The Nature of LNG Arbitrage: an Analysis of the Main Barriers to the Growth of the Global LNG Arbitrage Market

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Preface

When Polina Zhuravleva approached the Natural Gas Research Programme for advice and guidance in relation to her Masters thesis, none of us could have expected the paper which has resulted. With no previous experience of the LNG industry and at an early stage of her research career, Polina has produced an insightful and thought-provoking guide to LNG arbitrage which will be of interest to those who have experience of LNG trading, and those who are new to the subject. Her definitions and classifications of different types of trade, and barriers to future development of trade, are a particularly useful contribution to a subject where labels such as “arbitrage” and “spot trade” are often obstacles to understanding exactly what is being discussed.

I’m grateful to Polina for revising her thesis into a version suitable for publication, and very glad to add it to our published work on LNG issues.

Jonathan Stern June 2009

Abstract

Due to its gaseous form, and therefore low energy density, pipeline natural gas has traditionally supplied nearby regional markets which have been historically isolated from each other. Regional markets have traditionally had their own supply-demand balances, contractual structures and gas price formation mechanisms. This model is now under threat. With the growth of liquefied natural gas (LNG) supply which is increasingly flexible in terms of destination, regional markets are becoming progressively more connected. A decade ago, when the LNG industry was based exclusively on long-term take-or-pay contracts and the number of market players was limited, the impact of price signals, if any, was weak. The liquidity of the 'flexible' LNG market has increased in tandem with the growth in the number of LNG producing and consuming countries, the appearance of some uncommitted volumes of LNG and development of arbitrage activity. LNG arbitrage is a new pattern of gas trade still in an embryonic stage of development. Few outside the LNG industry or even outside LNG trading circles understand the term 'LNG arbitrage' let alone the specific mechanisms. One of the goals of this paper is to establish a clear definition of LNG arbitrage and distinguish it from other trading activities which superficially appear similar.

Historical gas price data for different markets suggests that price differentials have created opportunities for LNG arbitrage to take place. However, the scale of this type of trading has been constrained to date and has not led to demonstrable gas price convergence between markets. The second aim of the paper is an analysis of the main barriers to the growth of the LNG arbitrage market.

Research for this paper has enabled a framework of barriers and conditions for LNG arbitrage to be developed. According to this framework there are four necessary conditions for an arbitrage transaction to take place. Barriers, which deter arbitrage, can be divided into four groups. Analysis of the barriers has shown that some constrain arbitrage on the global level while others are more locally focussed. Some barriers strongly preclude arbitrage activity while others merely make it more challenging.

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This paper is based on the author's analysis of the primary and secondary research results and does not necessarily reflect the opinion of any particular survey participant.

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1. Introduction

LNG projects are highly capital-intensive and in order to protect the investment's return, the project developers traditionally covered all their future LNG production with sales and purchase agreements (SPAs). SPAs enabled them to share the risks – LNG sellers bore price risk, while the volume risk was transferred to the buyers.

Long-term contracts are still central to the LNG trade/industry, but some significant change has taken place in recent years: the elimination from some new contracts of the destination clause which was standard in long-term contracts signed before 2006, and an increase in the number of uncommitted LNG ships. LNG shipping is a crucial part of the LNG trade and just a few years ago there were a limited number of vessels that were not committed to a particular SPA with a defined delivery route.

Over the past five years or so it has become acceptable industry practice for even contractually committed LNG with a specified destination to be diverted to another market with the mutual agreement of both the seller and the buyer. The financial incentive to benefit from market inefficiency and regional supply-demand imbalances motivated market players to allow ad-hoc cargo diversions, sharing the profit resulting from the arbitraging between the respective parties. In 2007 the Equatorial Guinea LNG project sold its entire LNG output on an FOB basis to BG for 15 years, without incorporating a destination clause in the contract. This enabled the buyer (BG) to divert the cargoes and act as an aggregator (arbitrageur), optimizing and monetizing their delivery. Other significant sources of flexible cargoes are Qatar, Trinidad and Tobago, Algeria and Egypt.

The traditional destination clause and the non-availability of non-committed shipping capacity are not the only barriers to arbitrage. Other factors such as technical and market restrictions, high transaction costs, 'tight' LNG supply etc. hinder LNG diversions. The significance of these barriers varies over time and differs from market to market, however it is important to understand their theoretical importance and the extent to which they may constrain the development of the global LNG arbitrage market.

2. Methodology

Since there is no publicly available comprehensive study of LNG arbitrage and published data on this topic is scarce, this work is based on primary research involving three components: online questionnaires, interviews and feedback from the presentation of the research results at the Oxford Institute of Energy Studies (OIES).

The target group for the research was carefully selected to provide an informed range of insight. Thus, among the participants were natural gas and LNG traders, leading independent consultants, senior figures from several of the major energy companies and publishers of LNG journals and bulletins. The survey's sample size is relatively small due to the highly specialised nature of the topic, the paucity of trusted specialists in the LNG arbitrage trade and the difficulty in accessing experts. Nevertheless, the profiles and experience of the participants was representative of the best in the sector. The data for the quantitative analysis was obtained with the help of the online questionnaires. When all the responses were collected, each participant was interviewed to assist in the qualitative analysis of the data.

3. Defining LNG Arbitrage

The following definition has been developed during the research with the help of survey participants - **"LNG Arbitrage can be defined as a physical cargo diversion from one market to another, which offers a 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."** The two key drivers for arbitrage are **Commercial** and **Operational** respectively. The **Commercial** driver is the ability to take advantage of price differentials between the markets, which arise due to differing pricing structures, variations in the relative balances between supply and demand and market inefficiency. **Operational** reasons for LNG arbitrage include financial loss minimization in case of plant outages, overfull storage tanks or force majeure. LNG industry experts also acknowledge that arbitrage may occur for political reasons such as embargoes or conflicts and regard it as arbitrage for **Operational** reasons.

