indicating that the difference in OLS and IV coefficients is systematic. Furthermore, first stage regression results support the significance of IV's in both models. As a result we use IV regression results for interpretation.

Table 3.5 The results of Endogeneity test

	Model 1: Pipeline Gas Contracts	p-value	Model 2: LNG contracts	p-value	Model 3: All Contracts	p-value
Durbin score chi2(1)	4374.23	(0.0000)	138.93	(0.0000)	101.501	(0.0000)
Wu-Hausman F(1,151)	5831.75	(0.0000)	836.78	(0.0000)	121.962	(0.0000)

The results for the (LIB_DUM) in the Tables 3.7, 3.8 and 3.9 indicate that our first hypothesis has been supported. After the start of the gas market restructuring in the Continental Europe the length of contracts has shortened for around four years on average for pipeline gas contracts, around 1.5 years for LNG deals and 3.65 years for both contracts. Interesting results came up regarding the second hypothesis. While pipeline gas contracts became on average 4 years shorter, the chilled gas deals were 3.25 years longer due to recession. As we have mentioned earlier the demand for gas decreases during the recession. Due to uncertainty regarding future gas demand, buyers may be willing to go into LNG trade deals, possibly with flexible destinations, in order secure flexible volumes if the local market does not recover after the recession period ends. Rigid pipeline gas infrastructure does not allow gas re-direction to far away markets. Regarding the third hypothesis the results indicate that availability of FOB delivery terms increases the length of the contract by 1.8 years. It may imply that more flexibility in terms of destination motivate importers as well as aggregators such as Shell or BP to increase their resource portfolio and security of supply. They might be foreseeing that during the periods when price spreads are high it is possible to profit from arbitrage opportunities by diverting cargoes to more lucrative markets.

Table 3.6 Test for over identifying restrictions

	Pipeline Gas Contracts Model	LNG Contracts Model
Score chi2 (1)	1.85495 (p=1.85495)	1.41508 (p=0.2342)

Table 3.7 Results for Model 1: Long-term contracts for the sale and purchase of pipeline natural gas. (Pipeline Gas Contracts Model)

Econometric model		**IV estimation**			
Method of estimation	**OLS**	**First stage regression**	**2 SLS**	**GMM**	**LIML**
Independent variables	Dependent variable: CD		Dependent variable: CD Instruments: LN_W_VOL and EXP_MIDDLE EAST	Dependent variable:CD Instruments: LN_W_VOL and EXP_MIDDLE EAST	Dependent variable:CD Instruments: LN_W_VOL and EXP_MIDDLE EAST
	LN_T_VOL as exogenous variable		LN_T_VOL as endogenous variable	LN_T_VOL as endogenous variable	LN_T_VOL as endogenous variable
LN_T_VOL	3.1299*** (.3702)		2.1253*** (.3822)	2.1253*** (.3822)	2.0998*** (.3844)
BUY_GER	-1.239 (1.0632)	.0213 (.1081)	-1.0757 (1.067)	-1.0757 (1.0666)	-1.0716 (1.0675)

BUY_UK	-4.6989** (1.8933)	.0365 (.2137)	-4.628*** (1.7291)	-4.628*** (1.7291)	-4.6262*** (1.7296)
TKM_DUM	4.3176 (3.5221)	.5631*** (.1555)	6.1195*** (2.2789)	6.1195*** (2.2789)	6.1651*** (2.2518)
UK_DUM	-4.7912** (2.0089)	-.414** (.186)	-5.8447*** (2.0783)	-5.8447*** (2.0782)	-5.8714*** (2.0859)
NED_DUM	-2.9533 (1.9524)	-.0842 (.1349)	-2.1572 (1.407)	-2.1572 (1.407)	-2.1370 (1.408)
NOR_DUM	1.5902 (1.2988)	.0217 (.1765)	2.4099* (1.3697)	2.4099* (1.3698)	2.4306* (1.373)
RUS_DUM	-.6068 (1.3519)	.1677 (.1149)	1.0728 (1.2941)	1.0728 (1.2941)	1.1154 (1.299)
IMP_CHINA	-1.014 (5.8414)	.0266 (.1494)	1.5323 (2.2483)	1.5323 (2.2483)	1.5967 (2.2204)
IMP_INDIA	13.402** (5.1534)	.5759** (.2797)	14.1292*** (1.4994)	14.1292*** (1.4994)	14.1477*** (1.4974)
POST2008	-3.8513*** (2.3103)	.0351 (.3108)	-4.0784** (1.7707)	-4.0784** (1.7707)	-4.0841** (1.7695)
LIB_DUM	-3.1824** (1.4661)	-.1416 (.1994)	-3.8924*** (1.451)	-3.8924*** (1.451)	-3.9104*** (1.4640)
LN_DIFFOIL	7.8136*** (1.6413)	.4905*** (.1503)	7.8130*** (1.5183)	7.8130*** (1.5183)	7.8130*** (1.5216)
LN_OIL	-5.9289*** (1.7182)	-.3594** (.1530)	-6.3034*** (1.6219)	-6.3034*** (1.6219)	-6.3129*** (1.627)
YoS	-.1551** (.0697)	-.0158* (.0094)	-.1294** (.0647)	-.1294** (.0647)	-.1288** (.0648)
LN_W_VOL		1.1029*** (.0396)			
EXP_MIDDLEEAST		.4968*** (.1742)			
_cons	312.62** (137.28)	38.26** (18.49)	265.97** (127.72)	265.97** (127.72)	264.79** (127.88)
No of observations	124	124	124	124	124
F or Wald chi2 statistic	17.51	6730.30	1352.96	1352.96	1351.23
R-squared	0.7086	0.8941	0.6887	0.6887	0.6877

Heteroscedasticity robust standard errors are in parenthesis. *, **, *** denotes significance at 10%, 5% and 1% respectively.

The signs of the coefficients for the estimates related to the last two hypotheses came up in line with our expectation. The increase in the LNG tanker fleet and technological progress has resulted in the -0.036 (-3.60/100) and -0.006 (-0.6/100) years shorter LNG contracts. Low charter rates due to oversupply in LNG shipping market and technological development allowing economies of scale are likely to lead to ampler supplies therefore decreasing the incentives to be locked into the longer-term gas purchase deals.

Regarding other variables we found negative coefficients for:

- Oil price (-6.30) and (-2.493)[22]: The importers might be reluctant to be locked into agreements stipulating high base price;
- The oil price in the previous year (7.81) and (2.65): Higher crude oil prices in the previous year may have motivated buyers to secure supplies for a longer-term in order to provide security of supply in case if the price trends were in the year before will keep their prevalence for a longer period.
- Year of signature (-.0.08) and (-.013)[23]: It might be due to increasing supply, which decreases supplier switching costs as new projects are coming online.

Table 3.8 Results for Model 2: Long-term contracts for the sale and purchase of pipeline and liquefied natural gas. (All Contracts Model)

Econometric model	OLS	IV estimation			
Method of estimation		First stage regression	2 SLS	GMM	LIML
Independent variables			Dependent variable: CD Instrument: LN_W_VOL	Dependent variable: CD Instrument: LN_W_VOL	Dependent variable: CD Instrument: LN_W_VOL
LN_T_VOL	2.44*** (.2935)		1.249*** (0.215)	1.249*** (0.215)	1.249*** (0.215)
GASTYPE	-1.6162 (1.1217)	-.0365 (.0977)	-0.649 (1.13)	-0.649 (1.13)	-0.649 (1.13)
YoS	-.0516 (.0467)	-.0059 (.004)	-.0808* (.0468)	-.0808* (.0468)	-.0808* (.0468)
LNG_DUM	.3188 (1.1235)	.1596 (.1164)	1.592 (1.18)	1.592 (1.18)	1.592 (1.18)
EXP_CONT_EUR	2.8787* (1.5802)	.1602 (.14384)	3.459** (1.69)	3.459** (1.69)	3.459** (1.69)
EXP_N_AMERICA	1.9126 (1.89)	.4030** (.1750)	4.229** (1.976)	4.229** (1.976)	4.229** (1.976)
EXP_S_AMERICA	3.4263* (1.772)	.4780*** (.1397)	5.344*** (1.747)	5.344*** (1.747)	5.344*** (1.747)
EXP_MIDDLEEAST	2.0153 (1.6525)	.3016* (.1564)	4.003** (1.733)	4.003** (1.733)	4.003** (1.733)
EXP_AFRICA	1.1126 (1.70)	.1830 (.1484)	2.225 (1.775)	2.225 (1.775)	2.225 (1.775)
EXP_SE_ASIA	-.7889 (1.62)	.1209 (.1518)	0.993 (1.709)	0.993 (1.709)	0.993 (1.709)

[22] Note: Estimated coefficients are from pipeline and all contracts models.
[23] Note: Estimated coefficients are from pipeline and all contracts models.

IMP_NE_ASIA	2.2173* (1.1371)	.2151* (.1244)	2.365* (1.226)	2.365* (1.226)	2.365* (1.226)
EXP_AUS	1.0270 (1.7368)	.0599 (.1802)	2.533 (1.816)	2.533 (1.816)	2.533 (1.816)
IMP_INDIA	1.8862 (1.4646)	.2805*** (.100)	2.557* (1.526)	2.557* (1.526)	2.557* (1.526)
IMP_CHINA	4.52*** (1.0949)	.5062*** (.0906)	5.707*** (1.110)	5.707*** (1.110)	5.707*** (1.110)
FSU_DUM	3.0848* (1.6532)	.4244*** (.1429)	5.107*** (1.715)	5.107*** (1.715)	5.107*** (1.715)
TKM_DUM	2.5223 (2.0781)	.1985 (.1575)	3.880*** (1.24)	3.880*** (1.24)	3.880*** (1.24)
BUY_UK	-3.33*** (1.1003)	-.0051 (.1498)	-3.315*** (1.140)	-3.315*** (1.140)	-3.315*** (1.140)
BUY_GER	-.7424 (1.3501)	.099 (.122)	0.348 (1.39)	0.348 (1.39)	0.348 (1.39)
LN_OIL	-2.4642** (1.1326)	-.1185 (.1083)	-2.493** (1.199)	-2.493** (1.199)	-2.493** (1.199)
LN_DIFFOIL	2.4610** (1.2499)	.1360 (.1137)	2.65** (1.31)	2.65** (1.31)	2.65** (1.31)
POST2008	4.3044*** (1.6423)	-.1233 (.421)	4.11*** (1.57)	4.11*** (1.57)	4.11*** (1.57)
LIB_DUM	-3.5875*** (.8329)	-.2461*** (.0802)	-3.65*** (0.844)	-3.65*** (0.844)	-3.65*** (0.844)
3RD_EN_PKG	-5.5953*** (1.5637)	-.0126 (.4366)	-5.19*** (1.47)	-5.19*** (1.47)	-5.19*** (1.47)
LN_W_VOL		1.056*** (.0317)			
_cons	114.20 (92.57)	18.43** (7.83)	173.35* (92.89)	173.35* (92.89)	173.35* (92.89)
No of observations	481	481	481	481	481
F or Wald chi2 statistic	13.69	252.35	331.70	331.70	331.70
R-squared	0.4598	0.8070	0.4180	0.4180	0.4180

Heteroscedasticity robust standard errors are in parenthesis. *, **, *** denotes significance at 10%, 5% and 1% respectively.

The estimates for BUY US_UK, UK_DUM, and BUY_UK indicate that when the exporter or importer is located in the competitive market the length of all contracts tend to be around 1, 3 and 6 (4.6 in Pipeline Gas Contracts Model) years shorter on average. It may be due to availability of pipeline gas, LNG supplies and local gas production; increased competition among market players thanks to third party access to gas transportation infrastructure and mature financial markets offering gas derivatives for hedging risks. Norway contracts are 2.40 years longer on average. Results regarding Turkmenistan indicate 6 and 3.88 years longer length of contracts on average in Pipeline Gas and All Contracts models respectively. Huge investments into the giant Galkynysh field along with the plans for boosting gas production by 2030 up to 230 bcm motivates conclusion of the longer term export deals.

The results for the gas importers indicate that economic development locomotives of China and India along with industrialized countries of North East Asia who has access only to LNG supplies prefer lengthier agreements.

Table 3.9 Results for Model 3: Long-term contracts for the sale and purchase of liquefied natural gas. (LNG Contracts Model)

Econometric model	**OLS**	**IV estimation**			
Method of estimation	**OLS**	**First stage regression**	**2 SLS**	**GMM**	**LIML**
Independent variables	Dependent variable: CD	Dependent variable: LN_T_VOL	Dependent variable: CD Instruments: LN_W_VOL, SELF_SUFF_p	Dependent variable: CD Instruments: LN_W_VOL, SELF_SUFF_p	Dependent variable: CD Instruments: LN_W_VOL, SELF_SUFF_p
	LN_T_VOL as exogenous variable		LN_T_VOL as endogenous variable	LN_T_VOL as endogenous variable	LN_T_VOL as endogenous variable
LN_T_VOL	2.3974*** (.30727)		1.2505*** (.3639)	1.2628*** (.363)	1.2407*** (.3643)
GAS_CONS_GROWTH	22.4249* (2.8661)	3.9553*** (1.2373)	41.084*** (4.1735)	42.791*** (4.1302)	41.036*** (4.1813)
BUY_CHN	5.39*** (1.7588)	.54473*** (.1249)	7.8152*** (1.4449)	7.9184*** (1.43)	7.8281*** (1.4453)
SEL_QAT	1.4626* (.7958)	.0596 (.0761)	1.5071* (.8803)	1.4981* (.8761)	1.5089* (.8810)
BUY_US_UK	.8023 (1.2181)	-.1610 (.1862)	-1.2004 (1.9660)	-1.2306 (1.9479)	-1.1958 (1.9688)
POST2008	3.5898*** (1.3188)	.14715 (.1519)	3.254** (1.5804)	3.0935** (1.5773)	3.2569** (1.5808)
LIB_DUM	-1.1825 (.9247)	-.47*** (.0576)	-1.5722* (.8429971)	-1.6166* (.8421)	-1.5767* (.8430)
FOB_DUM	.8374 (.6908)	.102* (.0571)	1.7721*** (.7613)	1.774** (.7612)	1.7755** (.7619)
BUY_J_K_T	2.4663*** (.7045)	.1824*** (.0669)	2.3847*** (.7354)	2.3993*** (.7360)	2.3784*** (.7359)
LN_TECH_PROG	-3.3281*** (.8518)	-.5963*** (.0889)	-3.6893*** (.9955)	-3.5721*** (.9954)	-3.6954*** (.9958)

LN_FLEETCAP	-1.1167*** (.286)	.4676*** (.0092)	-.5878*** (.1723)	-.5970*** (.1719)	-.5833*** (.1725)
LN_W_VOL		1.1046*** (.0333)			
SELF_SUFF_p		.0002*** (.0000)			
_cons	62.583*** (8.38)	5.722*** (.8708)	60.6308*** (9.41)	59.5436*** (9.409)	60.654*** (9.414)
No of observations	187	164	164	164	164
F or Wald chi2 statistic	24.29	425.55	195.03	194.68	194.53
R-squared	0.5195	0.9288	0.5166	0.5159	0.5174

Heteroscedasticity robust standard errors are in parenthesis. *, **, *** denotes significance at 10%, 5% and 1% respectively.

The adoption of the Third Energy Package led to further decrease (-5.19) in the duration of the contracts.

We chose exporter situated in competitive market as the base group for comparison in the case of gas exporter continents and countries. Results imply that the contracts signed by exporters from other continents, regions or countries are several years longer. It might be due to greenfield nature of the deposits as in the case of Australia or huge investments into regasification facilities in North America in order to monetize plentiful production of unconventional gas. However, the most important factor might be a target to ensure demand security for a longer possible term as it presupposes revenue stream for subsequent period. Results regarding the Former Soviet Union countries indicate 5.1 years longer length of contracts. Utilization of long distance pipeline to Europe, production complexity in the terrain of Siberia in the case of Russia motivates them for the conclusion of the longer term export deals. Finally, the growth in the worldwide gas consumption has a positive effect on the duration of the natural gas contracts.

3.7 Conclusion

Unlike previous studies we approach the issue of long-term contracts from the exporter countries' perspective.

The following factors necessitate long-term contracts for the gas exporter countries: (Hartley, 2014; Crocker and Masten, 1991)

- They serve as strong basis for the investment in gas infrastructure;
- Allow for proper distribution of market risks;
- Decrease the ex-post costs;
- Ensure the demand security for the produced gas;
- Assist exporter in establishing market share in the buyer's market and in maintaining it for the duration of the contract.

Therefore, for policymakers, understanding the change in the duration of contracts is a prerequisite for revenue flow planning, maintaining future demand security and market share in the importing country for the commodity gas produced.

Our models' estimation results clearly indicate the fact that a number of global and industry specific events have contributed to the decrease of LTC duration. The evidence from gas market restructuring in Continental Europe might give clues on possible direction (shorter contracts) of the changes that might happen after the gas liberalization processes occur in other big markets of gas such as Japan.

The probability of the future with shorter contract duration was further confirmed by negative sign and statistically significant coefficient of the variables: year of signature, technological development and LNG tanker fleet capacity. These factors are likely to persist for years to come, further decreasing the length of contractual ties between exporter and importers.

The rise in the length of LTC's concluded during the recession period reflects precautionary demand associated with market concerns about the availability of future oil supplies rather than due to immediate needs of buyers.

