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# Can LNG increase competitiveness in the natural gas market?

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**Abstract**

The following paper aims at studying the competitive effect of the entry in the gas market of importers of liquefied natural gas (LNG hereafter). In particular we would like to analyze whether the construction of LNG terminals and the entry of LNG importers can have a positive effect on the gas price and therefore on consumers' welfare. The present paper formalizes some plausible scenarios for the gas market in the next years and studies the resulting prices. It will then turn to an empirical analysis in order to see which of the assumed scenarios is more likely to emerge in these future years. The main result of the model is that entry of LNG importers in the market for natural gas can have a positive competitive effect even if LNG has higher total cost, but only under some stringent conditions. The main of them can be summarized as follows: new competitors must enter the LNG market; an active spot market should develop; LNG cost should decrease. The empirical analysis shows that these conditions are very likely to be fulfilled in the future

Keywords: *Gas market; Cournot competition; entry.*

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## 1 Introduction

It is a long-time debate, between natural gas experts, the one concerning the potential role of transport through the LNG chain in facilitating the actual liberalization of gas market and the security of its supply. Indeed, import through LNG chain, that is, through the employment of LNG tankers for gas transportation, presents an undeniable advantage: it does not imply, for the importer, such investments as to determine, once they are sustained, an indissoluble physical tie between producer and buyer, as happens for transport via pipeline (Chernyavs'ka e Dorigoni, 2002). In other words, an investment in a pipeline is very specific, where the greater is the devaluation or the switching costs deriving from an alternative use, the greater is the specificity of an asset. In the case of a pipeline, the degree of specificity is maximum (more precisely, of the "site specificity" kind, Williamson, 1985): in fact, durable investments in pipelines' construction are made in order to support specific transactions, and their opportunity cost is much lower than those deriving from the best alternative uses. In these cases, the importance of the specific identity of the transaction counterparts is crucial and, consequently, great importance is given to the continuity of the contractual relation, so that contractual and organizational safeguards are often provided. In particular, these transactions take the form, for the natural gas market, of long-term agreements with minimum offtake requirements (take or pay clauses), designed to safeguard counterparts from ex-post contractual opportunism (hold-up problem), that is really likely in these circumstances. Such contracts definitely contribute to the "cartelization" of the market, hindering competition.

Unlike investments in pipelines, those in the LNG chain present a much lower degree of specificity: in fact, even though the construction of a regasification plant is generally tied to the stipulation of a long-term agreement (with take or pay clause), LNG chain costs have significantly decreased over time, thanks to technological innovation (Oil&Gas Journal 2006); moreover, it is getting increasingly common that part of the plant capacity is made available for spot transactions (in some countries this is a regulatory requirement, CEER, 2006). What's more, once the contract is expired and the investment is sunk, the importer may satisfy his gas supply needs on the basis of his relative gains. As for LNG chain costs, it is important to stress that, actually, some recent studies (such as IEFE 2008) have demonstrated that in the very last few years there has been a clear reversal of trend. Nevertheless, this increase in costs concerned also pipeline construction costs; so that we can say that the relative competitiveness of this two transports modality has not changed radically in recent years.

A part from theoretical considerations it is worth mentioning that for the time being LNG seems to represent the sole possibility for new competitors according to the lack of capacity on international import pipelines. Long term import take or pay contracts held by gas incumbents play a pre-emption activity on transit pipelines and access can not be granted to third parties.

Moreover LNG could enable traditional European importers to widen their gas suppliers' portfolio, also considering that some producing countries (i.e. stranded gas) can be reached only via sea. Increased possibilities of choice for importers, the widening of the group of exporting countries, and the increased integration of the European market, thanks to the possibility of redirecting cargoes depending on single countries' supply-demand balance, would contribute decisively to security of supply, market globalization and competition in the industry (IEA, 2004). Consequently, it is possible that some competition between producing countries will also occur.

This article is aimed at evaluating the impact of LNG on the liberalization of the European gas market. First of all this possibility will be analysed through the construction of a theoretical model. Afterwards the assumption of the model will be tested according to the empirical truth considering the features and the dynamics that are developing on the LNG market.