Redirection of LNG cargoes can be regarded as arbitrage only if, according to the contract, they were initially contracted to be delivered to another market. The margin resulting from the arbitrage is usually shared between the seller and the initial buyer. The participants of the deal can be: the seller, the initial buyer, the end buyer, an independent trader/trading team (intermediary), and so on. LNG arbitrage

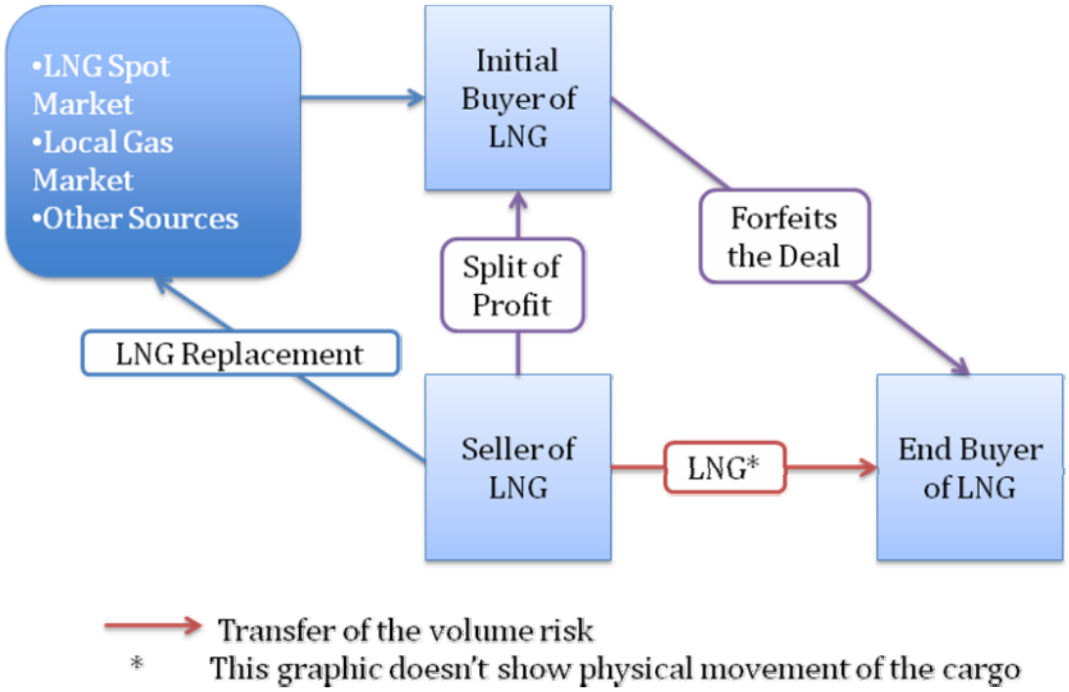
implies that more than two parties are involved in the transaction and it often consists of a number of trading operations in order to deliver the cargo to another market and to organize the replacement of the diverted cargo if required.

4. Models of Physical LNG Arbitrage

To make the above definition clearer, the three most commonly used arbitrage models have been explored. All the models imply that the Seller[1] of the LNG has a contract (whether it is a long-term, short-term or even a spot contract) with the Initial Buyer and is obliged to supply a cargo on these terms at a fixed date.

Model I: Seller-Arbitrageur

Figure 1: Model I. LNG Seller Acts as Arbitrageur



Source: own model

[1] In this section the terms 'Seller' and 'Buyer' are used to indicate the seller of the LNG cargo and the buyer of the LNG cargo. 'Initial Buyer' is the customer for whom the LNG cargo has been initially contracted, while 'End Buyer' is the purchaser of the diverted LNG.

$$\mathbf{P_{EB} > P_{SM}}$$

$$\mathbf{P_{EB} > P_{LGM}}$$

Where: P_{EB} – Price of the LNG at the End Buyer's market

P_{SM} – Price of LNG at the Spot market

P_{LGM} – Price of the LNG at the Local Gas Market

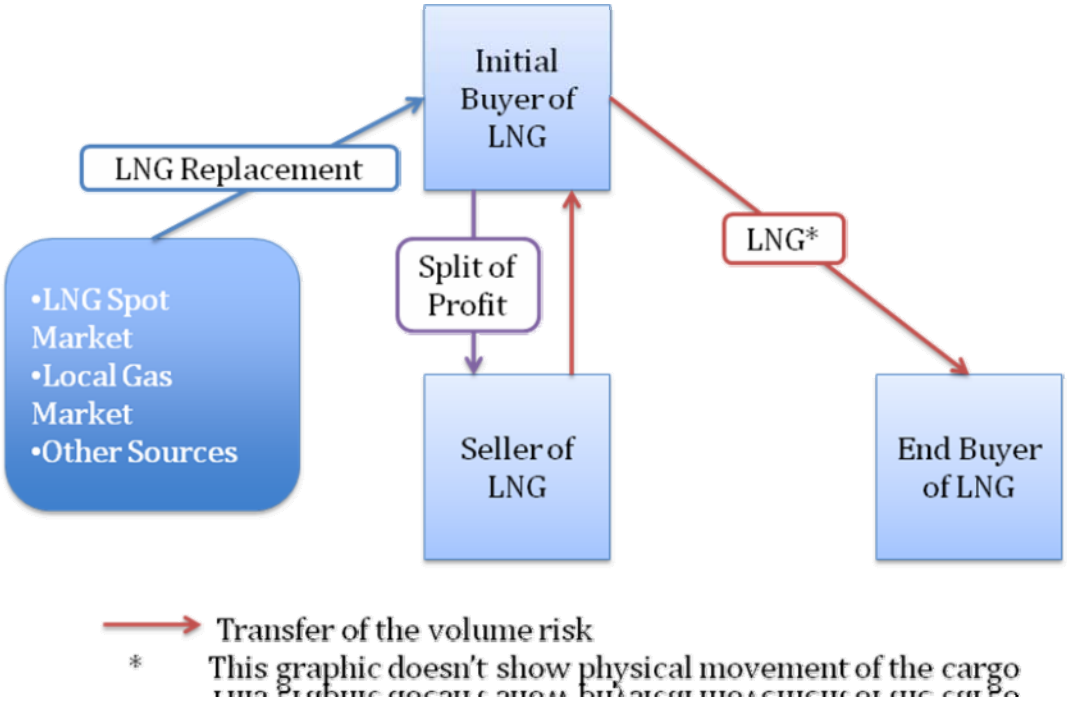
The first model (Figure 1) implies that the Seller initiates the arbitrage and takes the role of arbitrageur. The Seller, who has a contract with the Initial Buyer to deliver the LNG cargo on day N, sees the opportunity to sell this cargo in another market and acquire the margin. The Seller may offer the Initial Buyer the chance to forfeit the deal and share the margin. Sometimes, the diverted LNG cargo has to be replaced by the same amount of gas from the LNG Spot Market or from the Local Gas Market (local for the initial buyer). If the price differentials are high enough to cover transaction costs, the arbitrage deal is viable. The split of the profits is agreed between the contracting parties. It is important to mention that the Initial Buyer has a veto over the destination of the cargo and can refuse to agree to the diversion.