To sum up, the results suggest that the duration of the long-term contracts will further shorten leaving gas producing countries with the issue of searching for and discovering the instruments that are additional or complementary to the conclusion of long-term gas sales and purchase contracts in terms of planning and ensuring future cash flow stability, provision of the demand security for the produced gas, minimizing transaction costs for renegotiation and enforcement of long-term contracts and foreseeing proper distribution of market risks during planning for new gas infrastructure investments.

PART III FLEXIBILITY IN THE NATURAL GAS TRADE AND LONG-TERM CONTRACTS

Chapter 4 Empirical analysis of the factors that affect the choice of flexible destination clause in the long-term liquefied natural gas contracts

4.1 Introduction

Traditionally liquefied natural gas exporters and importers have relied on long-term natural gas sale and purchase agreements (hereinafter referred as SPA) in trade deals. The main features of those contracts included: take-or-pay clause for a minimum specified volume, 20+ years length, dedicated ships and destination clauses making the chilled gas trade point-to-point. Long-term contracts have been ensuring distribution of market risks among parties, taking into account considerable capital investments for the development of the LNG infrastructure that made possible the trade between the seller and the buyer to happen. However, contractual arrangements between chilled gas buyers and sellers have become more flexible due to ongoing inclination towards trade in spot and short-term markets, which have increased ten-fold since 2000, currently making up 29% of total LNG sales or 71.9 million tons (MT). (Crocker & Masten, 1991, Joskow, 1987; Newmann & Hirchhausen, 2004; Ruester, 2009; IGU, 2016a)

IGU (2016a) highlights the importance of the following factors while explaining vigorous growth in the non-long-term trade:

- The growth in the number of LNG contracts with destination flexibility;
- The rise in the number of market players thanks to cheaper gas prices and deployment of new technologies, such as FSRU and FLNG;
- The reliance on the spot markets to cope with sudden demand changes in the markets of Japan, Korea and Taiwan, which lack pipeline gas imports;
- Increasing number of uncommitted LNG cargoes thanks to cheaper coal prices in Continental Europe, increased unconventional gas production in North America and start-up of new projects in Australia;
- High price differentials between regional gas markets made arbitrage a lucrative strategy;
- Substantial rise in the number of uncommitted LNG tankers.
- Expiration of number of long-term contracts, which have not been prolonged or prolonged on more flexible terms;
- Reloading capacity additions in a number of countries.

Energy efficiency measures, significant increase in green energy generation and slowdown in Asian consumption contributed to the decline in the demand for flexible volumes from its peak of above 60 bcm reached in 2013. The demand for global flexible supplies was led by Japan and Latin America with the share of 45% and 20% respectively. Another notable pattern is the increase in the number of less established market players aiming to benefit from the low prices by tapping into short-term deals. Moreover, highly price sensitive demand in Asian developing countries is projected to rise by 40% (compared to 2016) to reach 350 bcm in 2021. For instance, lower gas prices enabled higher utilization of gas-fired capacity in India and Pakistan and boosted incremental demand in China and ASEAN countries. (IEA, 2016, pp.33-36)

Gas market liberalization in North America and UK along with prohibition of inclusion of destinatination clauses in the contracts with Continental Europe have allowed the buyers, sometimes on the basis of the agreement with the seller and in other cases independently to divert bought LNG cargoes to more lucrative markets in the presence of arbitrage opportunities given by price signals less transportation costs. Furthermore, India and Japan are planning to follow this trend in order to promote a transparent and diversified gas market.[24] While it is early to argue that the cargo redirection have become a routine in the global LNG trade, it has happened frequently mostly due to over-contractedness of the buyer at the intended LNG market or motivation to benefit from arbitrage opportunities. For example, the price spread between Japanese and European gas markets were on average 6 US dollars per MMBtu between 2011 and 2015. Around 30% of the demand for flexible volumes is covered by direct diversions or reloads of the supplies initially contracted to a specific country. Diversions and

[24] India, Japan to push for removal of destination clause in LNG contracts, India Business Insight, Business Line, Bangalore, January 15, 2016.

reloads exploit stronger reliance on pipeline imports and fuel switching in the power sector - embedded in the gas system of the intended country to free up LNG volumes for where they are most needed. Today, the aggregate overcontracted position in global LNG markets is around 70 bcm, and despite the fact that the production underperformance of some LNG exports has offset some of that it remains high. (IEA, 2016, p. 43)

To sum up, the dynamics of the system can be described as: an unforeseen high level of US domestic production, lower than anticipated demand levels and the huge growth in destination flexible LNG supply. (Rogers, 2010)

In this part of the dissertation global LNG market and trade flexibility brought by the ability of liquefied natural gas cargo diversions is explored. As it was mentioned in the previous part, the incorporation of FOB delivery terms into the LNG SPA's in accordance with INCOTERMS 2000 of International Chamber of Commerce enables to pass the risks and subsequently the cargo ownership from the seller to the buyer at port of loading, allowing the buyer diversion of the LNG cargo. "Accordingly, unless there are other contractual provisions that purport to limit the buyer's ability to resell or send the LNG to whatever destination he chooses under an FOB contract, the buyer may have almost complete destination freedom (subject to shipping and other commercial constraints." (Frinzio, 2016) However, DES or DAT contracts (DES was removed from Incoterms 2010) presuppose that the risks and subsequently the cargo ownership are retained by the seller until the LNG is unloaded at its destination thus making cargo re-export possible for the buyer conditional on owning cargo reloading facilities or by negotiating with the seller. In this case, the seller is responsible for shipping costs. Finally, reloading the LNG to another vessel for re-export requires additional costs from importer further squeezing or withering away potential profit from arbitraging.

In our opinion the flexibility has been brought by the possibility of the cargo diversion may largely affect the status quo of long-term gas contracts in the future. Today most of the LNG projects are greenfield in nature and the industry itself is relatively young as it started to function rigorously in the beginning of the 2000s. However, in the mid- and long-term future when the industry becomes more established and most of initial long-term contracts concluded for the trade of LNG from greenfield projects expire it may alter the whole status quo of the global natural gas industry. The growth of the spot and short-term LNG trade may reduce the size of the long-term pipeline gas resulting in higher dynamics of gas-to-gas competition in the world markets squeezing revenue income for gas exporting developing countries. The revenue is used for the investment in infrastructure, capacity building and human resource development.

While there is a growing trend towards relaxation of terms that limit destinations under long term contracts, substantial portion of contracts (particularly in the Asian Pacific market) still restrict destinations and resale. This situation removes volumes with restricted destination from the ability to exploit arbitrage opportunities.

Therefore, we state the following research question: What factors affect the choice of the destination flexibility clause (FOB) in the liquefied natural gas sale and purchase contracts?

This chapter is structured as follows:

Section 2 provides literature review. Section 3 talks about the flexibility in the LNG markets and long-term contracts. Section 4 analyzes cargo diversion possibilities and arbitraging between gas markets. Section 5 describes the INCOTERMS 2000 and specifies FOB and DES delivery terms. Section 6 defines the data and methodology. Section 7 explains empirical results. Finally, last section provides conclusions.

4.2 Literature review

The literature regarding the issue of the flexible destination clauses in the LNG SPAs is rather scarce. Producers use destination clauses in order to price the gas in relation to its competitor fuels in the destination market. (IEA, 2016)

The economic Law of One Price states that in the absence of transportation costs or any kind of economic barriers between supply and demand locations, commodity prices tend to converge to a single price over time. By means of arbitraging the price differences between locations are reduced to the level reflecting differences in transportation costs. (EIA, 2014) Zhuravleva (2009) establishes clear definition of LNG arbitrage and analyzes the barriers to the growth of the LNG arbitrage market. Ikonnikova et al. (2009) develop a two-stage model of LNG market to determine incentives to enter long-term contracts vs. spot trade and to understand the causes of new contract terms. They found that importers with excess supply will resell to importers with higher than expected demand and compete with exporters conditional on inclusion of “flexibility option” in their contracts. Moreover, authors argue that the appearance of the “flexibility option” and emergence of spot trade result from the value of investment cost and demand uncertainty level.

Cogan (2007) found that from the outset of LNG industry delivery terms for almost all LNG sales have been either FOB the liquefaction plant or DES the regasification plant in accordance with ICC’s Incoterms definitions. Later with the increase in the number of players and complexity of relationships, CIF terms have evolved, some parties are even considering deliveries on the high seas. Wood et al. (2008) argue that it is not necessarily the gas price differentials between regions but rather comparative spark spreads between chilled gas and competing power generation fuels (coal, distillate and fuel oil) that drive LNG trading for uncontracted LNG cargoes.

Relaxation of destination restrictions has also been under debate in East Asia as gas is often traded under rigid long-term contracts with destination restrictions. These clauses are introduced for reasons such as securing supply and investment. (Glachant & Hallack, 2009; Thomas et al., 2000) However, these restrictions cause inefficiency in the gas market. A study of real option valuation of free destinations in long-term LNG supplies argues that free destinations are highly likely to improve between 6% and 43% of the value of long-term LNG supplies (Yepes Rodríguez, 2008).

The emergence of competitive regulations prevents contractors from having any destination clauses in their sales and purchase agreements (Cogan, 2005). For instance, EU ruled that destination restrictions are not permissible from a competition policy perspective and G-7 nations and APEC agreed to relax such restrictions (Rowley, 2014). Furthermore, the current market conditions favor free destinations. According to Khalilpour (2011) the LNG business practice is changing rapidly with increasing medium-term or short-term contracts and a shift from DES to FOB delivery terms for a number of reasons, including more competition from gas market liberalization.

Ritz (2013) argues that regional price differentials can arise because of LNG exporters' market power rather than transport costs[25]. Author's key point is simply that for an exporter with market power, the arbitrage process stops when its marginal revenues are equalized rather than prices. For instance, if transport costs are identical as is roughly the case for Qatar's sales to the UK and Japan then export quantities are such that marginal revenues for each region are equal.

Growing literature discusses whether a global spot market is emerging, e.g. Jensen (2004), Foss & Dietz (2005), Foss & Juckett (2005), Charter (2007) and whether long-term contracts are to extinct. Hartley (2015) finds that deeper spot markets incentivize firms to increase contract flexibility and the share of spot purchases. Brito and Hartley (2007) provide yet another rationale for LTCs: if spot markets are thin, buyers and sellers may incur

[25] In a simple perfectly competitive model, price difference across two regions served by an exporter equals netback price minus transport cost for the exporter should be the same for each region. (Ritz, 2013).

costly delays as they wait for a suitable spot-trading partner. Huitric (2007) argues that despite emergence of swing producers in the Middle East and swing customers essentially in the Atlantic, LNG markets of the Atlantic and Asia-Pacific will keep their own dynamics for a foreseeable future generating regular and sometimes significant unbalances between markets opening the window for further price arbitraging. At the same time, Li et al. (2014) extend Neumann et al. (2006) and Neumann & Cullmann (2012) by concluding that Asian and European gas markets are integrated because of contractual links to oil prices, not arbitrage in a spot market.

Miyamoto et al. (2009) identifies the year 2004 as a time when changes in market fundamentals altered the relative prices of LNG inside and outside of Japanese contracts, triggering changes in pricing formulas. Agerton (2017) argues that these changes in the pricing formula were due to the willingness of the buyer to arbitrage between markets.

Ebinger et al. (2012) argue that exports of U.S. natural gas will take advantage of the benefits of producer surplus resulting from the pricing differentials between the natural gas markets in the United States, Europe and Asia.

4.3 Flexibility in the LNG markets and long-term contracts

Long-term contracts typically for 20 years or longer duration with carefully-structured system of risk sharing have been serving as traditional contracting pattern in the LNG industry. Unless the project is developed solely by a national oil company, traditionally the venture partners market chilled gas as a group directly to specific customers and the contract designates the destination of cargoes. On the contrary, in self-contracting, one or more of the partners in the venture (or their marketing affiliates) sign the SPA with the venture and assume the marketing risk for the contracted volumes. The resulting volumes commonly become part of the seller's supply portfolio and can be sold under any terms and conditions that he chooses to utilize.

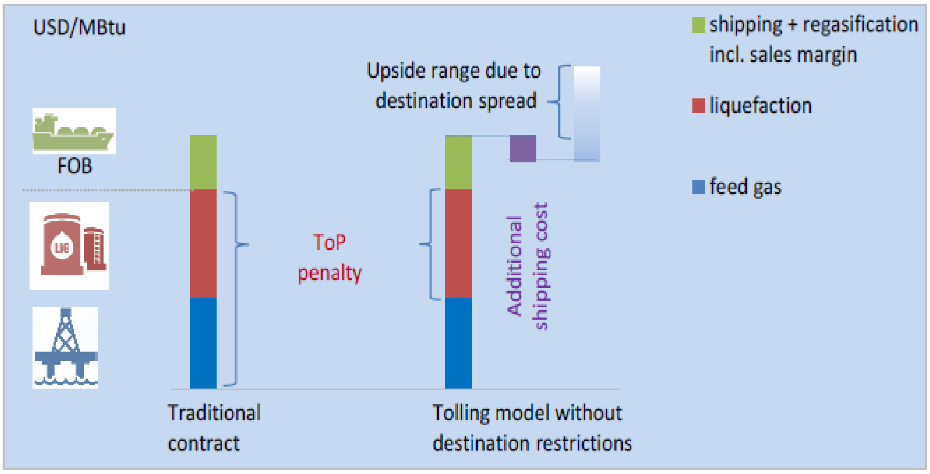

Figure 4.1 The upside of tolling fees and destination freedom[26]

LNG SPAs legally bind both parties to price and quantity, and in many cases, effectively prevent opportunistic behavior (i.e., the possibility of arbitrage) with destination restrictions and reduce the exposure to the natural gas market based price risks through the oil indexation price mechanism. The stability of cash flow that subsequently enables reduction of financing cost for long-lived, capital investments was the key motivation for entering in long-term contracts. (Hartley, 2014) While retaining dominance LNG SPAs went

[26] Source: IEA (2016, p.39)

through significant changes in recent years. For instance, “flexibility option” granted to buyers made possible for them to return spare volumes to a seller at some fee or re-export flexible volumes to benefit from arbitrage opportunities arising due to price spreads between regionally disparate gas markets. (Ikonnikova et al., 2009) Therefore, importers have been granted a room for maneuver when they end up with much more or much less chilled gas volumes due to price/demand volatility. Moreover, there is a rise in the number of contracts allowing buyer to re-route LNG shipments as long as the diverted volumes will not compete with seller’s other supplies at specified market(s). In this regard IGU reports that the major driver in spot and short-term trade growth has been the increased use of diversion options in flexible contracts (both short and long term). In addition, hybrid pricing schemes that designate a portion of the fixed traded volume to be indexed to oil (e.g., 80%) with the remainder linked to gas hub prices. A third area of ongoing change in long term contracts is the inclusion of opportunities for price re-negotiation (e.g., every 5 years). Overall, the increasing variety of business models is used in natural gas markets today and the extent to which this trend continues will be largely dependent on buyer acceptance of greater price volatility for potentially lower long-term average prices. (EIA, 2014) Nevertheless, as suppliers have shown great reluctance to proceed with a new project without some degree of long-term protection the industry reliance on long-term contracts seems likely to remain and act as the ‘filter’ that determines the flow of new projects into the market.

Table 4.1 Recent LNG contracts by destination clause flexibility[27]

	Destination clause	ACQ (bcm)	Average length
Signed in 2014	Flexible 51%	1.41	20
	Fixed 49%	1.35	12
Signed in 2015	Flexible 39.5%	1.55	17
	Fixed 60.5%	0.90	11

4.4 Evolution of the LNG markets

There are currently six significant regional markets importing LNG – Northeast Asia, Continental Europe, North America, UK, China and India. While Northeast Asia and Continental Europe have developed their gas industries based largely on imported supplies, the US and the UK have been relying on indigenous natural gas along with imports. China and India have had comparatively smaller gas industries based on domestic supplies, but now envision substantial growth based on chilled gas imports. These markets differ significantly in the balance of energy sources that compete with natural gas. Gas pricing in Northeast Asia and Continental Europe is a product of the price negotiations between the buyers and suppliers who are eager to get the highest possible netback for the depletion of their national resources. On the other hand, in the liberalized gas markets of North America and the UK gas pricing reflects gas-to-gas competition. China and India have a history of local gas pricing that has been heavily influenced by regulation. Therefore, the concept of a uniform international approach to LNG pricing may be a theoretical ideal, but it is far from a reality in current LNG markets. However, less uniformity in gas prices between different regions, compared to oil can be explained by

[27] Source: IEA (2016, p.62)

high storage costs of gas that result in volume and price restrictions for the price transmission function of LNG trade through arbitrage.