## 2 The model

The following model aims at studying the competitive effect of the entry in the gas market of importers of liquefied natural gas (LNG hereafter). In particular we would like to analyze whether the construction of LNG terminals and the entry of LNG importers can have a positive effect on the gas price and therefore on consumers' welfare. Despite the consistent decrease in the last years in the production costs of LNG (cost of building liquefaction plants, special LNG tankers and regasification terminals), at the moment LNG still has higher production cost than natural gas imported via pipe. Nonetheless, the entry of LNG suppliers in the gas market may have positive impact on price because, contrary to what happens with natural gas imported via pipeline, LNG importer's production facilities are not dedicated to a specific upstream producer (as we said before) and this in turn may lead to a more competitive market. Furthermore, a more competitive market structure, together with the fact that LNG production cost probably will continue to decrease, could lead to a lower price of gas.

The present model formalizes some plausible scenarios for the gas market in the next years and studies the resulting prices. It analyzes the pricing behaviour in a liberalized market and we assume that the firms are free to choose the price that maximizes their profits with no regulatory constraint. The competitive effect of the entry of LNG importers depends on several factors, including the number of importers and the type of competition that will take place among them and between LNG producers.

We consider 4 possible scenarios. In three of them we restrict our attention to competition among LNG importers and we rule out competition between natural gas imported via pipeline and LNG by assuming capacity constraint on the pipeline. As a result, the importer of natural gas via pipeline behaves as a monopolist on his segmented market and competition takes place only among LNG importers. The rationale for this assumption is the desire to investigate first the characteristics of the LNG market to understand whether it can be competitive with respect to the market for the gas imported via pipe. In the first scenario we assume that LNG market has the same structure of the market for natural gas imported via pipe: one importer with a long-term contract with one producer. The other scenarios, instead, assume an oligopoly structure with *n* importers. In the second scenario we analyze the oligopoly pricing behaviour under the assumption that each importer has long-term contract with one producer. In the third scenario we introduce a spot market for LNG so that the quantity needed to meet seasonal fluctuations can be bought on the spot market. Finally, in the last scenario we introduce competition among LNG and natural gas imported via pipe.

We focus our attention on Cournot (quantity) competition. This is because we believe the Cournot model is a more convenient way to capture the characteristics of the natural gas market and in particular because it has been shown that the Cournot solution is equivalent to the solution of a two-stage game where in the first period firms compete in capacity and in the second period firms compete in prices.

### 2.1 Fundamentals of the model

We restrict our attention to only two levels in the natural gas production chain: upstream production and downstream transportation and import. By doing this we look at the competition at import level and we ignore the retail distribution and the problems that may arise at this level (third party access, etc).

Consider a two-period model where in the first period the whole supply of gas is provided by natural gas imported via pipeline by a monopolist. This of course is a simplification of a more realistic situation with a dominant firm that "makes the market" and with few very small firms that behave as a competitive fringe. However, we believe this is a reasonable simplification since we are interested in the pricing behaviour of gas suppliers and the competitive fringe has no influence on market price[4].

[4] This implies, for example, that we ignore the regulatory constraint imposed by Italian regulator on the amount that the downstream supplier can sell. However, two considerations are in order. First, Italy is one of the few countries with this type of regulation. Second, and more important, firms that purchase gas from the monopolistic importer can hardly be credible competitors of the importer on the retail market.

In the second period gas demand increases and the constraint given by the capacity of the pipeline becomes binding. As a result the supplier of natural gas via pipe cannot meet the new demand and one or more suppliers of LNG enter(s) the market.

*Demand Functions*

We simplify matters by assuming there are only two groups of consumers: residential and industrial. The aggregated demand is the sum of these two components which have different elasticities: residential demand is quite rigid while industrial demand is more elastic. Indeed, the demand for heating is quite rigid in the short-medium term.

The residential inverse demand function is given by:

$$P_R = a_R - b_R Q_R$$

where $b_R < 1$. In one of the following subsections we will introduce the possibility that demand function of residential consumers is subject to seasonal fluctuations. The idea is to capture the random component in the demand for heating due for example to particularly cold winters.

The inverse demand function for industrial consumers is :

$$P_I = a_I - Q_I$$

It is immediate to derive the direct demand functions: $Q_I = a_I - P_I$ and $Q_R = \frac{1}{b_R}(a_R - P_R)$.

The two groups of consumers are different also for the commercial cost that the importer bears to serve them. The commercial cost for residential consumers $(\bar{c})$ is higher than the commercial for industrial consumers $(\underline{c}) : \bar{c} > (\bar{c})$.