A recent example: in March 2008 Oman decided to divert to Asia an LNG cargo which had previously been allotted to Spain. Oman offered its two Spanish customers, Union Fenosa and Gas Natural, the chance to forfeit the deal (divert the cargo to an Asian customer) and share the profits from the diversion. Official sources don't make it clear whether the cargo was replaced or not. This is a clear model of arbitrage, where the initiator exploited market inefficiency and diverted the cargo to the market with a higher price, thus acting as a balancing and price converging mechanism.

Model II: Initial Buyer-Arbitrageur

In this model (Figure 2) the Initial Buyer decides to divert the cargo to a market that offers a 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 that moment (due to overestimated demand, seasonal demand fluctuations or unforeseen outages). If contractual clauses allow cargo diversion (or if it was agreed with the seller), the Initial Buyer sends the cargo to the End Buyer and, in most cases, has to split the margin with the Seller. If replacement of the diverted cargo is required, it is the Initial Buyer's responsibility. If a destination clause is incorporated into the SPA, arbitrage by the Initial Buyer will be restricted.

Figure 2: Model II. Initial Buyer Acts as Arbitrageur



Source: own model

$$P_{EB} > P_{SM \text{ or futures price at the Spot Market}}$$

$$P_{EB} > P_{LGM \text{ or futures price at the Local Gas Market}}$$

Where: P_{EB} – Price of the LNG at the End Buyer's market

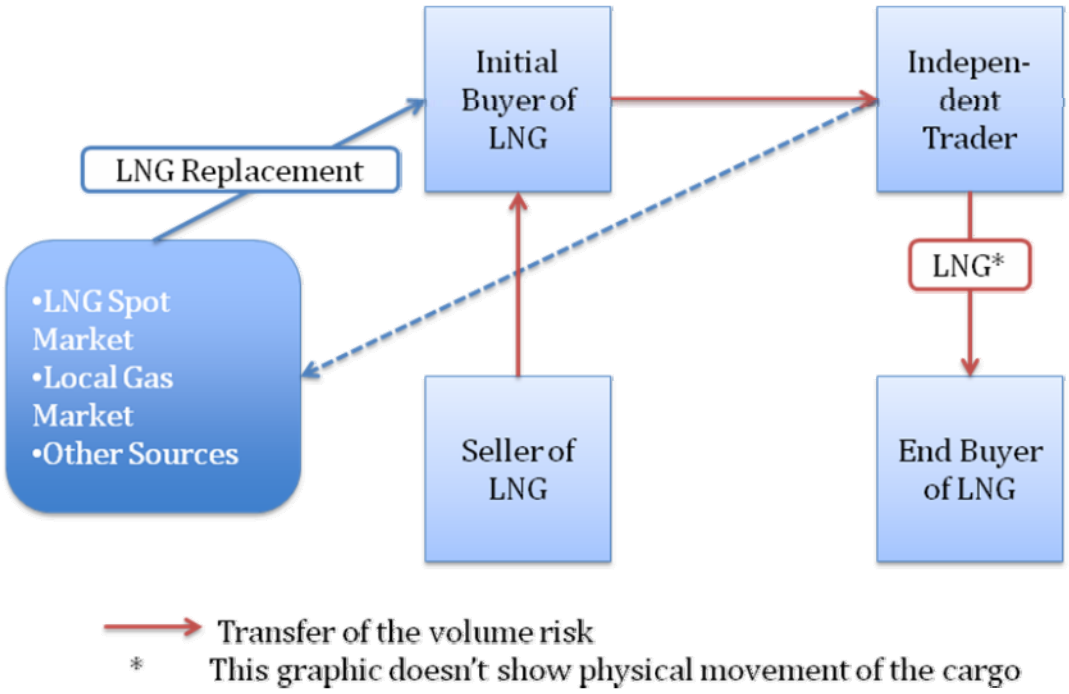
P_{SM} – Price of LNG at the Spot market

P_{LGM} – Price of the LNG at the Local Gas Market

This model is often used by Spanish importers which, due to finite storage capacity and government regulations concerning storage, often can't accept cargoes. Prices in the Asian market were high in 2007-2008, which allowed the Spanish traders to profit from the arbitrage and replace the LNG by spot cargoes later, when there was higher demand for gas in the Spanish market. The cargo is diverted to the market with a higher price and demand, which allows the Initial Buyer's market prices to remain stable (rather than risk downward pressure due to oversupply).

Model III: Independent Trader-Arbitrageur

Figure 3: Model III. Independent Trader Acts as Arbitrageur



Source: own model

$$P_{EB} > P_{SM \text{ or futures price at the Spot Market}}$$

$$P_{EB} > P_{LGM \text{ or futures price at the Local Gas Market}}$$

Where: P_{EB} – Price of the LNG at in the End Buyer's market

P_{SM} – Price of LNG at the Spot market

P_{LGM} – Price of the LNG at the Local Gas Market

In this model another player appears in the transaction – the Independent Trader (Figure 3). Any trading team, bank or individual trader can act as an Independent Trader. An Independent Trader buys the cargo from the Initial Buyer (seldom from the LNG Seller) or gets the right to divert the cargo to another customer offering a higher price. Whether the participants split the profit depends on the individual agreements and varies from case to case. If replacement of the diverted cargo is required, whether the Initial Buyer or an Independent Trader will replace it also depends on the agreement.