Table 4.2 Countries importing and exporting LNG in our dataset

Exporters	**Importers**
Argentina	Abu Dhabi
Belgium	Algeria
Canada	Australia
Chile	Brunei
China	Cameroon
Dominican Republic	Colombia
France	Egypt
Greece	Equatorial Guinea
India	Indonesia
Indonesia	Iran
Italy	Libya
Japan	Malaysia
Korea Republic	Nigeria
Kuwait	Norway
Lithuania	Oman
Malaysia	Papua New Guinea
Malta	Qatar
Mexico	Russia
Netherlands	Trinidad and Tobago
Poland	UK
Puerto Rico	US
Singapore	
Spain	
Taiwan	
Thailand	
Turkey	
UK	
US	

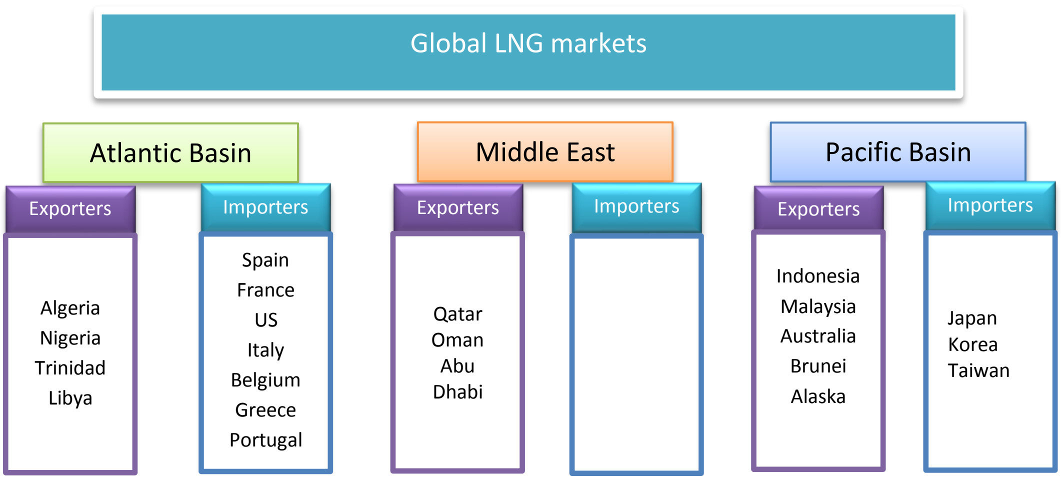

Figure 4.2 The classification of the global LNG markets in accordance with Jensen (2004)

Regulatory reforms in some countries brought alterations to the gas market. Following the implementation of the FERC Order 380 in 1984 (which relieved buyers of their ‘take’ obligations on long-term contracts), it became impossible to sell LNG at oil-linked prices in the US gas market. Moreover, the European Commission has argued that destination clauses are not in line with European competition law and 1958 Treaty of Rome as they restrict free movements of gas, such as re-sale. The first exporter to remove the destination clauses from existing and also future contracts with EU customers was Nigerian LNG in December 2002 followed by Gazprom’s consent in July 2002 to drop the destination clauses from all future contracts. As a result, the new destination flexibility has made possible for buyer to arbitrage between regional gas markets. Profit sharing mechanisms are usually incorporated into the agreement. (Energy Charter Secretariat, 2007)

Jensen (2004) defined three main regional LNG markets: Pacific Basin, Atlantic Basin and Middle East. The Atlantic Basin has an active arbitrage market involving European and US customers, and the Middle East has become the pricing arbitrage focal point between the Atlantic Basin and Northeast Asia. Moreover, buyers began to negotiate upstream equity positions from their suppliers as a part of new contracts. Examples of such equity positions include Kogas in Qatar’s Rasgas 1, Tokyo Gas and Tokyo Electric in Australia and China’s CNOOC in Australia’s Northwest Shelf and

Indonesia's Tangguh projects. (Corbeau et al., 2014; Energy Charter Secretariat, 2007)

Broadly speaking, there are three ways of delivering flexible volumes to those who require them: uncontracted production, contracted but divertible in accordance with contractual provisions and contracted but open to multiple destinations, such as volumes held by aggregators or portfolio players. (IEA, 2016) In this context, our research deals with volumes that are contracted to a specific destination but can be redirected to another market.

4.4.1 Flexibility provided in the form of diversions

The supplies from Trinidad and Tobago, Nigeria, Oman, Algeria and Peru were actively redirected. In the period between 2004-07 Trinidad's significant chilled gas volumes intended for Spanish market reached North American markets. Furthermore, the marketing structure of Train 4 of Atlantic LNG was based on tolling model. Nigeria LNG was financed by its shareholders (ENI, Shell, Total and the Nigerian state oil company), which resulted in contracting a bulk of the volumes not linked to any specific destination. Oman's diversions are related with lower offtake (relative to contracted volumes) by Japan and Korea. In the case of Algeria, a rise in export capacity led to the increased diversions in 2014 and 2015. Finally, the contracts governing activity of the Peruvian LNG export facility retain destination flexibility conditional on royalty payments to the Peruvian government calculated as netback from the final destination. Nevertheless the period of intensive LNG diversions was between 2011 and 2014 as a result of widening price differentials across regional markets prompted by the

Fukushima nuclear accident in Japan. To sum up, project's funding structure, host country participation and debt/equity ratio affect the level of flexible supply volumes that are not committed by means of long-term contracts. (IEA, 2016)

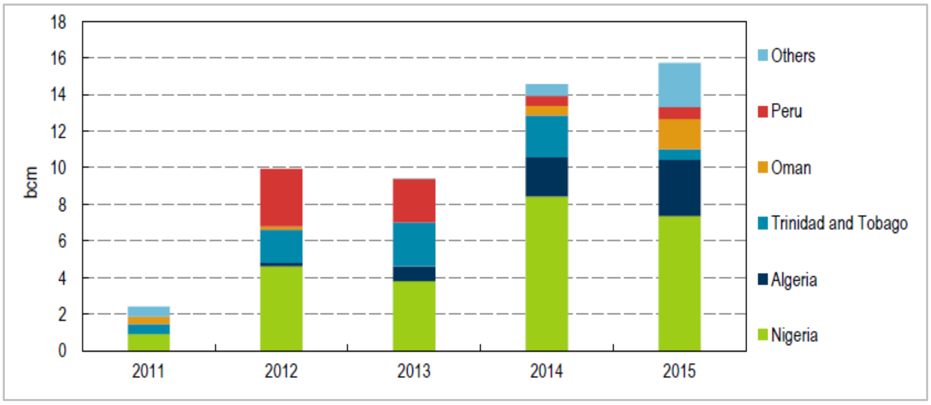

Figure 4.3 Flexibility provided by diversions[28]

4.4.2 Flexibility from reloading activity and North American export volumes

This category of cargo diversion implies a purchase of the LNG cargo on a DES delivery basis, discharging it from the vessel into the storage tank and subsequent reloading into another tanker. When the LNG is discharged at its initial destination, the buyer (re-exporter) no longer has to share potential profits if the gas is sold to a third party (Drewry, 2012). However, because unloading and reloading incur a cost and subsequently require higher price spreads across regional gas markets, direct diversions are more efficient way to re-route gas. Transaction costs related to negotiating with exporter is the main reason why overcontracted importers resort to reloads.

[28] Source: IEA (2016, p.53)

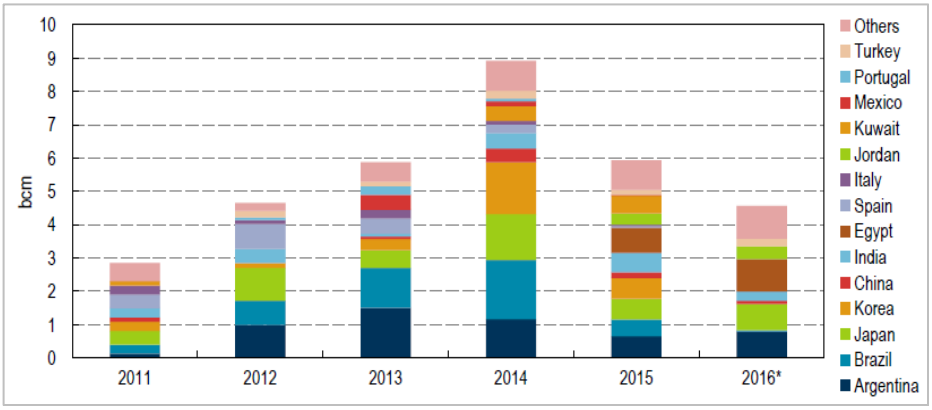

Figure 4.4 Share of reloadings by import country 2011-16[29]

According to IEA (2016) steady growth in reloads was observed in the period between 2011 and 2014 when they peaked at 9 bcm (dominated by Belgium and Spain in Europe) and fell back to 6 bcm in 2015 due to diminishing activity in Spain and Belgium and despite increasing in France and the Netherlands.

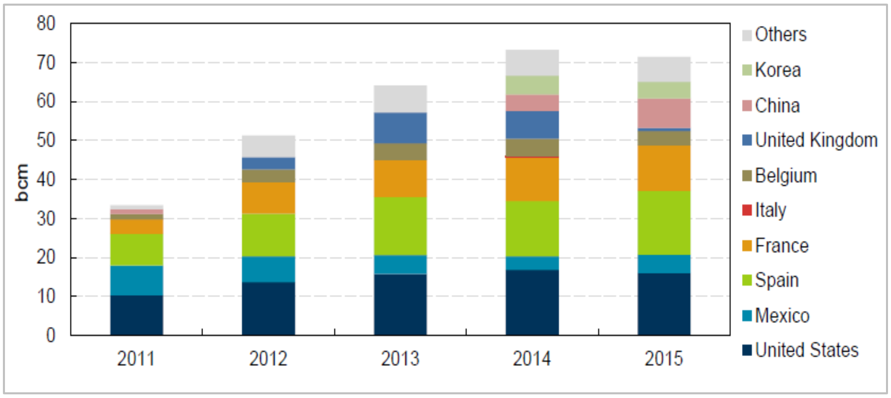

Figure 4.5 Overcontracted composition of LNG importers 2011-16[30]

Around half of the incremental supplies up to 2021 are expected to be sourced from US. This fact has brought expectations on that fully flexible

[29] Source: IEA (2016, p.57)
[30] Source: IEA (2016, p.45)

contractual model of large US exports will contribute to the growth of price arbitraging between disparate global gas markets in order to be able to timely react to the supply and demand shocks. Furthermore, the share of contracts with flexible destinations has been steadily growing. For contracts signed in 2015 this share reached close to 60%, from just around 33% for deals signed before 2009. (IEA, 2016)

On the other hand there are opinions about that today's oversupply should not be regarded as a structural feature of the market as 15% of LNG export infrastructure has lower physical production flexibility than commonly perceived due to lack of feedstock gas and a combination of security issues and technical problems. Furthermore, it is pointed out that LNG liquefaction plants operate as baseload facilities resulting in a basic lack of short-term upswing capability in LNG production and mention about European gas storage operators who have come under increasing economic pressure as shippers have become more hesitant to book capacity because of low spreads between summer and winter prices. (Snow, 2016; IEA, 2016)

Gas demand and supply are influenced by weather, seasonal gas consumption peaks, delay in domestic gas production, price and availability of competing fuels, and growing demand for cleaner and safer energy fuel. Therefore, short-term (less than four years contracts) LNG trade (accounting for 30-35 % of market) offers the flexibility to fill in the gaps caused by the supply shortages and to arbitrage prices between alternative LNG markets. In this context, Jonathan Stern, director of gas research at the Oxford Institute for Energy Studies points out that although LNG trading is not expected to look like the oil market soon, the move away from traditional supply deals is unavoidable. In the same vein analysts at Goldman argue that “increasingly assertive buyers will gradually turn away from long-term contracts.” (Anjli and Sheppard, 2015) Moreover, they recall the transformation of the crude oil trading in the mid 70’s when it took only a few years to revolution the world of oil trading with the rapid disappearance of the long-term contracts in favor of spot arrangements. For instance, according to Huitric (2007) existence of a strong gas-oil price relationship and the rise in short-term transactions supports the theory that LNG would soon be traded like oil.

4.5 Cargo diversion and arbitraging between markets

Given LNG’s mobile format despite the weaker price signals between markets due to smaller number of players and point-to-point nature of LNG trade in 2000s it was clear that “trading mindset would gain ground over the long term relationships paradigm”. (Rogers, 2010, p.37) The rise in the number of exporters and importers, availability of uncommitted chilled gas cargoes and development of arbitrage activity led to the increase in liquidity of the “flexible” LNG market. (Zhuravleva, 2009)

The main causes for regional variety in the pricing mechanisms for gas lies in differences in: (Energy Charter Secretariat, 2007)

1. **The development of import dependence**: Natural gas rich countries whose gas consumption can predominantly be covered by domestic production have regulatory control of supply (upstream) and demand (downstream) thus are able to influence the gas pricing mechanism. On

the other hand, supply side is beyond regulatory reach of import-dependent countries because main supply decisions influencing the balance between supply and demand are taken by resource owners. Nevertheless, they may try to influence export pricing either through raising the share of local production, or by diversification.

2. **The size of field**: Countries possessing many small fields can achieve resource rent optimization by an adequate taxation regime, where development and depletion will be decided by individual profit-maximizing upstream companies. However, depletion and market penetration rates so as to avoid flooding the export markets with gas by too rapid development of production at the focus of countries with super-giant or giant fields.

3. **Demand side**: Gas consumption for heating is highly dependent on temperature, but has little price elasticity. Unless dual-firing equipment is installed the gas for smaller and medium-sized industry and for commercial purposes is rather price inelastic in the short-term, but in the longer term most customers are able to switch to gas oil or fuel oil by investing into new equipment. In the power sector, where gas competes with coal on a short- and long-term basis, average costs of CCGTs can be lower compared to coal-based power generation. However, in the short-term, gas has to compete on a marginal cost basis against the use of coal, which is going to drag down the gas price to the lower levels compared to other sectors. This is the reason why

exporting countries try to avoid volume expansion by selling into a power sector.

4. **Implications for regulation from: the development of import dependence, field size and demand side**: Depletion policy (mainly speed and rent-taking by the resource owner) is the central issue of upstream regulation while downstream, the main issues are about concessions for the sale of gas, access to infrastructure (often regarded as a natural monopoly) and unbundling of integrated gas companies. Policy and regulation for the power sector has the most important influence on the volume and price elasticity of gas demand. For countries which use gas for domestic and export purposes, a question is whether to apply the same pricing principle domestically as for export, or, if not, how to deal with the resulting price differential between domestic and export prices. Inversely, for import-dependent countries with significant domestic production, the question is how to price their domestic production: one approach is to avoid price differentials by letting the price for domestic production adopt the price set or influenced by imported gas (as in the US, the UK, Germany, France and Italy); another option is to use cheaper domestic production to reduce the average gas supply costs or to allocate it to special consumer groups.
5. **Influence of political considerations on international pricing mechanisms**: Exporter country may offer lower prices for importing

countries (thus giving away a portion of its resource rent to a consumer state) in exchange for political cooperation.

Destination clauses restrict onward sales and limit use of gas sales only to contractually specified geographical market areas and thus prevent gas-to-gas competition. The European Union while recognized the role of long-term contracts have restricted the use of destination clauses. Item 25 of the 2003 Gas Directive states: “Long-term contracts will continue to be an important part of the gas supply of Member States and should be maintained as an option for gas supply undertakings in so far as they do not undermine the objectives of this Directive and are compatible with the Treaty [of Rome, 1958, establishing the EU], including competition rules. (Konoplyanik, 2005)

The fragmentation of LNG deliveries incentivized by the regional price differentials have started since mid-2000 being delivered broadly in line with contractual provisions. Now let’s look into the LNG cargo diversion development on the example of Rogers (2010) modeling price differentials between Continental and North American gas prices.

i) **North American Prices Higher than European Oil-Indexed Natural Gas Prices:** When gas prices rise to the level of residual fuel oil, fuel switching starts in the US power generation sector. The process results in the diminishing of some 70 mcm/day of gas demand. When switching is completed prices will continue to rise until: a switching band with distillates is reached and/or demand falls down in gas-intensive industries for the duration of the price spike. If the gas price stays high for a period of 4-6 month it results in drilling activity rise which will bring on new supplies after one year. If the situation persists acceleration of LNG projects with the North American market in mind (time lag of 4 to 5 years from sanction to new supply) is expected. In this price spread context, European importers have an incentive to divert flexible LNG to North America and increase nominations under its long-term oil-indexed pipeline contracts. This provides the European importer/wholesaler with net trading profit. As a result additional supplies of chilled gas arriving to North America storage inventory increases and depresses price. Europe will continue to divert LNG to North America and increase its take of oil-indexed pipeline gas until either:

- North American prices reduce to converge on European oil-indexed prices (at which point there is no incentive for further arbitrage);
- The nominations under long-term pipeline contracts reach Annual Contract Quantities or maximum short-term limits at which point the arbitrage dynamic ceases, despite a residual arbitrage price incentive.

ii) **North American Prices Lower than European Oil-Indexed Natural Gas Prices:** If gas prices fall below the level of coal prices the gas demand is going to increase as coal is displaced in the power generation sector. The period of 4-6 months of low gas prices will lead to the decrease in the number of active drilling rigs. If this situation persists marginal LNG projects will be deferred. When later market outlook appears more favorable they will have 4 to 5 years lag from sanction to production. In this context European buyers have an incentive to buy flexible LNG and reduce nominations of oil-indexed pipeline imports under long term contracts. This provides the European importer/wholesaler with a net trading profit. The reduction in LNG arriving in North America reduces storage inventory and increases price. Logically Europe will continue to buy flexible LNG and reduce its take of oil-indexed pipeline gas until either:

- North American prices increase to converge with European oil-indexed prices (at which point there is no incentive for further arbitrage).
- The nominations under long-term pipeline contracts reach take or pay or minimum short-term limits at which point the arbitrage dynamic ceases, despite a residual arbitrage price incentive.

Therefore, global natural gas markets despite their different pricing structures and security of supply concerns are connected by arbitrage driven system dynamics.