## 2.2 First Period: bilateral monopoly in the supply of natural gas imported via pipe

Consider for the moment a market structure with only one downstream supplier which purchases natural gas by a upstream producer. Gas is transported through a existing pipeline. The cost of building the pipeline has already been sunk (and potentially paid back), and therefore we can ignore it. Furthermore, we take as given the capacity of the pipeline. To solve the model we work backward by solving first the maximization problem of the downstream firm and then finding the optimal price for the upstream producer.

Downstream supplier demand function is:

$$Q = Q_R + Q_I$$

The quantity of natural gas that can be imported via pipe is constrained by the capacity of the existing pipeline. We assume that the quantity of imported gas is such that the pipeline is working at full capacity to meet the first-period demand, both residential and industrial.

Downstream supplier and upstream producer have signed a long-term contract with "take-or-pay" obligations so that the downstream supplier has an incentive to exactly cover its obligations. Let superscript $P$ denote the gas imported via pipe.

The cost function of the monopolistic supplier of natural gas via pipe is given by:

$$C^P(q) = P^W(Q_R + Q_I) + \bar{c}Q_R + \underline{c}Q_I \qquad \text{if} \quad Q_R + Q_I \leq \bar{q}$$

$$= w(q - \bar{q}) + P^W(Q_R + Q_I) + \bar{c}Q_R + \underline{c}Q_I \quad \text{if} \quad Q_R + Q_I > \bar{q}$$

where $\bar{q}$ is the quantity specified in the contract with the producer and $w > P^W$. Given the wholesale price paid to the upstream producer of gas $P^W$, downstream supplier optimization problem is given by:

$$\max(a_I - P_I)(P_I - P^W - \underline{c}) + \frac{1}{b_R}(a_R - P_R)(P_R - P^W - \bar{c})$$

We can rewrite the optimization problem with the quantity as choice variable rather than the price to get:

$$\max[(a_I - Q_I) - (P^W + \underline{c})]Q_I + [(a_R - b_R Q_R) - (P^W + \bar{c})]Q_R$$

whose solutions are $Q_I^* = \dfrac{(a_I - \underline{c} - P^W)}{2}$ and $Q_R^* = \dfrac{(a_R - P^W - \bar{c})}{2b_R}$.

Given the quantity demanded by the downstream firm as function of $P^W$, the upstream producer chooses the wholesale price by solving the following maximization problem:

$$\max(Q_I^* + Q_R^*)(P^W - C^e) = [\frac{(a_I - \underline{c} - P^W)}{2} + \frac{(a_R - \bar{c} - P^W)}{2b_R}](P^W - C^e)$$

where $C^e$ is the natural gas extraction cost. The optimal wholesale price is:

$$P^W = \frac{(a_I - \underline{c})b_R + (a_R - \bar{c})}{2(b_R + 1)} + \frac{C^e}{2}$$

Finally, given the wholesale price we can find the optimal downstream quantity and price for the industrial sector:

$$Q_I^* = \frac{(a_I - \underline{c})[2(b_R + 1) - b_R] - (a_R - \bar{c})}{4(b_R + 1)} - \frac{C^e}{4} \qquad (1)$$

Let $\gamma = (b_R + 1)$. Then we can rewrite eq. 1 in the following way:

$$Q_I^* = \frac{(a_I - \underline{c})[\gamma + 1] - (a_R - \bar{c})}{4\gamma} - \frac{C^e}{4}$$

and the resulting price is

$$P_I^* = \frac{4\gamma a_I - (a_I - \underline{c})(\gamma + 1) + (a_R - \bar{c})}{4\gamma} + \frac{C^e}{4} \quad (2)$$

In the same way we can determine the quantity and price for the residential sector:

$$Q_R^* = \frac{(a_R - \bar{c})(\gamma + b_R) - (a_I - \underline{c})b_R}{4b_R\gamma} - \frac{C^e}{4b_R} \quad (3)$$

$$P_R^* = \frac{4\gamma a_R - (a_R - \bar{c})(\gamma + b_R) + (a_I - \underline{c})b_R}{4\gamma} + \frac{C^e}{4}$$

Eq.1 and eq.3 imply that in order to have positive production for both industrial and residential consumers the following conditions must be satisfied:

$$\frac{(a_R - \bar{c})}{\gamma + 1} + C^e \frac{\gamma}{\gamma + 1} < (a_I - \underline{c}) < (a_R - \bar{c}) \frac{(\gamma + b_R)}{b_R} - C^e \frac{\gamma}{b_R}$$

Note that the above price mechanism presents the standard double marginalization problem: the retail price is higher and the quantity sold is lower than, respectively, the price and the quantity we would have with an integrated firm producing, transporting and selling the gas. This is because the producer, when deciding the wholesale price, does not take into account the negative effect that a higher price has on the quantity sold by the importer to consumers.