One interesting example illustrates an innovative scheme of arbitraging by a third party. In 2004, Gazprom and Gaz de France signed an agreement on pipeline gas delivery from Russia to France in exchange for LNG cargoes produced in Algeria **by** MED LNG and Gas and allotted for France. Gazprom sold the cargo to Shell Western LNG and sent the LNG directly from Algeria to the Cove Point terminal in the US operated by Dominion. This was the first "Russian LNG" arriving at the US terminal. As the details and prices of the deal are confidential, industry observers continue to argue whether the reason for that deal was commercial or operational (in this case political). As the prices of the cargoes were not officially published, one can assume that all parties received some benefit from this transaction. In any case, it is a good example of how a diverted commodity might be replaced.

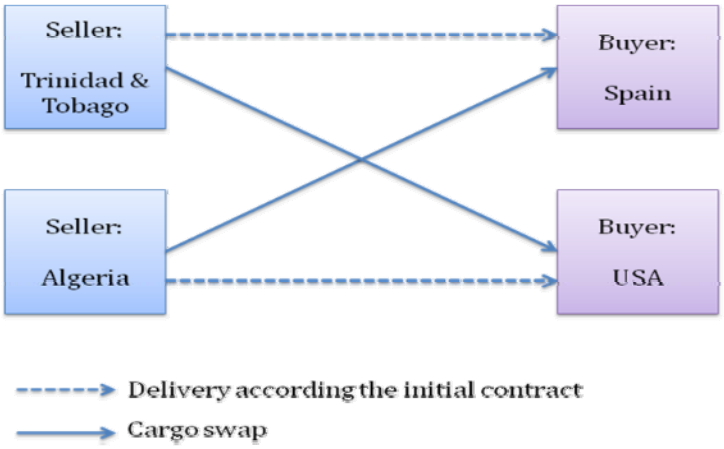
These are the three main models that are usually used in LNG trading but other isolated instances might exist and some new models are likely to develop in the future.

5. Controversial LNG Redirections

This section analyses two trading deals where industry opinion is divided as to whether they should be defined as arbitrage (the term has been defined earlier in this work). We sought to resolve this uncertainty by applying arbitrage theory, which means that the transaction was motivated by price differentials between the markets and thus contributes to arbitrage equilibrium.

5.1 Cargo Swap

Figure 4: Physical LNG Cargo Swap



Source: own model

The Cargo Swap is often regarded as an arbitrage transaction among LNG traders; however it does not meet the requirements of traditional arbitrage theory. Figure 4 shows an example of two cargoes that are to be exported from two countries (e.g. Trinidad and Tobago and Algeria). According to the contract the Algerian cargo is allotted to the USA, while the cargo from Trinidad and Tobago is committed to Spain. In order to reduce transportation costs and possible taxes (or, in some cases, the costs of LNG quality management) the parties decide to swap the cargoes and share the resulting profit. However, this profit arises from cost minimization, not from exploiting price differentials. Therefore this kind of redirection does not lead to price convergence and should not be defined as arbitrage.

5.2 LNG Reloading

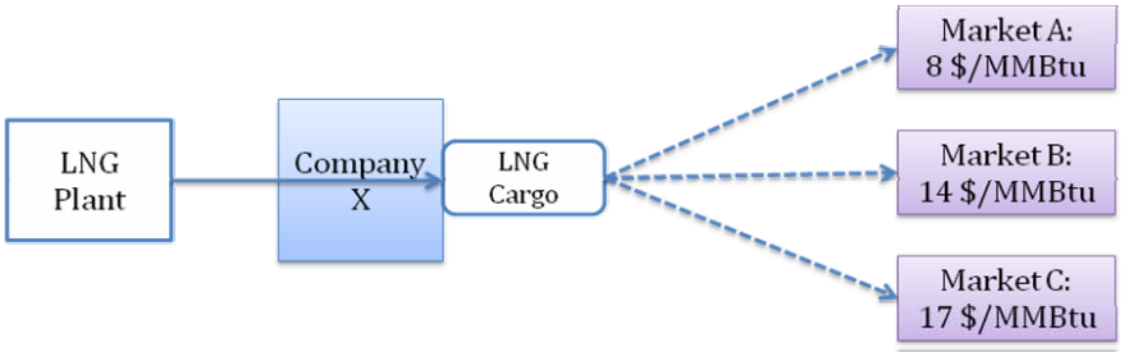
LNG Reloading is a new category of cargo diversion and implies a purchase of the LNG cargo, discharge from the vessel into the storage tank and a subsequent reloading of the LNG into another LNG ship. Following adaptations to the terminals at Zeebrugge[2] and Huelva to allow reloading, terminal users there have been enabled to ship delivered cargoes to other markets and take advantage of price differentials. For example, in the case of Zeebrugge the contractual destination clauses don't in the first instance allow diversions of the LNG; but the cargoes are delivered under DES (Delivered Ex-Ship) arrangement. As soon as cargo is discharged to the Zeebrugge storage tanks, it belongs to the terminal capacity user (GdF Suez, Electricité de France or Distrigas). This allows re-export of the LNG without violating the contract and avoids profit sharing with the initial LNG seller. The reloaded LNG is diverted to higher priced markets, thus acting as a balancing force; and so it can be regarded as arbitrage.

6. The Spot Trade and Portfolio Optimization

Sometimes, arbitrage transactions are confused with spot trade or with so-called portfolio optimization. In order to clear up this uncertainty, the following analysis differentiates between these three types of activity.

[2] Zeebrugge regasification terminal is owned by Fluxys, which by law is not allowed to trade in gas. Distrigas, GdF and EdF are the capacity users.