The use of the flexibility band in Europe’s long term pipeline gas import contracts is an instrument for physically adding or removing gas from the system i.e. literally by altering upstream production levels. However the scope of this physical adjustment is just some 40 bcm annually in a gas market of 1,600 bcm/a. (Rogers, 2010, p.79) Therefore the key issue from supply security perspective is how much flexibility in terms of destination is retained by the current and incremental chilled gas supplies, which is basically a contractual matter. To sum up, besides the supply side, the volume flexibility has to come from demand-side, production, pipeline import flexibilities offered by different regional gas markets. (IEA, 2016)

4.5.1 Price arbitraging between markets

Zhuravleva (2009) defines LNG Arbitrage "as a physical cargo diversion from one market to another, which offers higher price. The diversion of the cargo can be regarded as arbitrage if the cargo was initially committed to the first market and to the initial buyer in a commercial contract." (Zhuravleva, 2009, p.2) The two key drivers for arbitrage are Commercial (an ability to take advantage of price differentials between markets) and Operational **(**financial loss minimization in case of plant outages, overfull storage tanks or force majeure). In financial theory, arbitrage is defined as the practice of buying and selling equivalent goods in different markets to make a profit, without any risk or without making any investments (Berk & De Marzo, 2011). Sharpe, Alexander & Bailey (1998, p.907) have formulated the following definition of arbitrage: "The simultaneous purchase and sale of the same, or essentially similar, security in two different markets for advantageously different prices."

From the theoretical point of view the cargo diversion or arbitraging between different regional gas markets can be approached from the Law of one Price (LOP). When LOP holds there are no profitable strategies that are possible to exploit for any of the participants in the market. Cournot explained the LOP as commodity flow from the market where it has less value to the market where its higher valued, "until this difference in value, from one market to the other, represents no more than the cost of transportation". (Cournot, 1838, p.117; Finnema & Haugen, 2014) According to Ardeni (1989, p.1) : "…it is usually assumed that commodity prices are perfectly arbitraged, at least in the long-run”. It means that price divergence can exist between markets time by time, but as soon as the players notice it, the prices are going to move towards convergence until they become equal less transportation costs.

While several arbitrage models are explained in Zhuravleva (2009) the scope of our model covers committed LNG under the long-term contracts (more than four years), where the buyer (hereinafter referred as Initial Buyer) acts an arbitrageur or re-seller of the chilled gas cargoes to the independent arbitrageur. Notwithstanding that the LNG can be diverted by both seller and buyer we approach the issue from buyer’s side. Therefore, two important features of our model are the existence of long-term gas sale and purchase agreement between the seller (exporter) and the buyer (importer) and the capability of the buyer to re-export gas in accordance with contractual terms (FOB). FOB contract grants the buyer an ability to exercise destination flexibility by means of LNG cargo(es) diversion during the periods of substantial price differentials between regional gas markets. We define the destination clause as a DES contract concluded between parties to the trade, which restricts buyer’s capability for LNG cargo diversion. FOB and DES terms are interpreted in accordance with INCOTERMS 2000 of ICC. In our model we assume that DES contract completely rules out the possibility of negotiation between seller and buyer for re-direction of his supplies to other market(s) under existing contract. The reason for making these assumptions is impossibility to verify or reject our assumptions due to undisclosed nature of the full texts of the long-term liquefied natural gas contracts. Furthermore, we allow the possibility of the definition of "discharge port" as in the FOB type deliveries with modified destination clause (see Table 4.4 for details) or possibility of existence of rent sharing provision in FOB contracts because both cannot restrict the LNG cargo re-direction, rather legitimize conditions for rent sharing in case if the cargo was diverted by the buyer to more lucrative market(s). To sum up our model deals with direct diversions when the buyer has long-term contract with the seller.

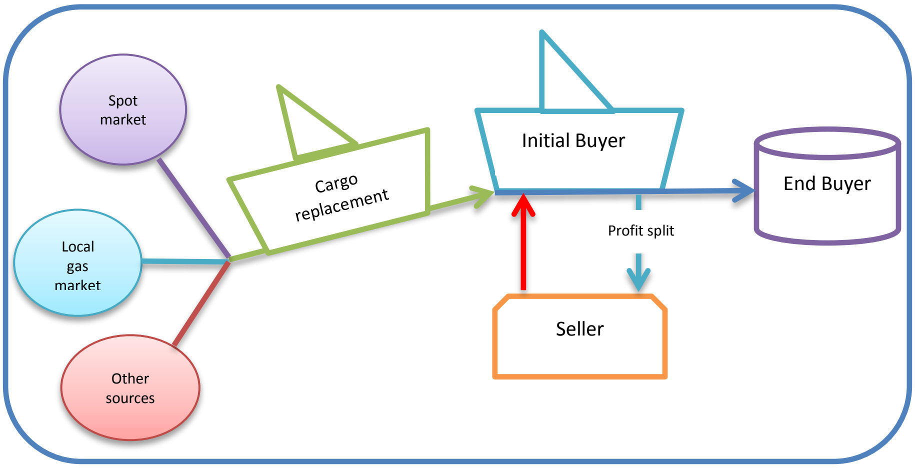

Figure 4.6 Initial Buyer acts as arbitrageur[31]

Our approach is based on the Initial Buyer-Arbitrageur Model.[32] In this model (Figure 4.6) the Initial Buyer decides to divert the cargo to a market that offers higher price. There can be two reasons why the Initial Buyer decides to divert the LNG vessel: first, the cargo can be replaced by cheaper gas from the local gas market or by LNG from the spot market; second, the buyer might not need the cargo at the moment (due to

[31] Note: Red arrows show the transfer of volume risk.
[32] Note: It is one of the theoretical arbitrage models from Zhuravleva (2009).

overestimated demand, seasonal demand fluctuations or unforeseen outages). (Zhuravleva, 2009) We assume that the contractual clauses allow cargo diversion if the trade deal is signed on the FOB delivery basis. The Initial Buyer sends the cargo to the End Buyer and may or may not split the profit margin conditional on the availability of specific provisions in the existing contract. If replacement of the diverted cargo is required it is the Initial Buyer's responsibility. If a destination clause is incorporated into the SPA (DES shipping terms), arbitrage by the Initial Buyer will be restricted. Furthermore, our approach can comprise *Independent Trader – arbitrageur model*[33] too. In this model another player appears in the transaction – the Independent Trader (see Figure 4.7). Any trading team, bank or individual trader can act as an Independent Trader. An Independent Trader buys the cargo from the Initial Buyer (who has FOB LTC with the seller) or gets the right to divert the cargo to another customer offering higher price. Whether the participants split the profit depends on bilateral agreements. If replacement of the diverted cargo is required, it also depends on the agreement whether the Initial Buyer or an Independent Trader will replace it. (Zhuravleva, 2009) This model is related to our model in the sense that the Initial buyer, who has the contract with seller, buys the cargo and sells it to the Independent Trader, who will divert it to another market. It implies that the cargo will reach other than the Initial buyer's market at the end of the arbitraging transaction.

[33] Note: It is one of the theoretical arbitrage models from Zhuravleva (2009).

We look into the LNG market flexibility approaching from perspective of the analysis of the factors that affect the choice of flexible destination clause (FOB delivery terms) in the long-term liquefied natural gas sale and purchase contracts.

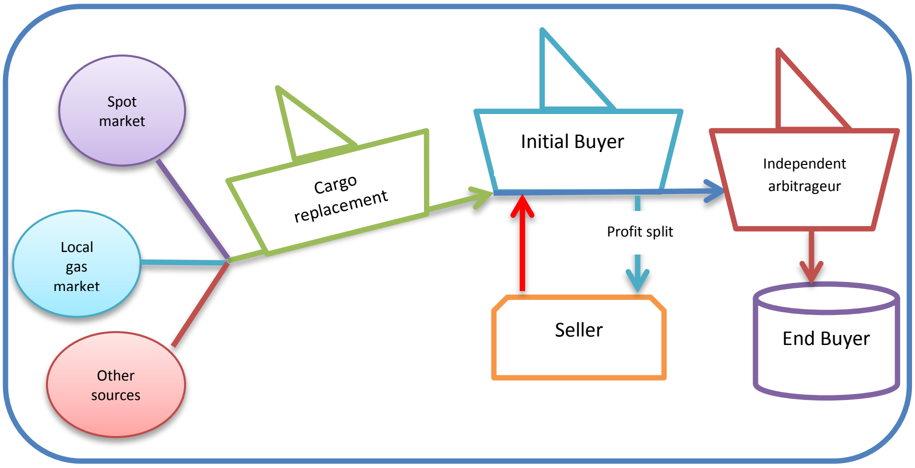

Figure 4.7 Independent trader acts as arbitrageur[34]

The destination clause restricting the sale of the LNG can be stipulated in the contract in two different forms. The first one can be in the form of "territorial restriction clauses ("re-export prohibition") and mechanisms having similar effects. (Frinzio, 2016) Nevertheless, for the first type of destination clauses we assume that they are gone. The first reason is that such clauses are impossible to incorporate for the supplies intended to the mature liberalized markets of the North America, United Kingdom and Continental Europe due to the potential breach of competition rules. The second reason lies in data availability due to undisclosed nature of LNG contracts. Furthermore, the data from EIA (2014) shows that the share of

[34] Note: Red arrows show the transfer of volume risk.

LNG contracts with destination clauses shrank from 67% to 49%. (see Table 4.3) The second clue supporting the fact that DES shipping terms act as destination clause is that in contracts where LNG is delivered ex ship risks and ownership of the cargo passes to the Initial buyer in the destination port. However, in the case when the LNG cargo delivery terms has been stipulated in the contract as FOB, the risks and liabilities and subsequently the ownership of the cargo passes to the Initial buyer at the loading port. This fact in our opinion creates a potential for the diversion of the loaded cargo to other than Initial buyer's discharge port if the price spreads between different regional markets allow. The LNG cargo(es) can be diverted by the Initial buyer himself or sold to the independent arbitrageur who can either buy the cargo(es) or divert them on the behalf of the Initial buyer. In this context, overestimated demand, seasonal demand fluctuations, unforeseen outages are among factors that can motivate the initial buyer for cargo diversion. To sum up, from the Table 4.3 we see that the share of contracts with fixed destination clause (67% and 49%) almost coincides with the share of contracts with DES (59% and 46%) delivery terms and the share of SPAs with flexible destination clause (33% and 51%) coincide with the share of SPAs with FOB (41% and 54%) delivery terms. Furthermore, we assume that the chilled gas cargoes are diverted due to only commercial reason and do not consider the diversion of the cargoes for operational reasons e.g. reduction of costs.

Table 4.3 LNG contracts evolution[35]

	Annual	Average	Price	Destination	Shipping

[35] Source: IEA (2016, p.61)

	Contracted Quantity (ACQ) (bcm/y)	length (years)	indexation	clause	mode
LNG contracts until 2009	1.75	18	Oil-linked 76%	Fixed 67%	DES 59%
			Gas to gas 24%	Flexible 33%	FOB 41%
LNG contracts signed since 2010	1.55	13	Oil-linked 49.5%	Fixed 49%	DES 46%
			Gas to gas 50.5%	Flexible 51%	FOB 54%

There might be two effects with regards to the LNG cargo diversion from the initially intended market:

- Prices in the Initial Buyer's market remain stable;
- Prices in the final buyer's market might go down affecting the revenue flow of the other incumbent supplier(s) deteriorating their market share.

In this stance let's look into main factors for arbitraging to become a reality between different markets and cargo diversion. For this reason in addition to our own variables we will utilize and quantify some of arguments from theoretical paper by Zhuravleva (2009) in order to quantitatively look into determinants for the choice of FOB delivery clauses (flexible destination clauses).

1. Substantial Price Differential between Markets

Without great enough price spread that allows arbitrageur to profit no arbitrage transaction for commercial reasons can occur. (Zhuravleva, 2009)

The prices in all gas markets increased sharply between 2006 and 2008 due to tighter market balances for gas and oil in conjunction with higher construction costs associated with price increases for steel and other commodities and escalation in labor costs. Subsequently, as a result of reduced economic growth associated with the global recession natural gas prices went to free fall in 2009. Additionally, the rise in green energy use in electricity generation in Europe left unrealized growth in the share of natural gas. Finally, the rise in unconventional gas production in North America reduced the need for significant LNG imports. All of aforementioned factors led to oversupply in the Atlantic Basin. The global recession, with concomitant reductions in manufacturing and shipping, further reduced demand for both natural gas and oil. Resulting decreases in oil prices (and associated oil-based gas prices) were significant, but not as severe as gas-on-gas price reductions. As a result, Pacific basin prices were roughly twice Atlantic basin prices in 2009 creating a substantial arbitrage opportunity. As may be expected, during this period global exchange of LNG accelerated, notably from the Atlantic basin to the Pacific basin. The year 2010 brought greater global economic growth and energy demand, which enabled a rebound in oil-indexed natural gas prices, and cold winter strengthened European demand which influenced increases in UK gas-on-gas prices. In North America, however, shale gas production continued to increase, and natural gas prices have stayed relatively low, excepting modest increases in LNG import prices which are affected by natural gas prices in other buying regions. In 2011, the Fukushima Daiichi nuclear disaster caused an increase in Japanese LNG imports through the spot market which have increased the average price of natural gas in the Asia-Pacific market. LNG demand exhibits seasonality as demand tends to increase from Japan, Korea, and other Asian markets in October and November to replenish inventories before winter heating and power demand ramps up. (EIA, 2014)

Hypothesis 1: Substantial price spreads between markets (North American, Asian and European) increases the willingness of parties to conclude contracts on the basis of FOB delivery terms.

2. Importer's gas self-sufficiency

The buyers in the markets with no alternative sources of gas (such as Japan, Korea or Taiwan) and subsequently with lower self-sufficiency will refrain from LNG diversions in order to maintain supply security. On the contrary, the European and North American markets with alternative oil-indexed pipeline gas and domestic production have higher self-sufficiency in terms of natural gas.

Hypothesis 2: Higher self-sufficiency of the importer motivates conclusion of contracts with flexible destinations.

3. The Number of Players in the LNG Market

As soon as there are more than two buyers in the market an arbitrage deal should be potentially possible. The increase in the number of exporters and importers has a potential to raise the number of divertible cargoes and demand destinations. (Zhuravleva, 2009) For instance, with the development of greenfield projects and the deployment of the floating liquefaction technologies utilization of the stranded gas became a reality increasing the number of gas exporters. At the same time low gas prices allowed new importers, particularly those with relatively small and highly price sensitive demand to enter the LNG market. Island countries are now able to connect to the LNG market through chartering floating storage and regasification units which is substantially cheaper option compared to the construction of onshore gas receiving facility.

Hypothesis 3: The increase in the number of players (exporters and importers) in the global LNG market raises the willingness of trade partners to agree on contracts with flexible destination clauses.

4. Availability of Experienced Traders and Specialists

Like any young and growing market, LNG trading is short of experienced brokers and traders. Big companies that possess the assets and dominate the market (e.g. Total, Shell, GdF, BP etc.) have very good trading teams, but not every company can make this claim. This probably explains why so few companies involved in the LNG business practice cargo diversion. (Zhuravleva, 2009)

Hypothesis 4: Availability of experienced team of traders and specialists increases the likelihood of the choosing FOB contracts.

5. Technical Restrictions

LNG and its infrastructure are far from standardized, and this complicates arbitrage to a significant extent. For example, the new mega sized Q-Max and Q-Flex tankers having capacities of 261,700 - 266,000 cm cannot moor in every LNG receiving terminal. As of January 2017 sixteen different import markets (41 out of 114 existing regasification terminals) were known to be capable of receiving Q-Max ships. Twenty-two of these terminals were located in Asia and Asia Pacific, and none in Latin America or Africa. An additional twenty-eight existing regasification terminals are capable of receiving Q-Flex vessels (217,000-261,700 cm), as well as conventional carriers. In total, twenty-one out of thirty-four import markets were confirmed to have at least one terminal capable of receiving Q-Class vessels. (IGU, 2017)

Hypothesis 5: The parties to the agreement may take into account technical restrictions of the receiving terminals while deciding to choose the flexible destination contracts.

6. Regulatory and Market Restrictions

Governments and some regulatory institutions impose various restrictions and obligations on the gas market players. For instance, restructured gas markets strive for third party access to infrastructure. In general some regulations may hamper spot trade and arbitrage, but others may encourage it. For instance, while the “use-it-or-lose-it” principle in most European countries encourages the purchase of spot or diverted cargoes in order not to lose the capacity, LNG authorization and vetting processes often taking long time may be detrimental for spot and arbitrage transactions. Moreover, regulation may become more stringent during periods of high demand, preventing the buyer from diverting a cargo to a higher price market. (Zhuravleva, 2009)

It stands to reason that the importer has to possess capacity at a regasification terminal, but the existence of a spare regasification capacity will not attract a diverted cargo unless a competitive price is offered and technical and regulatory restrictions don’t hinder it. Another point is that the main challenge for traders is to get access to the regas capacity at the most valuable time for this market, which means when demand and price for gas are high. Some markets, such as the US, charge high fees for spot cargoes (around 0.90 USD/MMBtu) or offer the Margin-Sharing Agreements with primary capacity owners.[36]

Regulatory and market restrictions certainly influence the arbitrage market and slow down its growth however do not prevent buyers from looking for opportunities for arbitrage.

Hypothesis 6: Regulatory and market restrictions are likely to discourage the use of FOB delivery terms in the LNG SPAs.