The downstream supplier profits are given by:

$$\Pi^G = Q_I^*(P_I^* - P^W - \underline{c}) + Q_R^*(P_R^* - P^W - \bar{c}) = \frac{(a_I - \underline{c} - P^W)^2}{4} + \frac{(a_R - \bar{c} - P^W)^2}{4}$$

### 2.3 Second Period: entry of LNG importers

Gas demand has been constantly growing in the last decades and forecasts for the next decades confirm this trend. We capture this by assuming that in the second period demand is higher and new facilities, either a new pipeline or new regasification terminals, must be built to meet this growing demand. Given that LNG demand has been rising at an even faster rate than the demand of natural gas, we focus our attention on the entry of one or more LNG importers. Thus, in the second-period the importer of gas via pipeline operates at full capacity

but is unable to meet the increased demand.

We assume that second-period demand is equal to first-period demand multiplied by $(1+s)$ where s is a scalar that represents the growth rate of natural gas demand. Then, the new demand function is:

$$Q^2 = (1+s) \cdot [Q_R^1 + Q_I^1]$$

The simplest case is the one with $s = 1$, i.e. when demand doubles.

*Rationing*

As said before we assume that the pipeline capacity is insufficient to meet the growing demand for gas. If natural gas importer via pipe operates at full capacity in the first period, the whole increase in second-period demand must be satisfied by LNG importers. We assume that customers are assigned to different suppliers according to a *random rationing mechanism* (called also *proportional rationing*) where all consumers have the same probability of being served by each supplier[5]. The rationing mechanism is important because, as it is shown below, gas is sold at different prices but of course, all consumers would like to buy from the low price importer. Under proportional rationing or random rationing, the downstream supplier of gas via pipe sells the same quantity as before and the new demand is satisfied by the entrants, i.e. LNG importers. Let the subscript $L$ indicate LNG and lowercase letters indicate the variables that refers to LNG, so that, for example, $p_I^L$ and $q_I^L$ are the price and the quantity of LNG for industrial consumers, respectively.

*Regasification Capacity choice*

After deciding to enter the market, LNG importers decide the capacity of the regasification terminal and finally they decide the quantity of LNG to sell. Ignoring seasonality problems and strategic storage, regasification capacity of the terminal will be chosen to minimize the cost of building the terminal given the optimal amount of LNG that the importer wants to sell on the market. Let $R(k)$ be the cost of the regasification terminal as a function of the capacity $k$. We assume that the cost function $R(k)$ is U-shaped so that there exists a capacity that minimizes the cost of building the regasification terminal. For example if $R(k) = \overline{R} + R(k-8)^2$ we obtain

$$k^{\min} = 8$$

Then, a capacity of $k = 8$ billion $m^3$ will be chosen provided that the optimal quantity of LNG to be sold on the market is $q_L \leq 8$.

The capacity installed is an important element in determining the degree of competitiveness in the market. We need to assume not only that there exist a capacity that minimizes the cost but also that this capacity is larger than the quantity sold by the importer on the market. The choice of the capacity of the regasification terminal, $k$, sets an upper bound on the quantities the importer can sell: $q_R^{Li} + q_i^{Li} \leq k$. But if $q_R^{Li} + q_I^{Li} = k$ and, in general if importers have a capacity $k$ such that $nk = Q(p^*)$ where $p^*$ is the equilibrium price, then each importer is a monopolist in his market. In order to have a competitive effect, importers must compete on the retail market, and this in turn

[5] Alternative hypotheses would be either efficient rationing or cream skimming.

implies that each importer must have a market share strictly smaller than $k$: $q_R^{Li} + q_I^{Li} < k$. This means that importers must profitably choose a regasification capacity in excess of the one needed. This is profitable only if, given $k^{\min} > q_R^{Li} + q_I^{Li}$, it follows that $R(k^{\min}) < R(q_R^{Li} + q_I^{Li})$.