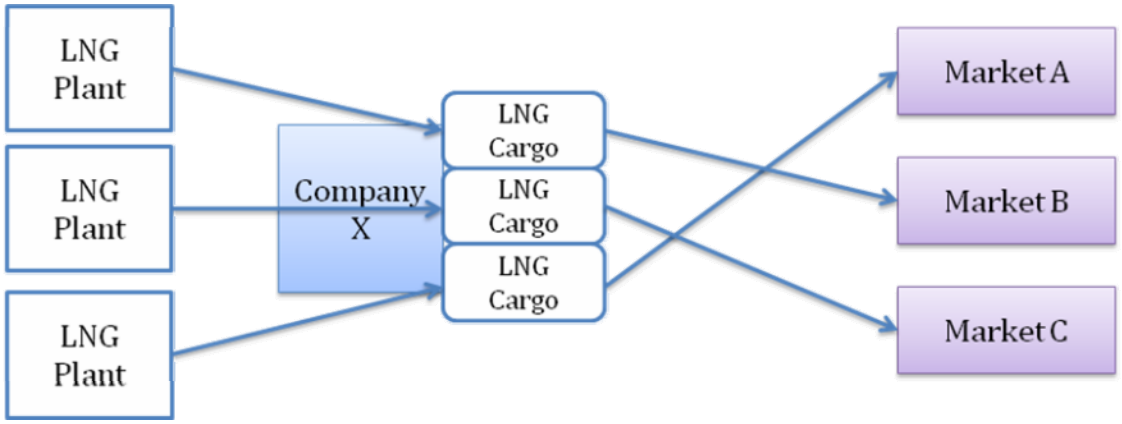
Figure 5: Spot Trading in LNG



Source: own model

Figure 5 illustrates a spot transaction. A spot trade implies that a single or several LNG cargoes were produced by the LNG plant for company X and are not committed to any specific market. There are several markets willing to pay different prices for these cargoes. Company X is a seller and decides to which market the cargoes will be delivered. Logically, the company is likely to choose the market that allows for the highest profit. That doesn't necessarily mean that the LNG will be directed to the market with the highest price, because transportation costs, fees and other additional costs and factors must be taken into account. This is a seller-buyer model, usually called a spot trade transaction. As arbitrage implies that more than 2 parties are involved in the trade and more than one market is affected by the transaction, spot trade should not be seen as arbitrage.

Figure 6: Portfolio Optimization



Source: own model

Portfolio optimization (Figure 6) is often mistaken for LNG arbitrage. Portfolio optimization means profit maximization by means of cost reduction. In the example above, Company X possesses three cargoes allotted by the LNG producers and the company has three buyers awaiting the cargoes. Theoretically, all these three LNG cargoes are committed, but Company X can decide which cargo goes to which market, thus optimizing its portfolio and increasing its profit. As the LNG cargoes might not originate in the same geographical location and the quality of the LNG may differ, the Seller can organize an optimal "cargo-buyer" match. It doesn't really matter how much each buyer pays for a cargo – the deals have already been established and the only thing Company X can do to maximise profit is to reduce transaction costs and other possible expenses. Of course, unequal sizes of the cargoes and technical restrictions complicate these redirections. This is a seller-buyer model and as the cargoes are not being resold, no price differentials at the markets are being exploited. This scheme looks more like a series of cargo swaps within a company. And if the amount of LNG going into each of the (three – in the model above) markets is fixed then that means that market prices are not affected, thus it should not be regarded as arbitrage.

It is important to distinguish between LNG spot deals, portfolio optimization and LNG arbitraging. Both models above represent "seller-buyer" transactions without reselling the cargo.

7. Barriers to the Growth of LNG Arbitrage Market

The growth of the LNG arbitrage market implies an increase in the number of arbitrage transactions per year and an increase in the volumes that are being diverted from one market to another. In order to investigate which factors impede the growth of the LNG arbitrage market and which of these are the most significant, 12 possible barriers have been considered. After qualitative analysis of the answers, obtained by means of questionnaires and interviews, these barriers were broken down into four main groups, or constituents, in our arbitrage barriers framework (see below Figures 7 and 8). However, it is important to note that, when we talk about arbitrage, some of the barriers are not applicable for operational reasons (e.g. price spread and contractual limitations in the case of force majeure), when the principal incentive is minimization of losses.

7.1 12 Barriers

1. The Price Differential between Markets is Not Great Enough

Without a price spread that allows the trader to profit, no arbitrage transaction will take place (unless it is diversion for operational reasons, to reduce costs). This barrier is the most critical of those considered. Price spread must be great enough to cover the transaction costs and be a sufficient incentive for the aggregator, who often has to share the profit with another party.

2. Lack of LNG Supply and a Very Tight LNG Market

It doesn't matter how big the spreads between the markets are, and how many divertible (free from destination clause) cargoes there are, these are not enough to encourage a buyer to divert a cargo if the market is very tight and it is not possible to replace the diverted LNG from the spot LNG market or domestic gas market. A very tight gas or LNG market means that the gas/LNG producers struggle to cover the gas demand and the buyers have a physical need for each cargo. Hence, theoretically, this might be a big hurdle for arbitrage market development. Some markets (e.g. Japan and South Korea) have no alternative sources of gas and, in a tight market, will refrain from LNG diversions in order to maintain a secure supply.

3. Small Number of Players in the LNG Market

As soon as we have more than two buyers in the market an arbitrage deal should be possible. The number of players itself does not really predetermine the number of arbitrage transactions. The 'quality' of players, not the quantity is critical: traders should possess divertible cargoes, buyers must offer a competitive price, and both parties have to be able to organize logistics (access to capacity, regulatory issues, etc.).

4. No Global LNG Informational and Trading Platforms

Despite several years of LNG trading activity, LNG is still being traded over-the-counter (OTC) and no commodity exchange trades LNG. Absence of a trading platform is one of the factors that hinder LNG from becoming a liquid traded commodity. In addition, there is no global informational platform in sight. The LNG trading world is a 'club', where traders, producers and buyers know each other and know how and where to find the necessary information. It is so-called 'pick-up-the-phone-and-call' trading. Surprisingly, almost all interviewees admitted that within this 'club', communications and information flows are organized rather well. Some sources provide a wide range of credible information

for traders (e.g. Poten and Partners, Global LNG Markets etc.) and it is expected that global LNG trading and information platforms will appear with the further development of the trade. APX Group is planning to launch an LNG screen trading facility in the future. In addition, The Dubai Hub is in the process of setting up an international LNG Exchange. The existence of trading platforms and global informational tools would be expected to facilitate and accelerate the LNG trade.