7. Availability of Shipping Capacity

Diversion is hardly possible if there is a shortage of shipping capacity and carriers have tight schedules. Very often arbitrage implies a longer journey and needs spare shipping capacity. An increase in the volume of overall LNG trade, usage of vessels for LNG storage and the lengthening of marine routes should be taken into account when estimating availability of uncommitted shipping capacity. (Zhuravleva, 2009) At present year of 2017 however there is no shortage in LNG shipping capacity. As of January 2017 the global LNG shipping fleet consisted of 439 vessels, including conventional vessels and ships acting as FSRUs and floating storage units. In 2016, a total of 31 newbuilds (including two FSRUs) were delivered from shipyards, a 7% increase compared to 2015. Relative to the previous year, this was a much more balanced addition relative to liquefaction capacity (which grew by 35 MTPA). Nevertheless, the accumulation of the tonnage buildout from the previous years is still being worked through, keeping short-term

[36] Analysis of LNG Arbitrage examines main barriers to developing market, *LNG Journal*, February 09, 2010. Available at: https://lngjournal.com/index.php/test-ticker/item/9566-analysis-of-lng-arbitrage-examines-main-barriers-to-developing-market.

charter rates at historical lows. (IGU, 2017) For instance, average estimated spot charter rates for steam vessels fell below $20,000/day for a period of time during the year, with rates ultimately averaging ~$20,500/day. Average dual-fuel diesel electric (DFDE)/ tri-fuel diesel electric (TFDE) day rates dipped to ~$33,500/day as demand for Atlantic volumes in the Pacific Basin continued to decrease, resulting in a more regionalized LNG trade. The continuous wave of new builds hitting the market in 2017 will further push the LNG shipping market deeper into a period of oversupply, maintaining the current trend for spot charter rates in the near term. However, more substantial increase in new liquefaction capacity is likely to come online during 2017, which could potentially absorb some of the excess capacity. (IGU, 2017)

Hypothesis 7: The availability of uncommitted shipping capacity motivates the parties to the LNG contract to choose the FOB delivery terms to allow arbitraging between markets.

8. Availability of Regasification Capacity

Additional capacity coming online in established markets such as China, Japan, France, India, Turkey, and South Korea led to an increase in global regasification capacity to 794.6 MTPA by the end of January 2017. Moreover, 90.4 MTPA of capacity were under construction in the beginning of 2017. The expansion of new markets slowed in 2016, as capacity was only added in Jamaica – both Colombia and Malta received their initial LNG cargoes in 2017. A combined eleven projects are under construction in China and India, countries that displayed the strongest LNG demand growth in 2016. New entrants are also set to complete regasification projects in the coming years, including the Philippines, Bahrain, and Russia (Kaliningrad).

Furthermore, the notable fact is that global FSRU capacity reached 83.0 MTPA since 2015. (IGU, 2017)

Hypothesis 8: The increase in global regasification capacity raises the willingness of the buyer and seller to conclude SPA on the basis of FOB delivery terms.

9. Technological progress

Another issue is related to the impact of technological change on the flexibility of LNG trade. Technological innovation in the exploration and production sector has equipped the industry with tools and practices necessary to continuously increase the production of natural gas in order to meet rising demand. Our focus as in the previous part is on the increase in the capacity of the LNG tankers. Therefore, we have chosen the difference in the vessel size as a proxy for technological progress.

It is likely that technological development will result in increased supply which can result in more flexible LNG trade. (Niyazmuradov and Heo, 2017) On the other hand the rush for the development of new projects which started during the period of high oil and gas prices led to an increase in overall costs, such as steel, labour and construction. In addition to the fact that is that up-to-date technologies entail higher costs their adoption requires absence of any technical restrictions and full compatibility with existing liquefied natural gas infrastructure. Therefore, we state the following hypothesis:

Hypothesis 9: Technological progress will affect destination flexibility in the LNG trade.

10. Contract duration

The contract duration (CD) is a good proxy for the intensity of the relationship between the seller and the buyer (Crocker and Masten, 1988). The findings from the empirical studies done in the first part of dissertation clearly indicate that after the change of the gas market structure from monopolistic to more liberalized institutional framework the average length of contracts shortened. Therefore, the buyer is likely to insist on the flexible destination cargoes while concluding the SPA with longer duration in order to be able to benefit from price arbitraging during the periods of lucrative price differentials between regional gas markets.

Hypothesis 10: The duration of the long-term LNG contract is likely to affect the choice of flexible destination clause.

4.6 INCOTERMS 2000: DES (Delivered Ex-Ship) vs FOB (Free on board)

The Incoterms are predefined rules accepted by governments, legal authorities, and practitioners worldwide for the interpretation of most commonly used terms in international trade. They set who has to take the cost and the risk between the seller and the buyer when trading. It is the International Chamber of Commerce who in 1936 (were amended in 1953, 1967, 1976, 1980, 1990, and 2000) created the terms to make it easier to negotiate with foreign companies. The last revised edition was in 2010, which has a total of 11 rules (Export.gov, 2014).

The first version of Incoterms was clearly focused on commodity trading and fixed the important delivery points at the ship's side or the moment when the goods were taken onboard the ship, such as FOB ("Free On Board"), CFR ("Cost and Freight") and CIF ("Cost, Insurance and Freight"). Incoterms 1936 contained trade term representing the minimum obligation of the seller, namely EXW ("EXWORKS"). At that time the goods were handed over to the carrier in so-called container yards or container freight stations. In 1967, it became necessary to add terms for cases when the seller undertakes the delivery of goods to destination. The 1990 revision was triggered by the shift from paper documents to electronic communication. Final revision of 2010 was made because of the need for some clarifications. Indeed, the key trade term FOB is understood differently in the United States than in Incoterms merely representing a point that could be anywhere. In order to achieve an equivalent to FOB under Incoterms, it would be necessary to add the word "vessel" after the term FOB. A new trade term which indicates appropriate place - DAP ("Delivered at Place") - has therefore been introduced. However, DAP is inappropriate in cases where the goods should be made available to the buyer unloaded from the means of transport. Therefore, another new term - DAT ("Delivered at Terminal") - has been added to be used for the cases when the unloading of the goods from the means of transport should be performed at the seller's cost and risk. This means that the maritime terms DES ("Delivered Ex Ship") and DEQ ("Delivered Ex Quay") in Incoterms 2000 have been replaced, respectively, by DAP and DAT, since the "terminal" in DAT corresponds to the "quay" in DEQ where the goods are unloaded from a ship. If the parties continue to use

DES or DEQ under Incoterms 2000, the result will be the same as under DAP and DAT in Incoterms 2010. (Ramberg, 2011)

Despite defining appropriate Incoterms by parties disputes might nevertheless arise in practice owing to unexpected events that the parties have failed to consider in their contract in a clear and conclusive manner. In such cases the 1980 UN Convention on Contracts for the International Sale of Goods (CISG) has now become recognized worldwide, thus contributing significantly to transparency and effective dispute resolution in international trade. Thus, Incoterms appropriately supplement the CISG and have accordingly been endorsed by UNCITRAL. (Ramberg, 2011)

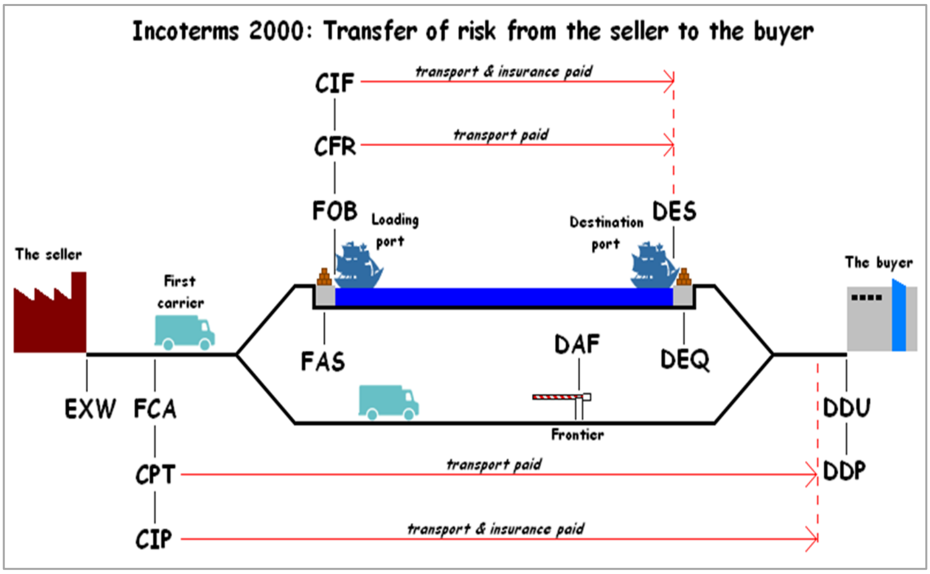

Figure 4.8 Transfer of risk from seller to buyer in accordance with INCOTERMS 2000.[37]

For the sake of our analysis we are going to use FOB and DES terms in accordance with INCOTERMS 2000 interpretation.

i) FOB – Free on Board (named port of shipment)

[37] Source: http://www.dacomacar.ro/en/Useful-info/Legislatie.html

FOB contract requires the seller to deliver goods on board a vessel that is to be designated by the buyer in a manner customary at the particular port. In this case, the seller must also arrange for export clearance. On the other hand, the buyer pays cost of marine freight transportation, bill of lading fees, insurance, unloading and transportation cost from the arrival port to destination. FOB should only be used for non-containerized sea freight and inland waterway transport. FOB terms are beneficial to the buyer for several reasons: controlling the cargo (possibility for arbitraging), flexibility in purchasing LNG from alternate sources in the event of a seller default or force majeure. It can also be a benefit to a seller who does not wish to bear the risks of a maritime "adventure" or the financial commitment which LNG shipping requires. (For details see Appendix A)[38]

ii) DES – Delivered Ex Ship (port of destination)

Where goods are delivered ex ship, risk transfer does not occur until the ship arrives at the named port of destination and the goods made available for unloading to the buyer. In this case the seller pays freight and insurance costs and additionally bears risk and title up to the arrival of the vessel at the named port. The costs for unloading goods and any duties, taxes, etc. are incurred by the buyer. (For details see Appendix A) [39]

The use of FOB and DES trade terms in the LNG industry grew out of practical experiences among merchants over long periods of time. New LNG trade terms will evolve as new experiences are encountered. Nevertheless,

[38] http://www.worldclassshipping.com/incoterm_fob.html
[39] http://www.worldclassshipping.com/incoterm_des.html

FOB and DES terms are likely to remain as standard in LNG sales because of the relative certainty and comfort they provide.

Table 4.4 Examples of LNG delivery terms[40]

FOB-type deliveries (from a 1995 long-term Pacific Basin LNG sale and purchase agreement)	**FOB-type deliveries with modified "destination clause" (from a 2005 long-term Middle East LNG sale and purchase agreement)**	**DES-type deliveries (from a 1995 long-term Pacific Basin LNG sale and purchase agreement)**
The LNG to be sold by Seller and purchased by Buyer hereunder shall be delivered to Buyer at the Delivery Point at the Loading Port. Delivery of LNG shall be deemed completed and title to and risk of loss of such LNG shall pass from Seller to Buyer as the LNG passes the Delivery Point. As used in this agreement, the "Delivery Point" means the point at the Loading Port at which the flange coupling of seller's loading line joins the flange coupling of the LNG loading manifold onboard an LNG Tanker. [Other provisions allocate responsibilities for (i) taxes and port charges in the loading port jurisdiction, (ii) LNG tankers (which Buyer agrees to provide), (iii) operations, etc.]	Title to and risk in LNG delivered under this Agreement shall pass from Seller to Buyer as the LNG passes the Delivery Point. Buyer shall be responsible for the transportation from the Delivery Point to the Discharge Port of all quantities of LNG to be sold and purchased under this Agreement. As used in this Agreement, (i) "Delivery Point" means the point at which the flange coupling of the loading line at Seller's Facilities joins the flange coupling of the loading manifold of the LNG Vessel, and (ii) "Discharge Port" means……….[or an alternate port nominated by buyer which meets certain minimum requirements and contains provisions to calculate the increase in the delivered price of the LNG, if any, resulting from delivering the LNG to an alternate port. The net increase would then be shared between buyer and seller]	The LNG to be sold by Seller and purchased by Buyer hereunder shall be delivered to Buyer at the Delivery Point. Delivery shall be deemed completed and title and risk of loss shall pass from Seller to buyer as the LNG reaches the Delivery Point. As used in this agreement, the "Delivery Point" means the point at an Unloading Port where the flange coupling of Buyer's unloading line joins the flange coupling of the LNG discharging manifold on board the LNG tanker. [Other provisions allocate responsibilities for (i) taxes and port charges in both the loading port and the unloading port jurisdictions, (ii) LNG tankers (which Seller agrees to provide), (iii) operations, etc.]

[40] This table is constructed by the author based on Cogan (2007).

As we can see from the extracts of real contracts signed in 1995 on DES and FOB terms - the Delivery Point defines the concrete place where the risks and liabilities for the LNG pass from the seller onto the buyer. However in the case of 2005 FOB contract with modified "destination clause" the term "Discharge port" is added. Nevertheless, later it continues as: "[or an alternate port nominated by buyer…. contains provisions to calculate the increase in the delivered price of the LNG….. The net increase would then be shared between buyer and seller]". Therefore, clear identification of the discharge port ceases to be the destination clause rather it implies stipulation of a special provision in the contract that preconditions profit sharing when the buyer decides to divert the cargo to benefit from arbitrage opportunities.

4.7 Data and methodology

In this empirical study we utilize the same dataset as in the previous part. In our analysis we depart from the point that long-term sale and purchase agreements for the liquefied natural gas concluded on FOB (free on board) delivery terms contribute to the flexibility of the LNG markets and the global gas market as a whole. Therefore we found it interesting to look into the determinants that affect the choice of flexible destination delivery terms. Chilled gas cargoes divertibility in our opinion will further contribute to the moves towards price convergence between regional gas markets and potentially may have drastic effects on the market shares of the traditional gas exporters. Consequently, the increase in the number of contracts with flexible destinations in the LNG trade may have effect on the security of demand of traditional gas exporters, subsequently negatively affecting the revenue flows which are used for development needs and fostering economic growth.

As it was mentioned earlier we approach the chilled gas diversion possibility from the buyer's perspective. The term "buyer" presupposes the initial buyer who has a contract with the seller.

We further recall that LNG SPA contains direct and indirect destination clauses. The first one is clearly written clause that prohibits the resale of the chilled gas to another buyer by the initial buyer without prior permission from the seller and usually through the mechanism of profit share and the second one is the use of DES (delivered ex ship) delivery mode from ICC's INCOTERMS that assumes the ownership and all risks related to the cargo passes to the buyer when it is unloaded from the vessel in the destination port. Of course, the LNG can be re-exported in this case too, but the costs of discharging and reloading can be quite substantial and result in withering away of the profit margin.

Owing to the fact that most of the mature restructured markets have abolished destination clauses we analyze the determinants of the cargo divertibility by means of approaching it from whether the specific liquefied natural gas contract is FOB or DES. Therefore, our dummy dependent variable is equal to one when the LNG delivery terms in the contracts is stipulated as FOB and zero otherwise. The fact that the dependent variable chosen is a dummy variable induces us to the use of Linear Probability, Logit or Probit Models. The linear probability model is simple to estimate and use, but it has some drawbacks. The two most important disadvantages are that fitted probabilities can be less than zero or greater than one and the partial effect of any explanatory variable (appearing in level form) is constant. These limitations of the LPM can be overcome by using more sophisticated binary response models, such as Logit and Probit Models. Moreover, the same issues concerning endogenous explanatory variables in linear models also arise in logit and probit models. Another possible issue is non-normality of error term. Naturally, if e does not have a standard normal distribution, the response probability will not have the probit form. Another possible specification problem, also defined in terms of the latent variable model, is heteroscedasticity in e. If Var($e|\boldsymbol{x}$) depends on $\boldsymbol{x}$, the response probability no longer has the form $G\ (\beta_0 + \boldsymbol{x}\beta)$; instead, it depends on the form of the variance and requires more general estimation. Such models are not often used in practice, since logit and probit with flexible functional forms in the independent variables tend to work well. (Wooldridge, 2009)

Table 4.5 Variables for the empirical analysis

Dependent Variable: FOB_DUM:	=1 for Contracts signed on FOB terms; = 0 otherwise
Independent variables:	LN_REGAS_CAP: = Total regasification capacity in the defined year
YoS: The year in which the contract was signed	TECHNICAL RESTRICTIONS: =1 if the importer country has a regasification terminal capable of receiving Q-type (Q-max and Q-flex) tankers = 0 otherwise
CIF_JPN-HH: The difference between CIP Japan and Henry Hub gas prices	LN_FLEETCAP: Total LNG tanker capacity in the definite year
CIF_JPN-GER_BOR: The difference between CIF Japan and German border prices	AVAILABILITY_OF_EXP_TRADING_TEAM: =1 when IOCs are party to LNG contract (either as buyer or seller) = 0 otherwise

GER_BOR-HH The difference between German border and Henry Hub prices	LN_Y_VOL: Yearly contracted volume
CD: Contract duration	TECH_PROG: The difference between the biggest tanker capacity minus average tanker capacity in the specific year
CARGO_RELOAD: =1 if the importing country owns at least one LNG import terminal with cargo reloading facilities = 0 otherwise	LNOIL: Average price for Brent during the year the contract was signed (USD/bbl.)
TPA_TO_REGAS: =1 if the importer country provides third party access at least in one of its LNG receiving terminals = 0 otherwise	SELF_SUFF_p: [(domestic gas production/ domestic gas consumption)]*100: Self-sufficiency rate of the gas importing country
LN_No_of_PLAYERS: The number of companies active in the LNG markets	EXP_MIDDLE_EAST: =1 if the exporter is located in the Middle East =0 otherwise
IMP_ATL_BASIN: =1 if the importer is located in the Atlantic Basin =0 otherwise	EXP_ATL_BASIN: =1 if the exporter located in the Atlantic Basin =0 otherwise

Instrumental Variables

LN_T_VOL: Total contracted volume	IMP_TERMINALS: The total number of LNG import terminals in the importing country in the specific year

The LNG and global natural gas markets have become more flexible as a result of the gas market liberalization processes in the US, UK and Continental Europe along with abundant supplies of the blue fuel from the North American shale plays and new greenfield undertakings from Australia and some other countries. Therefore, we include the (YoS) in order to check whether the LNG SPAs signed in the later years are more inclined towards incorporation of the flexibility clauses.