5. Lack of Price Transparency

In relation to countries involved in LNG trade, the US and UK gas markets are the most transparent and liquid in the world. In Continental European gas markets where LNG is important – Spain, France, Belgium - liberalisation is less far advanced and almost none of the importers publish prices for LNG.[3] In the Pacific, there has been very little progress in relation to gas market liberalisation.[4] Lack of price transparency complicates arbitrage trade and demands quickness of wit and good connections between the traders. It is interesting to note that some traders regard a lack of price transparency as a favourable condition for arbitrage, while others blame it for impeding LNG trading. We can only surmise that the first commentators are better-connected than the second. The traders that have access to information on prices in the 'closed' markets are better placed to undertake arbitrage. This barrier creates favourable conditions for specific traders, but not for the entire LNG market. One might say that this would be a significant limitation for trading but is unlikely to stop individual traders from arbitraging.

6. Lack 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. BG, 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. In this environment, where information is scarce and hard to obtain, the experience and personal contacts of individual traders gain

[3] For a study of progress of natural gas liberalisation in a range of European countries see Haase, N. (2008), European gas market liberalisation: are regulatory regimes moving towards convergence? Oxford Institute for Energy Studies, May 2008, http://www.oxfordenergy.org/pdfs/NG24.pdf

[4] For details of developments in Japan, Korea and China, see relevant chapters in Stern, J. (2008), Natural Gas in Asia. 2nd edition. Oxford: Oxford University Press.

in importance. This barrier is very likely to be overcome as the arbitrage market continues to grow, but it is probably one reason for missed arbitrage opportunities today.

7.Contractual Limitations

Even if the market creates the conditions for cargo diversion, it will be impossible unless contractual clauses allow it. Destination Clauses and Ex-Ship arrangements make arbitrage almost impossible, with rare exceptions (outages or other exceptional cases). This is clearly one of the most significant barriers. When a buyer's market emerged for a short period, some suppliers permitted cargo redirection but only if the profit from arbitrage was shared.

Contractual limitations are likely to be relaxed in the future, because buyers may be unwilling to automatically extend existing contracts without including greater flexibility. New liquefaction capacity coming on stream in the near future and a softening in the demand growth rate gives buyers the expectation of increased influence. This should facilitate a more flexible position on destination clauses and diversion flexibility.

8. Technical Restrictions

LNG specification and its infrastructure is far from standardised, and this complicates arbitrage to a significant extent. Historically, before building regasification and liquefaction terminals, the parties signed long-term Sales-and-Purchase Agreements, where the importer determined the LNG specifications (calorific value, impurity content etc). Certainly, there are ways to deal with many of these problems – so-called quality correction equipment allows the specifications to be altered by blending, etc. There are two 'buts' here: first, not every ship or receiving terminal possesses this equipment and, second, quality correction requires additional costs, which means that the price spreads should be significant enough to cover these costs as well. LNG specifications are not the only technical restrictions; ship-shore compatibility and compatibility of the offloading and receiving equipment must be taken into account as well. For example, the new mega-sized Q-Max and Q-Flex ships can moor only in a few LNG receiving terminals. It is not always possible for importers to change and standardize their ports and equipment, and even if they can it will require additional costs and time.

Technical issues undoubtedly restrict diversions of LNG vessels and impede the trade; this barrier is considered to be one of the most critical when we talk about arbitrage market growth.

9. Regulatory and Market Restrictions

Governments and some regulatory institutions impose various restrictions and obligations on gas market players in order to create a more competitive, efficient and fair market. Liberalized markets strive for non-discriminatory access to infrastructure for third parties. However, not all the markets are liberalized and this remains an obstacle. LNG ship authorisation and vetting processes often take a long time and are detrimental to spot and arbitrage transactions. For example, two months are required to get a ship approved by local authorities for delivery to Tokyo[5].

Some regulations may hamper spot trade and arbitrage, but others may encourage it. One example is the "use-it-or-lose-it" principle in most European countries. This means that, for example, a regas capacity owner should have some minimum number of cargoes coming into the terminal during a certain period of time; failing which, the allotted slots or capacity must be offered to third parties by the terminal operator[6]. Regulation may become more stringent during periods of high demand, preventing the buyer from diverting a cargo to a higher price market. On the other hand, this regulation encourages the purchase of spot or diverted cargoes in order not to lose the capacity. Another example is LNG storage service rules in Spain, which sometimes prevent a ship from delivering a scheduled cargo. This forces the importer to divert the cargo in order to minimise financial losses, even if the price spreads do not always cover the margin.

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

10. Lack of Shipping Capacity

On the face of it, this is a major barrier to cargo diversion. Diversion is hardly possible if there is a shortage of shipping capacity and the carriers have tight schedules. Very often arbitrage implies a longer journey and a need for spare shipping capacity. 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. In the present year – 2009 - there is no shortage of LNG shipping capacity.

[5] Didier Holleaux, "Value of Transatlantic Arbitrage", LNG 15 Conference, Barcelona, 24-27 April, 2007.
[6] Didier Holleaux, "Value of Transatlantic Arbitrage", LNG 15 Conference, Barcelona, 24-27 April, 2007.

11. Lack of Regasification Capacity

It stands to reason that the importer has to possess capacity at a regasification terminal, but the existence of spare regas capacity will still 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 the price of gas are high. Some markets, such as the US, charge high fees for spot cargoes (around 0,90 USD/MMBtu[7]) or offer Margin-Sharing Agreements with primary capacity owners.

12. Inefficient Hedging Instruments

There are some hedging[8] instruments commonly used to mitigate risks: options, swaps, futures and forward trading. Due to the specifics of the LNG trade, such as delivery delays and cargo evaporation, these derivatives cannot provide a very high level of security. Moreover, some instruments are limited due to a lack of standardized delivery contracts, thus making it difficult to match the price/volume of the deal with the price/volume of the hedge.

Another barrier for hedging is the absence of gas pricing indices in many markets (a good example is the Far East), which means that they don't have a reference price and derivatives cannot be constructed. There is no perfect risk-mitigating instrument in sight, but an experienced trader is able to minimize the risks by well-organized logistics and knowledge of how to use hedging instruments.

7.2 Framework of the Barriers

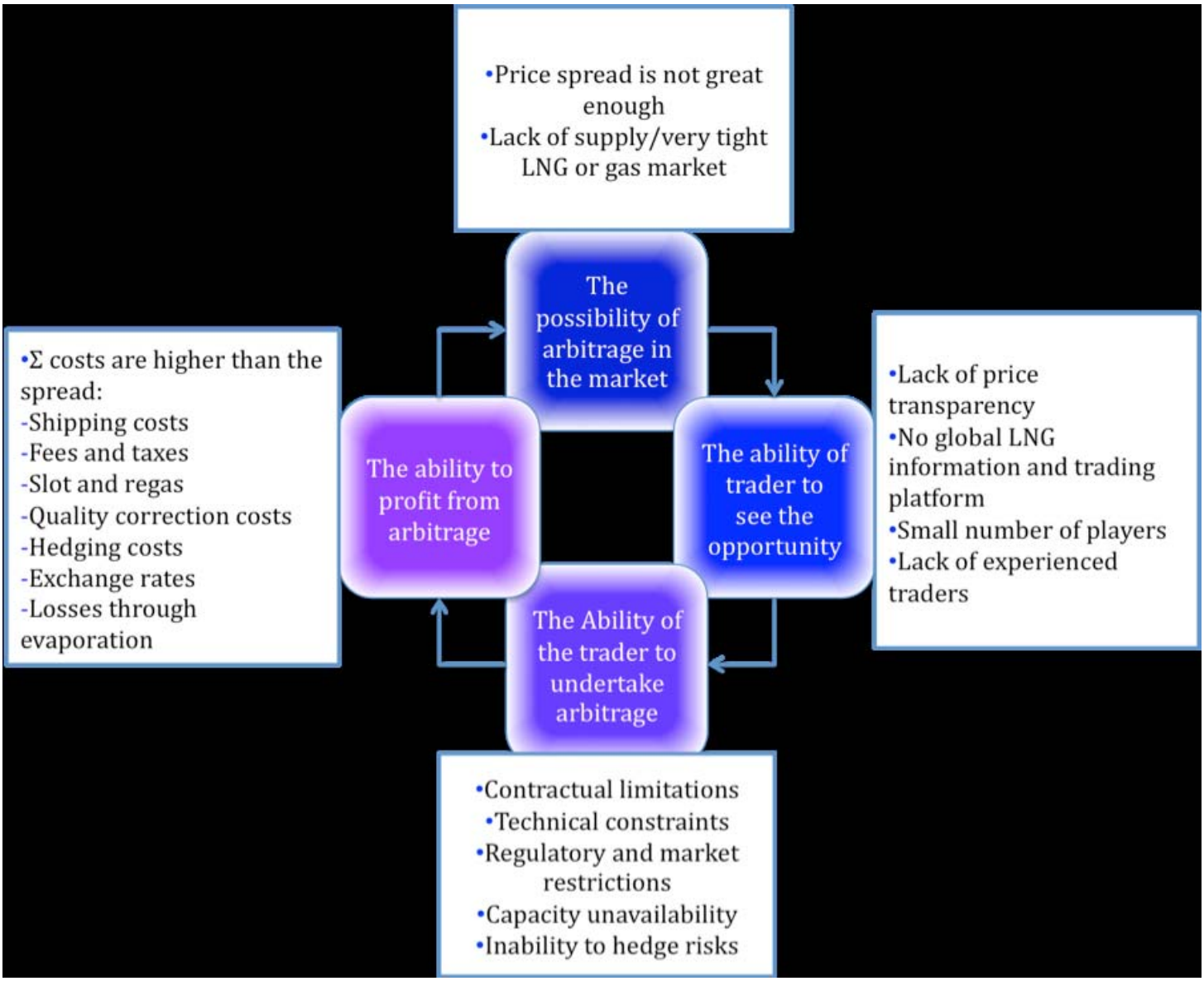
The following framework (Figure 7 below) has been developed to structure the barriers for LNG arbitrage market growth. The four coloured boxes I, II, III and IV present the conditions necessary for arbitrage to happen. The white boxes behind each condition contain barriers to these conditions. The arbitrage transaction for commercial reasons can take place if there is an arbitrage opportunity created by the global gas and LNG markets. The second and third conditions are the ability of the traders and market players to see these opportunities and the ability to close the arbitrage deal and physically deliver the cargo. But even when all three conditions are met, the deal won't make sense if the total cost of the

[7] Didier Holleaux, "Value of Transatlantic Arbitrage", LNG 15 Conference, Barcelona, 24-27 April, 2007.
[8] It is important to note that the resulting gas is hedged, not the LNG itself.

transaction exceeds the margin or reduces it to the extent where the arbitrage transaction is not attractive any more for the arbitrageur.