First of all we are going to present the variables related to the choice of the flexible destination clause in the contract from the point of view of the arbitraging potential between markets. In accordance with the theoretical paper by Zhuravleva (2009) we have constructed and quantified the following variables:

a. ***The price spread between markets***: As we know, presently there are three main LNG markets globally: North America, Europe and Asia. The former two are usually referred as an Atlantic Basin, while the latter one – Pacific Basin. It is the difference across regional gas market prices that stimulate the LNG buyers to divert bought cargo(es) in case if the price in other market promises good profit less transportation costs. Therefore, we define three variables that represent the exhaustive set of possible price differentials among three main gas markets. As we have mentioned earlier the North American gas market is liberalized, mature market with a number of hubs well connected to each other through the network of pipelines. However, the price in all of those hubs is defined as a differential to the Henry Hub located in Louisiana. Moreover, all long-term contracts for the sale and purchase of the natural gas are escalated to the HH price. Therefore, as in many other studies we have chosen the Henry Hub price as a benchmark representing North American market prices. Regarding the European market the decision was to select the German Border price, which represents the price of the imported pipeline gas instead of NBP in UK, because first of all unlike UK other parts of Europe still on the way of shifting to more liberalized common market. Moreover, long-term contracts for the purchase of pipeline gas still dominate the Continental Europe's market. For the Asia Pacific market or so-called Pacific basin the CIF Japan LNG price was chosen as a benchmark. The choice is explained by the fact that currently Japan is the biggest LNG importer globally and contracts for Pacific Basin have been historically pegged to the Japan Crude Cocktail (JCC) - average CIF price for imports of crude oil to Japan - price plus a constant to reflect freight and other costs. Regarding emerging benchmark, Platts began assessing LNG spot price, Japan Korea Marker (JKM), on February 2, 2009. However we use the data spanning from 1960s, therefore CIF Japan prices are deemed to be more representative for the current analysis. The reason for the inclusion of the three price differential variables lies in the willingness to find out which among three spreads of three different regional LNG markets have played significant role in the choice of the FOB contracts:

i. CIF_JPN-HH: The difference between annual average CIP Japan and Henry Hub gas prices;
ii. CIF_JPN-GER_BOR: The difference between annual average CIF Japan and German border prices;
iii. GER_BOR-HH: The difference between annual average German border and Henry Hub prices;

b. ***Importer's gas self-sufficiency***: The variable SELF_SUFF_p is added to the analysis. In our opinion the higher self-sufficiency of the importer country adds up to its capability of LNG cargo diversion. Furthermore, usually, the gas importing countries tend to contract higher volumes than the country's real gas demand in order to be able to take control of unpredictable demand.

c. ***Number of players in the LNG market***: In recent years, the number of natural gas market players has been increasing and spot market volumes have been growing. (EIA, 2014) As LNG is a very capital intensive industry involving huge investments in gas production, transportation, liquefaction, shipment and regasification, it has high entry barriers. Another important issue is the access to the gas resources and traditional point-to-point nature of long-term contracts with dedicated ships haven't granted opportunity to outsiders to enter the market. Therefore, naturally the number of players has not been significant. But increasing wave of gas market liberalization requiring the provision of third party access and abundant gas supply thanks to the technological development led to steady rise in the number of the players. The higher number of players decreases the supplier switching costs. To sum up, in this context we are interested in revealing whether the decrease in supplier switching costs have affected the choice of looser contracts in terms of final destination. Therefore we have added the count variable LN_No_of_PLAYERS.

d. ***Availability of experienced traders and specialists***: The diversion of the cargo even in the case of availability of lucrative price spreads is not an easy task. The LNG market is a young and developing market and therefore there might be a shortage of experienced traders and brokers and for the time being can be handled only by the oil and gas majors with big and highly experienced team of marketers who has wide networks within the market and able to find in a timely manner the buyer in the other more lucrative market(s), negotiate the deal and exercise it. (Zhuravleva, 2009) Therefore, the dummy variable AVAILABILITY_OF_EXP_TRADING_TEAM is incorporated to the analysis to check the contribution of the existence of big IOCs with highly experienced teams to the flexibility of LNG trade.

e. ***Technical constraints***: It is not possible to charter or buy LNG vessel which is compatible with all or even most of regasification terminals due to little standardization between LNG projects around the world. (Kwok, 2012) We chose to approach technical restrictions issue from the ship-shore compatibility aspect. As we have pointed out previously less than one-third of existing terminals are able to receive Q-type chilled gas tankers. Therefore, we incorporate the dummy variable TECHNICAL RESTRICTIONS in order to reveal the effect of technical restrictions on the flexibility of the LNG trade.

f. ***Regulatory and market restrictions***: Absence of the third party access to the gas infrastructure is detrimental to the competition in the gas supply and trade. Liberalized markets strive for non-discriminatory access to LNG regasification plants, however few markets are liberalized. Furthermore, access to arbitrage opportunities is limited by the prevalence of restrictive terms in long term contracts; supply chain limitations; and national policies that limit imports and exports. National-level export limits for natural gas can promote divergence in global prices. National-level limitations on the importation of natural gas may be explicitly established as a numeric limit, or implicitly established through tariffs, a concerted avoidance of LNG import terminal development, or discriminatory access to the national natural gas infrastructure. At the global level, import limits restrict arbitrage opportunities. While this does not prevent convergence to "one price" with respect to international trades, it does send a market signal of lower demand from the nations that impose these restrictions. (EIA, 2014) Therefore, the dummy variable TPA_TO_REGAS will enable to reveal the effect of third party access to the regasification terminals on the flexibility of LNG trade.

g. ***The rise in LNG tanker fleet***: When LNG import capacity is available the receipt of short-term and spot trades may be limited by the global LNG carrier (LNGC) fleet. Historically, the LNGC fleet, like LNG production capacity, has been developed by securing long-term contracts for service prior to final investment decisions and the typical 2 to 3 year construction period, leaving very little shipping capacity for short term and spot market trades. In recent years, an increasing number of LNGCs have been available for short term and spot trades. Therefore, the variable LN_FLEETCAP is added into the analysis in order to check the effect of abundance of uncommitted LNG tankers on the choice of flexible destination clause in the chilled gas LTCs.

h. ***The rise in regasification capacity***: The number of regasification terminals is increasing with the rise in the number of new chilled gas importers and expansion in the traditional importer countries. While liquefaction terminals tend to have high utilization rates, the regasification terminals can work with lower ones in comparison as a result of the fact that they are used by importer countries as the leverage for the diversification of the fuel supply and subsequently energy security. Nevertheless, in the periods of lucrative prices in the specific regional market there will be many market players who are willing to divert extra volumes to earn extra rents. Therefore, we include the variable LN_REGAS_CAP with the logic that the more is the regasification capacity globally the higher the foresight by the potential arbitrageur to select the delivery mode FOB in the contract that will not restrict the cargo diversion.

Furthermore we found it useful to add the following variables to check their relationship to the flexibility in LNG trade:

i. ***Contract duration***: The longer the length of the contracts the higher might be the willingness to choose more flexible destination clauses as buyer’s insist on flexibility in terms of diversion as an exchange for their lock into 20 + years contracts.

j. ***Technological progress:*** We have chosen the deviation between the maximum capacity and the average capacity of the tankers serving LNG trade lanes in the year observed as a proxy for technological change. As more recent additions to the fleet demonstrate a bias toward vessels with larger capacities we are interested in the effect of the technological progress (LN_TECH_PROG) in the LNG industry on the choice of the flexible destination clause.

Some of the LNG importers own cargo reloading facilities. From one point of view it is likely to make them indifferent in terms of the choosing between FOB or DES contracts because they retain a capability to immediately reload the imported cargo to the other chartered tanker and send to different market on demand. On the other hand, the reloading process is costly and requires significant price differentials in order to profit after recouping incurred costs. Furthermore, the reloading process can take time and requires spare space in the buyer's import terminal storage. Consequently, we incorporated the variable CARGO_RELOAD to check whether the availability of the reloading facilities by the importer country has an effect on the flexibility of the LNG trade. According to IGU, as of January 2017 the total number of terminals able to reload cargoes was 23 in 13 different countries.

Given the traditional oil price indexation of LTC's (usually several months) a higher oil price might provide disincentives for the buyer to enter into a long-term contract. Therefore, we include dummy variable (LNOIL) representing oil price prevailing in the year of contract signature.

The relationship between yearly contracted volumes (LN_Y_VOL) and the choice of the destination clauses is not clear ex-ante. We expect that the contracts with higher annually contracted volumes are less prone to the inclusion of the flexible destination delivery terms, as the country which has higher annual contracted volume usually has the task of satisfying bigger demand than the countries that have rather small yearly import volumes regarding the specific contract. We suspect that this variable can be endogenous. Therefore, we include two instrumental variables: Total contracted volume (LN_T_Vol) and IMP_TERMINALS in order to conduct instrumental variable probit regression (probit regression with endogenous covariates).

After performing probit regression with endogenous covariates in STATA 12.0 statistical package Wald test have shown the existence of endogeneity. Furthermore, we went further by performing Hausman like test to compare the models: probit and probit with endogenous covariates (IV probit) and found that two models differ from each other. The null hypothesis that two models are identical was rejected. As a result we report instrumental variable probit regression results for our model.

4.8 Empirical results

Regarding our first hypothesis the estimation shows mixed results. While for the price spreads between Japan CIF & German Border Price; German Border Price & Henry Hub came in line with expectation, the result for the pair of Japan CIF & Henry Hub discovered to be with negative sign. It can be explained by the fact that Japan and North America (until the trigger of high-scale unconventional gas development and production) traditionally have played a role of leading importers with significant demand. However, in North America domestic gas production is available which is not true for the Japan – the country totally dependent on LNG imports in terms of gas. Consequently, the relative rise in price spread usually occurred due to the inflation of prices in the North East Asia rather than North America. Therefore, the North East Asian importers might wanted to secure supplies and were less prone to allow cargoes to go to other destinations during the periods of high price spreads. As we have explained earlier there is a dynamic system of the gas trade between Continental Europe and North America as both of the Continents retain flexibility from pipeline gas imports. As a result each market might be closely watching the price differential dynamics between Europe and US in particular in order to benefit from lucrative spreads. Surprising results came up with regards to the variables: YOS, LN_TECH_PROG and LN_REGAS_CAP. The results showed that the later the date of the contract signature the more likely the trade partners to choose the DES shipping clause. The LNG industry is quite young and most of the investments have been done in recent two decades, therefore the parties may have been willing to recoup investments and most of the contracts are still far from the date of expiry when they can be renegotiated on more flexible shipping terms. The technological progress requires huge investment and it is happening simultaneously with the development of global LNG industry. Big investments require the risk share among importer and exporter to ensure the demand for sellers and prices for buyers. Furthermore, investing party strives for the market share in the importer's country. The same worries about the defending their market share may be in the heads of the incumbent wholesalers in the countries offering the third party access to the regasification infrastructure. Furthermore third party access is usually provided in the countries with around 90% gas import dependence. The same arguments may serve as an explanation of the result for LN_REGAS_CAP. It is only recently we saw the increase in the number of terminals functioning on a tolling basis but in the beginning decades of the LNG industry most of the terminals have had almost the same demand as the plant capacity. Finally, it might be an evidence of the fact that an increase in the number of players (both exporters and importers) is more important in the LNG industry rather that the expansion in regasification capacity alone.

Each new player in the LNG market is likely to increase the probability of FOB contract choice by 113.43% in the chilled gas trade deals. The emergence of new nodes in the LNG trade network decreases the switching costs and increases the number of exporters and importers. Surprisingly, the software output shows that buyers owning LNG reloading terminals understand better than others significant costs related to the reloads and probably resort to reloading only in the cases of extreme price differentials. Therefore, they are 54.35% likely to resort to FOB contract compared to DES. Regarding the technological progress the findings indicate that the parties to the long-term SPA are 118.87% less likely to choose the destination flexibility whenever they invest in new technologies in order to monetize the gas resources as LNG. It might be related to the willingness to spread market risks and avoid opportunistic behavior by non-investing party until the investment is recouped.

Interesting results came up regarding the effect of contract duration to the choice of flexible destination terms. The longer the duration of the contract the more is the willingness to agree on FOB delivery terms. The lower transaction frequency decreases the risks of the opportunistic behavior and mutual trust can be built during the period of the contract validity. Another point is the fact that currently there are plenty of investments in the greenfield projects in a number of destinations globally. As we have mentioned in the previous sections long-term contracts with rigid terms such as “take or pay” and destination clauses act as filter for entrants with greenfield projects. It means that in the current market where the contract durations have become comparatively shorter, market players are more prone to pursue the flexible destination clauses that will allow them to benefit from arbitraging between markets conditional on lucrative price spreads when they are bound by longer term SPAs.

It is natural that the cargo diversion process is not an easy task and requires experienced staff. The results indicate that the availability of experienced traders increases the probability of going into FOB contracts by 17.28%. At the same time technical restrictions such as ship-shore compatibility decrease the probability of flexible shipping terms by 76.35%.

We found that the increase in the LNG tanker fleet size and the self-sufficiency level of the importing country has a positive effect on the choice of FOB contracts. However, the oil price increase decreases the willingness of the trading partner to go into FOB contracts. During those periods importers maybe busy on securing volumes rather than thinking of re-direction of future supplies.

Finally the exporters located in the Atlantic Basin and in the Middle East are more prone to the choice of FOB contracts compared to the sellers in the Pacific Basin. It may imply that LNG exporters from the Pacific Basin are more inclined to ensure supply security and it is true that they usually offer higher rents compared to the other regional markets. Importers in the Atlantic Basin are having flexibility from pipeline supplies are open for the FOB contracts allowing LNG diversion compared to the buyers located in the Pacific Basin.

Table 4.6 Empirical results

ECONOMETRIC METHOD	IV PROBIT (Dependent variable FOB_DUM Instruments LN_T_VOL and IMP_TERMINALS)	AVERAGE MARGINAL EFFECTS
LN_Y_VOL	.9320*** (.2458)	.1546*** (.0499)
SELF_SUFF_p	.0023** (.001)	.0004*** (.0001)
JAPANCIF-GER_BORDER	2.3063** (1.12)	.3825** (.1540)
JAPANCIF-HH	-1.873* (.9977)	-.3106** (.1384)
GER_BOR-HH	1.9505* (1.053)	.3235** (.1470)
EXP_MIDDLE_EAST	.7589 (.5749)	.1259 (.0857)
EXP_ATL_BASIN	1.2332* (.6847)	.2046** (.0990)
CD	.0015***	.0002***

	(.0005)	(.0001)
LN_OIL	-3.5718**	-.5925**
	(1.7972)	(.2581)
YoS	-1.2533*	-.2079**
	(.6962)	(.1045)
IMP_ATL_BASIN	-5.7745***	-.9578***
	(1.9847)	(.2398)
LN_TECH_PROG	-7.1660**	-1.1887***
	(3.2388)	(.4639)
LN_No_of_PLAYERS	6.8384**	1.1343***
	(2.8037)	(.3792)
AVAILABILITY_OF_EXP_TRADING_TEAM	1.0419**	.1728***
	(.4487)	(.0621)
TECHNICAL_RESTRICTIONS	-4.5967**	-.7625***
	(2.0048)	(.2699)
CARGO_RELOAD	3.2768**	.5435***
	(1.4036)	(.1876)
TPA_TO_REGAS	3.4709***	.5757***
	(1.1344)	(.1408)
LN_REGAS_CAP	-2.0198**	-.3350**
	(1.044)	(.1774)
LN_FLEETCAP	13.7690*	2.2839**
	(7.6534)	(1.1527)
Constant	2365.516*	
	(1301.853)	
/athrho	-1.0308**	
	(.4992)	
/lnsigma	-.7761***	
	(.2271)	
Rho	-.7742	
	(.1999)	
Sigma	.4602	
	(.1045)	
No. of observations	181	
Probability of correctly predicted	85.64%	
Wald chi2	89.44	
Pseudo R2	0.7040[41]	

****, **, * denote P-values less than 0.01, 0.05 and 0.1 respectively. Heteroscedasticity robust standard errors are in parenthesis.*

Heteroscedasticity robust standard errors were used in this analysis.

[41] The Pseudo R-squared was calculated in accordance with Mc Fadden (1974): 1- (log likelihood from the model/log likelihood from the model with only constant) = 1- (-56.441128/-190.71718) = 0.7040.

4.9 Conclusion

The flexibility has been brought by the possibility of the cargo diversion may largely affect the status quo of long-term gas contracts in the future.

As we have seen even if markets create conditions for cargo diversion, it will be unrealistic unless contractual clauses allow it. Destination clauses and ex-Ship arrangements (DES) make arbitrage almost impossible, with rare exceptions (outages or other exceptional cases).

After disputes (when a buyer’s market emerged) some suppliers permitted cargo redirection but only if the profit from arbitrage was shared. Contractual limitations are likely to be relaxed in the future. The reason for this is that buyers may be unwilling to automatically extend existing contracts without inclusion of greater flexibility. New liquefaction capacity is coming on stream in the near future and softening in demand growth rate gives buyers the expectation of increased influence. This should facilitate more flexible position on destination clauses and diversion flexibility.

As we have seen from the results, self-sufficiency of the importer countries, price spreads among North East Asian and North American markets and between Henry Hub and German Border prices, an increase in the number of LNG market players, third party access to the regasification plants and rise in the chilled gas tanker fleet and availability of the experienced trading team increases the probability of the choosing FOB contracts, allowing the cargo diversion among markets. Of course the flexibility in this context may not be high enough presently, however with the arrival of new supplies from U.S and

Australia as well as many other greenfield projects it is likely to be quite significant and capable of altering the status quo in the global natural gas industry. Furthermore, the technological development in the field of unconventional gas production in the North America can have a spillover effect for other traditional importers possessing huge reserves of the shale gas. Utilizing the same methods they might increase their natural gas self-sufficiency or even some of them can become future exporters of blue fuel. The differences in the pricing mechanisms and the nature of the different regional markets will enable LNG cargo diversion - sometimes higher volumes in the other times much lower volumes - depending on the demand and supply shocks. Another point is that the number of importers and exporters started to increase recently. If previously extremely costly chilled gas infrastructure was the main barrier to enter into the market nowadays with the emergence of floating LNG technologies such as FSRU it became cheaper to export and import gas and utilize stranded resources. For instance, floating, storage and regasification units can be chartered from shipping companies for the period of 10+ years saving funds and time for the potential LNG importers compared to the lengthy approval periods and cost of onshore regasification facilities. Looking into the future - at least the short- and medium-term - this trend is likely to be persistent. With the increasing surge for market liberalization as in traditionally significant LNG markets such as Continental Europe, Japan and probably China and India in the longer-term third party access to the chilled gas terminals is going to increase. Finally, as the LNG market grows the extent of the experience in the cargo re-direction will be increasing as well.

To sum up, gas exporting countries should take into account the effect of aforementioned factors to the flexibility of the LNG trade in order to able to plan future cash flows, foster security of demand and think of the diversification strategies in order to complement long-term contracts in the liquefied natural gas trade.

PART IV CONCLUSION

Chapter 5 Conclusion and Policy Implications

5.1 Conclusion

This dissertation investigates the evolution of the long-term natural gas trade contracts in the changing industry environment. In this context we have looked into the effect of changing gas industry and market environment variables on the duration of pipeline gas and LNG contracts and factors affecting the choice of flexible destination clauses inherent in liquefied natural gas long-term contracts.

The results of our empirical studies conducted in the first part of the dissertation show that contracts for the sale and purchase of the natural gas have become shorter in duration since the trigger of gas market liberalization in Continental European Markets. Furthermore, the pipeline gas trade deals concluded during the period of the economic recession tend to be shorter, while chilled gas SPA’s longer. Moreover the longer is the LNG trade contracts the more flexible they are, while technological progress and the increase in the chilled gas tanker fleet has a negative effect on the duration of the liquefied natural gas sale and purchase agreements.

Other findings indicate:

Pipeline gas contracts:

- If the pipeline gas importer or exporter is located in the competitive gas markets the length of the contracts tend to be shorter on average;

- Another striking point is that the only Norway's contracts tend to longer on average among European gas producers;
- An increase in the oil price is likely to affect negatively the length of the LTC's;
- The gas export contracts of Turkmenistan are more than 6 years longer on average;
- Gas contracts for Europe are one year shorter, while gas export deals with China and India are longer on average;
- The total contracted volume positively effects the duration of contracts;
- The later the conclusion date the shorter the contract length.

LNG contracts:

- The total contracted volume positively effects the duration of contracts;
- The growth in global gas consumption positively affects the length of LNG trade deals;
- When the buyer is located in China, Japan, Korea or Taiwan the contract duration tend to be longer, however shorter in the case of exports to the competitive markets of UK or US;
- The export deals of Qatar tend to be longer on average.

All contracts:

- The later the conclusion date the shorter the contract length;
- The total contracted volume positively effects the duration of contracts;

- Continental exporters' contracts are longer on average compared to the exporters located in the competitive gas market;
- Importers in China and India offer longer purchase deals compared to buyers located in competitive markets.

The results of the statistical analyses in the second part of the dissertation indicate the following outcomes in terms of the factors affecting the destination flexibility in LNG contracts. In this context the following factors tend to motivate parties to include destination flexibility while concluding LNG contract:

- The more is the yearly contracted volumes the higher is the probability of choice of FOB contracts;
- Availability of experienced trading team;
- The number of market players;
- An increase in contract duration;
- If the exporter is located in the Atlantic Basin;
- The higher price differentials across markets: North East Asia & Continental Europe; and Continental Europe & North America;
- The higher the self-sufficiency of the importer the more is the willingness to go for flexible contracts.

Here is the list of factors making the choice of destination clause more likely:

- An increase in price spread between North East Asia and North America;
- An upward surge in oil prices;

- The later the year of signature the more inclination for the choice of destination restricted LNG SPA;
- If the importer is located in the Atlantic basin.

At the same time current gas industry and market developments can be characterized by the following factors and trends:

- Domestic consumption of the gas producing countries have been increasing substantially due to generous subsidies (in some countries they were abolished) and is likely to be increasing even further thanks to the increase in population and voluntary commitments shouldered by those countries on the basis of Paris Agreement on climate change;
- Gas supply glut as a result of heavy investment during the period of high oil prices due to producers' believe in the existence of the first mover advantage for instance in the liquefied natural gas exports;
- Expiry of the decades ago concluded long-term contracts, opening the window for renegotiation within the present context of the 'buyers' market', allowing greater flexibility both in terms of volume and length, curtailing or completely removing destination clauses and diminishing the minimum take quantities, diversification of the supply portfolio by the importers;
- Arbitrage opportunities evaporated due to the anemic prices in almost all the gas markets, price difference hasn't been wide

enough to enable diversion of the cargoes for the more lucrative markets;

- Expansion of the Panama canal has resulted in shorter voyage times from the U.S Gulf Coast to the Asian Markets pushing down transportation costs;
- The option of chartering floating regasification and storage unit is a likely the trend of the future, being less expensive compared to the capital investment related to the erection of the onshore regasification terminal. Furthermore, FSRU enabled to bring into the market stranded gas and supply small-scale LNG consumers as island countries in the Caribbean or huge countries with many islands, such as Indonesia, where the construction of pipelines is not economically viable and technically difficult;
- Low oil prices pushed down the investment incentives worldwide resulting in the spare workforce and slack equipment opening the way to the investors who are willing to invest into new projects to make it less costly manner compared to the previous period which was distinguished by the surge for LNG capacities sometimes as the way to enter the market.
- Oil and gas companies profits has been curtailed by around 30% on average which induced them to perform serious restructuring processes to divest into non-core businesses downsizing personnel and looking for new business models such as entering into and being nimble in international markets;

- Stricter marine environmental regulations as those related to cut in sulphur emissions have made companies to think of shifting to the use of liquefied natural gas as the marine fuel. At the same time some countries as Singapore is planning to take the advantage of the potential developments by positioning themselves as future LNG bunkering hubs through the investment in that potentially lucrative sector in the medium-term perspective.
- Natural gas is in the competition with coal the latter is being currently cheaper than the former meaning that without stricter environmental regulations gas is fated to lose the battle. The issue is that as the gas price went down drastically due to the widespread unconventional gas development the same fact have pushed down coal prices as well due to moving away from coal towards gas trends in the countries such as United States relieving huge volumes for export for a cheaper than before prices. At the same time the coal is more abundant than gas worldwide therefore utilizing domestic coal reserves is more economical for some countries rather than importing relatively expensive gas.

As we have seen the global gas industry environment has been changing in recent decades. So-called oil commodities prices super cycle during opened the way for the investment in a variety of new gas projects, including the technological breakthrough in terms of gas production from unconventional resources. Technological change have been occurring in the liquefied natural gas sector too i.e. the development of floating technologies such as FSPO and FSRU which granted the opportunity for the new players, especially those having highly price sensitive demand to enter the global gas market either as an exporter or importer.

To sum up, the results suggest that the duration of the long-term contracts will further shorten leaving gas producing countries with the issue of searching for and discovering the instruments that are additional or complementary to the conclusion of long-term gas sales and purchase contracts in terms of planning and ensuring future cash flow stability, provision of the demand security for the produced gas, minimizing transaction costs for renegotiation and enforcement of long-term contracts and foreseeing proper distribution of market risks during planning for new gas infrastructural investments. Furthermore, gas exporting countries should take into account the effect of aforementioned factors to the flexibility of the LNG trade during the process of long-term strategy elaboration. Those factors will continue to gain prominence in the long-term affecting the contract duration and flexibility of the gas trade. Consequently, gas producing countries might need to look for other means of fostering gas demand security which will be complementary to resorting to long-term contracts on the way of monetization of gas resources.

Because of data limitation due to the fact that unconventional gas and renewable energy productions are comparatively new phenomena when compared with pipeline and liquefied natural gas industries we couldn't incorporate those developments in our analysis. Therefore, they can be a focus of future studies. At the same time future research may cover the integrated analysis of the gas monetization options in order to formulate possible strategies for the gas exporting countries to complement long-term contracts on the way of fostering gas demand security.

5.2 General Policy Implications

We can define direct and indirect implications from the results of the empirical studies. Direct implications from the dissertation findings are:

- The findings of our empirical studies are in line with (Akhmetov, 2015). Estimating the gas demand security index (REED) for five Central Asian states (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan) and comparing it with OPEC countries the author found that Turkmenistan's gas demand security is twice better. In the same vein, the findings from our model for pipeline gas sale and purchase agreements indicate that the contracts concluded between Turkmenistan and the importers are on the average 6 years longer. It is the sign of good positioning in the short and medium-term, but in the longer-term perspective overall trend of shortening the duration of contracts might affect Turkmen export deals too.
- The results indicate that the exporters should strive for the conclusion of the longer-term contracts in order to ensure the revenue flow stability.

- The exporter countries may need to offer some flexible contractual terms for gas exports to the markets where liberalization in planned;
- During the period of economic recession gas exporters should be inclined to the conclusion of LNG contracts as they are concluded for longer terms compared to pipeline export deals.
- In terms of the chilled gas export deals exporters should have to offer flexibility in terms of destination (ability to re-direct LNG cargoes) in order to conclude longer trade deals. It can be done at least in the case of markets where their own supplies will not compete with the re-directed supplies of the buyer. Moreover, they can insist on the inclusion of the profit sharing provision in the cases when the buyer diverts bought cargo(es) to more lucrative market(s).
- While the LNG fleet overcapacity maybe a short- or medium term event and market will come into balance sooner or later the exporters should keep in mind the negative effect of the technological change on the chilled gas export contract length.
- Sellers should strive to export to the markets of China and India which have been offering longer term-contracts compared to the European market. Nevertheless, the exports to Europe should be considered too, but may be in terms of geographical diversification rather as primary destination.
- As the global gas consumption growth increases the contract length the exporter should think of other business models for creation of

additional gas consumption such the LNG based aviation fuel, ship bunkering, chilled gas for transportation etc.

- LNG exporter should look into the markets of China, Japan, Korea and Taiwan which have been offering longer term agreements.

In accordance with empirical findings in order to foster gas demand security by the gas exporting countries it is more favorable to go into contracts with longer-term contracts offering markets such as China and India. The players in the mature liberalized or on the way of liberalization markets of UK, North America and Germany (which represents the state of the gas markets in the Continental Europe) offer shorter term contracts because of availability of indigenous supplies, both liquefied natural gas and pipeline gas options, existence of well-developed or rigorously developing liquid hubs and petroleum exchanges where the gas price can be hedged on the basis of the futures or forward contracts. Previous papers point out to the importance of being available in all of the LNG markets for exporters. In pipeline gas export case the geographical diversification is important as well but not always technically possible due to the rigid pipeline infrastructure which implies usually point-to-point trade or small number of connected nodes if we think of the gas trade as a network.

Overall in the periods of global recession when the commodity prices are low producers may think for diversification into the LNG markets as they offer longer SPAs. But it will be an option for the producers who retain both pipeline and LNG infrastructure.

In addition there are indirect implications from the findings of the research. Producers that export the gas in the pipe gas form are usually landlocked countries that do not have access to the seas. Therefore, definitely, the diversification into liquefied natural gas projects is not their case. Recalling economic instruments used by suppliers for the enhancement of the gas demand security we remember: owning gas storage facilities, controlling transportation routes, trials to offset or correct the changes in the regulation of consuming countries, strategy of diversification in terms of export markets, energy production, gas processing and export of value-added products and diversification away from energy goods. In this context an option with the most potential especially for the developing countries is an export of value added products through utilization of different available gas monetization options: Gas-to-Gas (pipeline, LNG, CNG), Gas-to-Solids (gas hydrates), Gas-To-Liquids (Syngas – diesel, naphta, lubricants, olefins), Gas-to-Power (electricity, heat), Gas-to-Chemicals (Ammonia, urea). For instance, landlocked gas producing countries can diversify their production to include CNG, GTL, Gas-to-Power and Gas-to-Chemicals. In this regard, GTL technology providers claim that USD15-USD20 oil price results in profitable GTL plant. (Senden & McEwan, 2000; Fleisch, 2000) Furthermore, the literature on the development of natural resource rich countries points out to the need in investment in education and infrastructure in the earlier periods of development. (Van der Ploegh & Venables, 2011; Collier, Van der Ploeg Spence & Venables, 2010)

The general result of the empirical studies conducted in the dissertation points out that the length of the pipeline gas contracts has shortened, while in the case of liquefied natural gas contracts when their duration is longer they are more flexible. In this context pipeline gas exporter(s) can allow more flexibility in their gas export contracts either via increasing the flexible volumes available besides take-or-pay volumes, removal of destination clauses and only agreeing on some amendments which do not allow the importer to re-direct bought gas to the destination (s) where it will compete with exporter's deliveries. Another possibility to allow the importer in the periods of low demand to move the some part of annually committed offtake volumes through take-or-pay clause to the next period. The offtake postponement period can be stipulated in the contract or readiness to make an amendment to the contracts in such cases can be incorporated as a declaration clause. This point should be considered bilaterally or multilaterally - on an international level. The strategy of controlling gas routes is widely used by the Russia e.g. the rejection of the third party access to the pipeline system in their territory to other producers such as Central Asian states which allows them prevention or restriction of the access of the new competitors to the European markets.

In case of availability of the access to the international seas diversification into LNG markets would be the best option in accordance with the quantitative findings. The results of the empirical studies indicate that if exporters wish to conclude longer contracts they need to offer destination flexibility to the buyers. Therefore, it is an excellent opportunity for the fostering gas demand security for the former pipeline gas producer tapping into longer and more flexible LNG contracts which are better in terms of reach to regionally disparate gas markets. Furthermore, presently LNG tanker fleet market is oversupplied and charter rates reached historical lows. Therefore, there is no anymore need for the purchase of the chilled gas tanker for the specific project as it can be easily chartered for any needed period. Moreover the liquefied natural gas market entry barriers have become lower with the introduction of floating gas production, storage and liquefaction technologies.

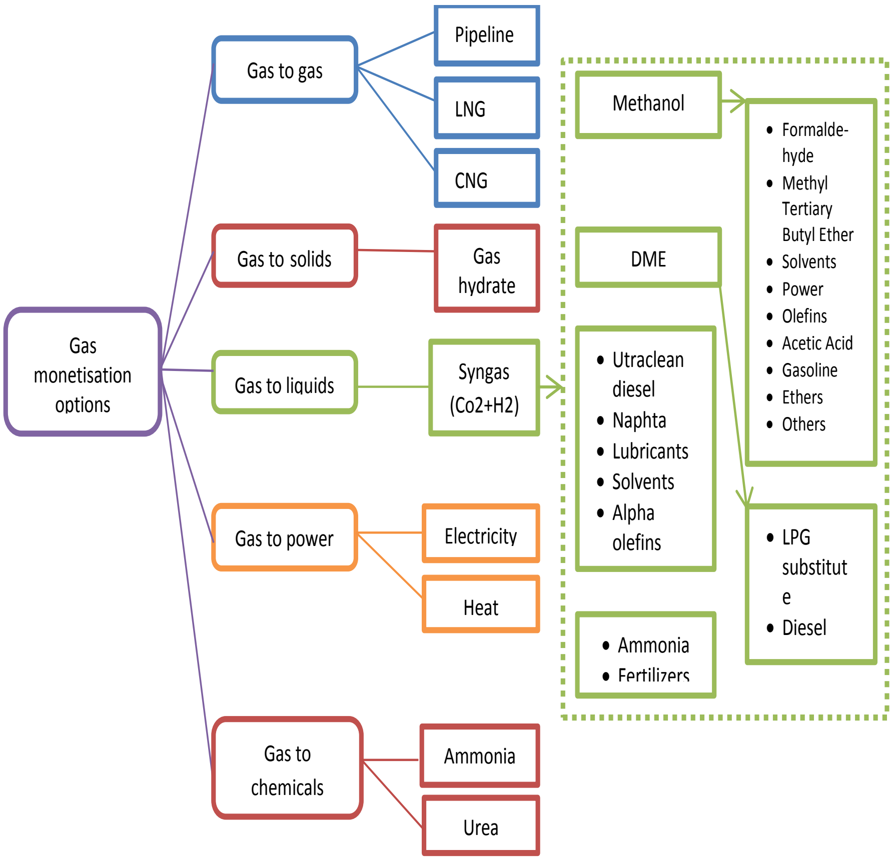

Figure 5.1 Possible gas monetization options.