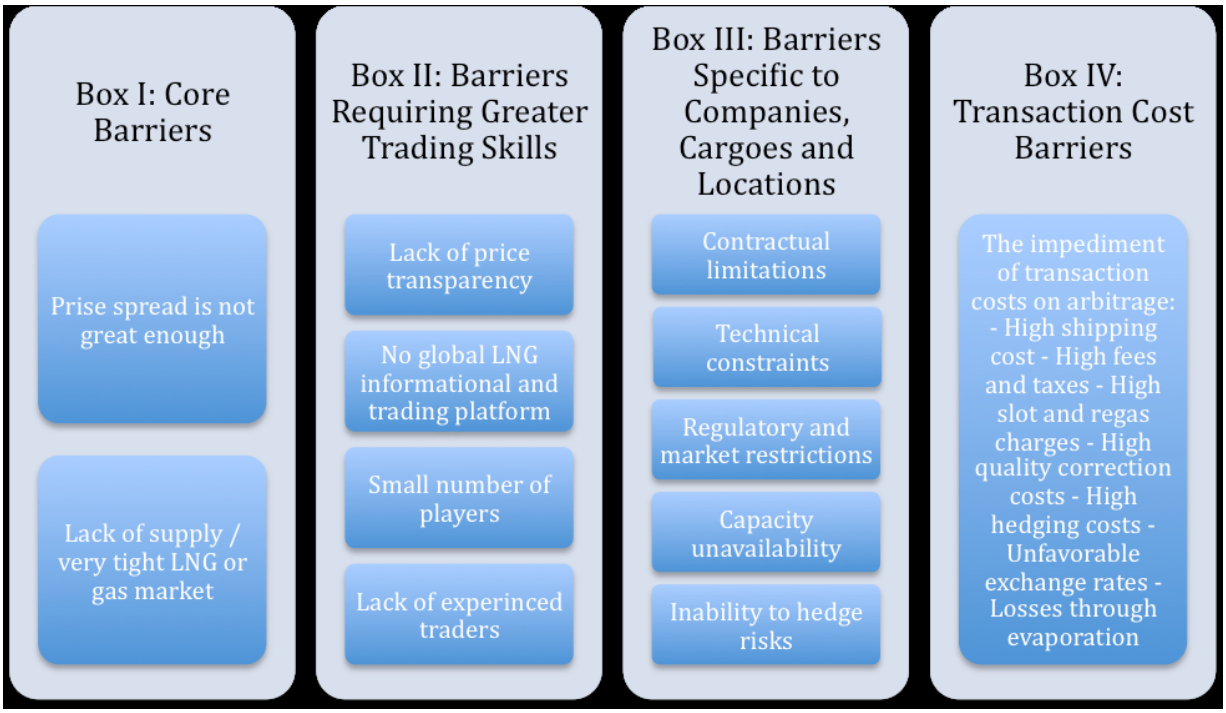
Each condition referred to above has barriers that may hinder it. We have divided the barriers into four groups and attached them to each condition. Thus each necessary condition for LNG arbitrage has a group of potential barriers that may affect it (Figure 7).

Figure 7: Conditions and Barriers for Commercial LNG Arbitrage



Source: own framework

Figure 8: Four Groups of Barriers



Each group of barriers has its own specifics and level of significance for the growth of the LNG arbitrage market. The core barriers that affect the global/interregional LNG trade and arbitrage market are shown in Box I. If the spreads are not significant or there is a very tight supply, it is very unlikely that an arbitrage transaction will take place. At the very least, the number of arbitrage diversions will be sharply reduced.

The barriers in Box II have an influence on the global LNG market, but do not stop the trade. They rather make trading more challenging and require a high degree of skill from traders. For example, such barriers as lack of price transparency or absence of a global trading platform cannot stop arbitrage diversions; however, some opportunities will be missed.

In Box III there are barriers that are relevant for particular companies, particular cargoes, or sometimes for a regional market. For example, technical restrictions may prevent the diversion of the LNG vessel if the vessel has unfavourable specifications and is not compatible with a port or receiving facility. This is a barrier for the redirection of this particular cargo. Regulatory constraints or an inability to hedge the risk can be relevant for a particular market and have no real effect on other regional markets.

Box IV contains a barrier that is associated with high transaction costs. If the total costs that are needed to accomplish the cargo redirection are higher than, equal to or almost equal to the margin, there is no motive for the trader to divert the cargo. The only exception is LNG arbitrage for operational reasons. The total cost of the transaction comprises shipping costs, all the fees and charges as well as additional costs for quality correction where needed. This barrier can't stop the trade as conditions and prices vary from case to case and from market to market. It can be challenging to find the most economical way to physically deliver the LNG, but this doesn't hinder the growth of global LNG arbitrage.

Figure 9: Features and Significance of the Different Groups of Barriers*

	a) Greatly impede arbitrage and sharply reduce the number of deals	**b)** Increase the **challenges** involved in arbitrage but do not prevent it
A) Impact on **global** LNG arbitrage	I. Core barriers	II. Barriers requiring greater trading skills
B) Impact on particular LNG market **players** or cargoes, or regional LNG markets	III. Barriers specific to companies, cargoes and locations	IV. Transaction cost barriers

** For the list of barriers see Figure 8.*

In Figure 9 the groups of barriers are analysed by two criteria:

1) The scope of their impact: whether they influence the global LNG arbitrage market or just some regions, particular players, etc;

2) The degree to which they impact LNG arbitrage: sharply reducing the number of transactions or just making the arbitrage trading more challenging and to some extent reducing the number of diversions.

According to the methodology developed in this paper, Box I has ‘Aa’ characteristics, Box II – ‘Ab’, Box III – ‘Ba’ and Box IV ‘Bb’.

We suggest that barriers with ‘Aa’ characteristics must be the “core barriers” to the growth of LNG arbitrage. They not only affect all players and markets, but also have the potential to almost eliminate arbitrage trades. ‘Ba’ Barriers are significant as a large quantity of the players (companies, markets) confront them. The barriers with ‘Ab’ and ‘Bb’ characteristics reduce the number of arbitrage transactions but cannot stop the trade. Better organization of logistics and better-prepared and experienced traders can overcome these barriers and limit their negative effects.

8. Conclusions

Physical LNG arbitrage in commercial terms implies LNG cargo diversion from one market to another in order to benefit from gas price differentials. A cargo swap should not be regarded as arbitrage as its main goal is to maximize profit via a reduction in the transaction costs. This activity does not lead to price convergence and arbitrage equilibrium. The reloading of LNG suggests that the cargo will be sent to a market with a higher price and therefore can be considered to be arbitrage activity.

LNG arbitrage involves more than two buyers; hence ‘buyer-seller’ models (e.g. spot deals and portfolio optimization) are not arbitrage transactions even if they might lead to interregional gas price convergence. According to the definition of LNG arbitrage adopted in this paper, the cargo must belong to an initial buyer and be redirected from the initial buyer’s market to another market with the higher price.

Even though LNG diversions seem to be a profitable activity, there are some barriers to the development of the arbitrage market. The significance of these barriers may vary over time. Some of them can be relevant for the particular players or regions, while others may affect the trade on the global level. The framework developed during this research allows an analysis of the degree to which the effect of the barrier is global or local and how critically the barrier hinders LNG diversion. Most of the barriers can be managed, reduced or even eliminated; consequently, LNG market participants can influence, accelerate or impede LNG arbitrage market growth.

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