Considering policy implications for LNG exporters they are better positioned compared to the pipeline gas exporters in terms of security of their gas demand in accordance with the outcomes of the empirical studies. Especially, the result related to the contracts concluded during the period of recession, when the commodity price trends reached their bottom. The same period is observed currently when the anemic prices for the oil and gas affect budgets of the gas exporting countries in the worst possible manner. It is in line with our findings regarding the effect of the oil price decrease on the length of the gas export contracts. On the other hand, natural gas, including LNG has good positioning in terms of the environmental friendliness compared to oil products, coal etc. Therefore, chilled gas exporters can go for the advertisement of using LNG as aviation fuel, a fuel for the road transport or ship bunkering. In this context there are a number of projects in terms of LNG bunkering and using it as a fuel for ships. Singapore and Korea along with Spain are on the forefront of that undertaking.

The use of natural gas, either pipe form of liquefied for the electricity generation is a privileged possibility as it is the way for enhancement not only exports but internal economy as well.

The country should have many possible options for the gas monetization in order to be able competitive in terms of exports no matter the global or regional economic situation is. In this context the period of low commodity prices is an opportunity when the countries can invest heavily into the distressed assets while many private or semi-private and even public companies disinvest in a number of their relatively non-core assets.

Furthermore, the construction materials, labor force costs and service costs are decreasing in this period due to anemic functioning of the economies as whole and less orders from the oil and gas industries. As getting loans becomes more difficult during that period producers can make use of the accumulated funds in the sovereign wealth type of funds which are usually in place in every of the gas exporting countries.

Inviting importer or investor for joint exploration and investment and maybe even common marketing can be another option for the gas exporting countries. In this case the customer is already identified and probably going to assist in finding new markets and another potential customers for the sale of the share of production.

5.3 Policy Implications for Turkmenistan

Based on the findings of the study the following policy recommendations can be made for Turkmensitan:

- Gas may be processed into the aviation fuel to make the country an aviation hub at least in the Central Asian region. It’s worth mentioning that currently the country is deliberating on the allowing the foreign airlines to use airport services and aircraft refueling on discounted prices;
- Natural gas swap agreements with neighboring countries can be used;
- Biggest chemical and fertilizer producers can be invited to set up their production in territory of the country. It would enable the energy

diversification of the export, technology transfer and learning processes by the domestic specialists;

- Deliberating and foreseeing the use of underutilized LNG terminals in the LNG exporting countries or partnering in the LNG projects with other countries. For instance, Iran is planning to use Omani liquefaction terminals for the export of the Iranian gas.
- Energy production in terms of electricity. In this context the country is a significant exporter of electricity to the neighboring countries as well as to Tajikistan and Turkey;
- Working together with regional neighbors on the development of gas hub which is going to enable exporters to hedge the risks as it is done in the mature developed markets of UK and US. For instance in the North America they make use of 72 weeks futures contracts in order to hedge risks.
- Conclusion of contracts with importers that offer longer term deals in accordance with the findings of our empirical studies. An excellent example is planned exports to India through Turkmenistan-Afghanistan-Pakistan-India Pipeline (TAPI);
- Geographical diversification of export markets. In this context, TAPI, Nabucco etc. can be a good examples. For instance, lower gas prices enabled higher utilization of gas-fired capacity in India and Pakistan and boosted incremental demand in China and ASEAN countries.
- Searching for niche markets and products.
- Tapping into GTL production.

Regarding most of these options the Turkmenistan have been making significant efforts in terms of investments. Fertilizer facilities, power plants and GTL plants using natural gas as a feedstock has been constructed, scheduled to come online or planned to be built in the mid- or long-term future.

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Appendix

A. Comparison of FOB and DES shipping modes in accordance with ICC's INCOTERMS

Table A1. The rights and obligations of the Seller and the Buyer under DES and FOB delivery terms[42]

DES-Delivered Ex Ship-(named port of destination)	**FOB-Free on Board-(named port of shipment)**
"Ex Ship" means that the seller fulfils his obligation to deliver when the goods have been made available to the buyer on board the ship uncleared for import at the named port of destination. The seller has to bear all costs and risks involved in bringing the goods to the named port of destination. This term can only be used for sea or inland waterway transport.	"Free on Board" means that the seller fulfils his obligation to deliver when the goods have passed over the ship's rail at the named port of shipment. This means that the buyer has to bear all costs and risks of loss or damage to the goods from that point. The FOB term requires the seller to clear the goods for export. This term can only be used for sea or inland waterway transport.
A. The seller must	A. The seller must
A.1. Provision of goods in conformity with the contract	A.1. Provision of goods in conformity with the contract
Provide the goods and the commercial invoice, or its equivalent electronic message in conformity with the contract of sale and any other evidence of conformity which may be required by the contract.	Provide the goods and the commercial invoice, or its equivalent electronic message, in conformity with the contract of sale and any other evidence of conformity which may be required by the contract.
A.2. Licences, authorisation and formalities	A.2. Licences, authorisation and formalities
Obtain at his own risk and expense any export licence or other official authorisation and carry out all customs formalities necessary for the exportation of the goods and, where necessary, for their transit through another country.	Obtain at his own risk and expense any export licence or other official authorisation and carry out all customs formalities necessary for the exportation of the goods.
A.3. Contract of carriage and insurance a) Contract of carriage Contract at his own expense for the carriage of the goods by a usual route and in a customary manner to the named	A.3. Contract of carriage and insurance a) Contract of carriage No obligation.

[42] Source: The table is compiled by the author by means of using the materials from: www.worldclasshipping.com.

place at the named port of destination. If a point is not agreed or is not determined by practice, the seller may select the point at the named port of destination which best suits his purpose. b) Contract of insurance No obligation.	b) Contract of insurance No obligation.
A.4. Delivery Place the goods at the disposal of the buyer on board the vessel at the usual unloading point in the named port of destination uncleared for import on the date or within the period stipulated, in such a way as to enable them to be removed from the vessel by unloading equipment appropriate to the nature of the goods.	A.4. Delivery Deliver the goods on board the vessel named by the buyer at the named port of shipment on the date or within the period stipulated and in the manner customary at the port.
A.5. Transfer of risks Subject to the provisions of B.5., bear all risks of loss of or damage to the goods until such time as they have been delivered in accordance with A.4.	A.5. Transfer of risks Subject to the provisions of B.5., bear all risks of loss of or damage to the goods until such time as they have passed the ship's rail at the named port of shipment.
A.6. Division of costs Subject to the provisions of B.6. - in addition to costs resulting from A.3.a), pay all costs relating to the goods until such time as they have been delivered in accordance with A.4.; - pay the costs of customs formalities necessary for exportation as well as all duties, taxes or other official charges payable upon exportation and, where necessary, for their transit through another country.	A.6. Division of Costs Subject to the provisions of B.6. - pay all costs relating to the goods until such time as they have passed the ship's rail at the named port of shipment; - pay the costs of customs formalities necessary for exportation as well as duties, taxes and other official charges payable upon exportation.
A.7. Notice to the buyer Give the buyer sufficient notice of the estimated time of arrival of the named vessel in accordance with A.4. as well as any other notice required in order to allow the buyer to take measures which are normally necessary to enable him to take the goods.	A.7. Notice to the buyer Give the buyer sufficient notice that the goods have been delivered on board.
A.8. Proof of delivery, transport document or equivalent electronic	A.8. Proof of delivery, transport document or equivalent electronic

message Provide the buyer at the seller's expense with the delivery order and/or the usual transport document (for example a negotiable bill of lading, a non-negotiable sea waybill, an inland waterway document, or a multimodal transport document) to enable the buyer to take delivery of the goods. Where the seller and the buyer have agreed to communicate electronically, the document referred to in the preceding paragraph may be replaced by an equivalent electronic data interchange (EDI) message.	message Provide the buyer at the seller's expense with the usual document in proof of delivery in accordance with A.4. Unless the document referred to in the preceding paragraph is the transport document render the buyer, at the latter's request, risk and expense, every assistance in obtaining a transport document for the contract of carriage (for example, a negotiable bill of lading, a non-negotiable sea waybill, an inland waterway document, or a multimodal transport document). Where the seller and the buyer have agreed to communicate electronically, the document referred to in the preceding paragraph may be replaced by an equivalent electronic data interchange (EDI) message.
A.9. Checking-packaging-marking Pay the costs of those checking operations (such as checking quality, measuring, weighing. counting) which are necessary for the purpose of delivering the goods in accordance with A.4. Provide at his own expense packaging (unless it is usual for the particular trade to deliver the goods of the contract description unpacked) which is required for the delivery of the goods. Packaging is to be marked appropriately.	A.9. Checking-packaging-marking Pay the costs of those checking operations (such as checking quality, measuring, weighing, counting) which are necessary for the purpose of delivering the goods in accordance with A.4. Provide at his own expense packaging (unless it is usual for the particular trade to ship the goods of the contract description unpacked) which is required for the transport of the goods, to the extent that the circumstances relating to the transport (e.g. modalities, destination) are made known to the seller before the contract of sale is concluded. Packaging is to be marked appropriately.
A.10. Other obligations Render the buyer at the latter's request, risk and expense, every assistance in obtaining any documents or equivalent electronic messages (other than those mentioned in A.8.) issued or transmitted in the country of dispatch and/or of origin which the buyer may require for the	A.10. Other obligations Render the buyer at the latter's request, risk and expense, every assistance in obtaining any documents or equivalent electronic messages (other than those mentioned in A.8.) issued or transmitted in the country of shipment and/or of origin which the buyer they require for

importation of the goods. Provide the buyer, upon request, with the necessary information for procuring insurance.	the. importation of the goods and, where necessary, for their transit through another country. Provide the buyer, upon request, with the necessary information for procuring insurance.
B. The buyer must	B. The buyer must
B.1. Payment of the price Pay the price as provided in the contract of sale.	B.1. Payment of the price Pay the price as provided in the contract of sale.
B.2. Licences, authorisations and formalities Obtain at his own risk and expense any import licence or other official authorisation and carry out all customs formalities necessary for the importation of the goods.	B.2. Licences, authorisations and formalities Obtain at his own risk and expense any import licence or other official arthorisation and carry out all customs formalities for the importation of the goods and where necessary. for their transit through another country.
B.3. Contract of carriage No obligation.	B.3. Contract of carriage Contract at his own expense for the carriage of the goods from the named port of shipment.
B.4. Taking delivery Take delivery of the goods as soon as they are placed at his disposal in accordance with A.4.	B.4. Taking Delivery Take delivery of the goods in accordance with A.4.
B.5. Transfer of risks Bear all risks of loss or damage to the goods from the time they have been placed at his disposal in accordance with A.4. provided, however, that the goods have been duly appropriated to the contract, that is to say, clearly set aside or otherwise identified as the contract goods. Should he fail to give notice in accordance with B.7., bear all risks of loss of or damage to the goods from the agreed date or the expiry date of the period stipulated for delivery.	B.5. Transfer of risks Bear all risks of loss of or damage to the goods from the time they have passed the ship's rail at the named port of shipment. Should he fail to give notice in accordance with B.7., or should the vessel named by him fail to arrive on time, or be unable to take the goods, or close for cargo earlier than the stipulated time, bear all risks of loss of or damage to the goods from the agreed date or the expiry date of the period stipulated for delivery provided, however, that the goods have been duly appropriated to the contract, that is to say, clearly set aside or otherwise identified as the contract goods.

B.6. Division of costs Pay all costs relating to the goods including unloading from the time they have been placed at his disposal in accordance with A.4., provided, however, that the goods have been appropriated to the contract, that is to say, clearly set aside or otherwise identified as the contract goods. Should he fail to take delivery of the goods when they have been placed at his disposal in accordance with A.4., or to give notice in accordance with B.7., bear all additional costs incurred thereby. Pay all duties, taxes and other official charges as well as the costs of carrying out customs formalities payable upon importation of the goods.	B.6. Division of costs Pay all costs relating to the goods from the time they have passed the ship's rail at the named port of shipment. Pay any additional costs incurred, either because the vessel named by him has failed to arrive on time, or is unable to take the goods, or will close for cargo earlier than the stipulated date, or because the buyer has failed to give appropriate notice in accordance with B.7. provided, however, that the goods have been duly appropriated to the contract, that is to say, clearly set aside or otherwise identified as the contract goods. Pay all duties, taxes and other official charges as well as the costs of carrying out customs formalities payable upon importation of the goods and, where necessary, for their transit through another country.
B.7. Notice to the seller Whenever he is entitled to determine the time within a stipulated period and/or the place of taking delivery, give the seller sufficient notice thereof.	B.7. Notice to the seller Give the seller sufficient notice of the vessel name, loading point and required delivery time.
B.8. Proof of delivery transport document or equivalent electronic message Accept the delivery order or the transport document in accordance with A.8.	B.8. Proof of delivery, transport document or equivalent electronic message Accept the proof of delivery in accordance with A.8.
B.9. Inspection of Goods Pay, unless otherwise agreed, the costs of pre-shipment inspection except when mandated by the authorities of the country of exportation.	B.9. Inspection of goods Pay, unless otherwise agreed, the costs of pre-shipment inspection except when mandated by the authorities of the country of export.
B.10. Other obligations Pay all costs and charges incurred in obtaining the documents or equivalent electronic message mentioned in A.10. and reimburse those incurred by the seller in rendering his assistance in accordance therewith.	B.10. Other obligations Pay all costs and charges incurred in obtaining the documents or equivalent electronic messages mentioned in A.10. and reimburse those incurred by the seller in rendering his assistance in accordance therewith.

초 록

변화하는 산업 환경에서의 장기 천연 가스 계약의 진화

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본 논문의 목적은 국제적으로, 그리고 지역적으로 진행되고 있는 천연가스 계약방식의 변화에 초점을 맞추어 이러한 장기계약의 진화적 측면에서 변화의 특성을 분석하고 천연가스산업의 발전과 천연가스 수입 및 수출국가에 영향을 미칠 가능성에 대하여 접근하여 조사하였다.

이 논문은 두 편의 essay로 구성된다. 2SLS, GMM, LIML과 같은 도구 변수 방법을 사용하는 첫 번째 essay는 시장 규제 완화, 기술 변화, LNG 탱커 함대 용량 증가, 천연 가스 판매 및 구매 계약 기간에 대한

세계 경제 침체 등 효과의 분석을 통해 장기 계약의 진화를 경험적으로 탐구한다.

세 가지 모델을 분석에 사용하였다. 첫 번째 모델은 pipeline gas 계약을 분석하고 두 번째 모델은 liquefied natural gas 계약을 조사하고 마지막 모델은 두 계약과 다루고 있다. 요약하자면 전반적인 결과는 위에 언급한 요인 및 사건의 발생으로 계약 기간이 평균적으로 감소하는 경향이 있음을 나타낸다. 유일한 요점은 세계 경기 침체 기간 동안 체결된 LNG 계약은 평균적으로 더 길지만 그 동시에 보다 유연한 경향이 있다는 것이다.

두 번째 essay 에서는 Probit model with endogenous covariate 를 사용하여 장기적인 액화천연가스(LNG) 판매-구매 계약서에서 유연한 목적지 조항의 선택에 대한 결정 요인 분석을 통해 liquefied natural gas 화물 re-direction 의 가능성으로 가져 오는 LNG 시장과 무역 유연성을 탐구하였다. 목적지 조항을 냉장 가스의 판매자(수출국)와 구매자 (수입국) 사이에 체결된 계약서에서 규정된 DES delivery terms 으로 정의했다. 따라서 오늘날 FOB 계약의 선택에 있어 글로벌 가스 시장 및 특히 LNG 시장에서 널리 퍼져있는 요인을 분석하였다.

결론적으로, 연구의 결과는 현재의 액화천연가스(LNG)시장, 산업 및 해당 밸류체인(value chain)에서 분석한 요인의 대부분과 진행 상황은 유연한 계약 방식의 선택 쪽으로 긍정적인 영향을 미친다는 것을 뚜렷이 보여주고 있다. 또한, 이러한 추세는 중장기 적으로 지속될 가능성이 높으며, 이는 LNG 무역의 전반적인 유연성에 기여하며, 글로벌 가스 시장의 전반적인 유연성에 영향을 미칠 것으로 보인다. 천연가스 거래에서 장기계약을 활용하는 대다수의 천연가스 수출국 및 수입국의 전략수립 과정에 본 연구의 정량적 분석결과를 사용할 수 있을 것이다.

키워드 : 천연 가스; LNG; 장기 계약, 목적지 조항, 기술적 변화,

(transaction cost)거래 비용, 가스 수요 보장.

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