The LNG importer takes the quantity of natural gas imported via pipe as given so that its demand function is the residual demand. If, for example, natural gas demand doubles, the residual demand for LNG is given by $q^L = (a_R - p_R^L) + (a_I - p_I^L)$ where we have simplified notation by deleting the superscript indicating the time period since supply of LNG is available only in the second period by assumption.

We can now analyze the different competitive scenarios. In the first one the LNG market structure is given by a bilateral monopoly where the only LNG importer has a long-term contract with a monopolist LNG producer. In the second scenario we analyze an oligopoly with $n$ LNG importers. Also in this second scenario we assume that each LNG importer has a long term contract with an upstream, so that there is no competition among producers. In the

third scenario we relax the assumption that each importer has a long term contract with a producer for the entire quantity of LNG and we assume that importers have long-term contracts only for a fraction of the quantity sold and the remaining part is bought on the spot market. Thus, in this scenario we study the effect of competition among LNG producers in addition to the competition among importers. Finally, in the last scenario we examine competition between LNG importers and the importer of gas via pipe.

We first assume that the LNG supplier(s) has decided to enter the market and only after solving for the equilibrium quantity and price we check whether the conditions that make entry profitable are satisfied.

### *2.3.1* Bilateral Monopoly in the LNG market

Let $r$ be the unit regasification cost of the LNG importer, $p^W$ the unit price paid to the LNG producer, and as before $\underline{c}$ and $\bar{c}$ the cost of serving industrial and residential consumers, respectively. The quantity of LNG sold to industrial consumers is the solution of the following maximization problem:

$$\max(a_I - q_I^L)q_I^L - (p^W + \underline{c} + r)q_I^L$$

which is $q_I^L = \dfrac{a_I - (p^W + \underline{c} + r)}{2}$. Similarly, the quantity sold to residential consumers solves:

$$\max(a_R - b_R q_R^L)q_R^L - (p^W + \bar{c} + r)q_R^L$$

and is given by $q_R^L = \dfrac{a_R - (p^W + \bar{c} + r)}{2b_R}$.

Following the same procedure we used for the gas imported via pipe, given the quantity demanded by the LNG importer as a function of the price paid to the producer, we find the optimal wholesale price. Finally, given the wholesale price we solve for the retail price for LNG. For the moment we assume that there is no difference in the extraction cost for the gas, $C^e$, independently of the country where it is produced, so that the entire difference in the cost between gas via pipe and LNG is given by the regasification cost $r$, and the liquefaction cost $l$. The first is paid by the importer and the second by the producer. Then, the upstream producer's profit function is:

$$\pi = \left[\frac{a_R - (P^W + \underline{c} + r)}{2b_R} + \frac{a_I - (P^W + \bar{c} + r)}{2}\right](P^W - C^e - l)$$

and the optimal wholesale price is:

$$P^W = \frac{(a_I - \underline{c})b_R + (a_R - \bar{c})}{2(b_R + 1)} + \frac{(C^e + l - r)}{2}$$

The wholesale price for LNG is function of both the regasification cost $r$ and the liquefaction cost $c$. However, they have opposite sign since they are paid by the two opposite contractual parties. Given this wholesale price retail quantities are:

$$q_I^L = \frac{(a_I - \underline{c})(\gamma + 1) - (a_R - \bar{c})}{4\gamma} - \frac{(C^e + l + r)}{4}$$

and

$$q_R^L = \frac{(a_R - \bar{c})(\gamma + b_R) - (a_I - \underline{c})b_R}{4b_R\gamma} - \frac{(C^e + l + r)}{4b_R}$$

The corresponding prices are:

$$p_I^L = \frac{4\gamma a_I - (a_I - \underline{c})(\gamma + 1) - (a_R - \bar{c})}{4\gamma} + \frac{(C^e + l + r)}{4} \quad (4)$$

and:

$$p_R^L = \frac{4\gamma a_R - (a_R - \bar{c})(\gamma + b_R) - (a_I - \underline{c})b_R}{4\gamma} + \frac{(C^e + l + r)}{4} \quad (5)$$

By comparing expression 4 with expression 2 it is easy to see that, LNG retail price is higher for both groups of consumers:

$$p_I^L - P_I^* = p_R^L - P_R^* = \frac{(r + l)}{4} > 0$$

LNG can be sold at a higher price than gas imported via pipe because of our assumption that the capacity constraint on the quantity of gas imported via pipe is binding. Thus, the final retail price for natural gas for both groups of consumers will be a weighted average of the two prices.
LNG importers' profits are:

$$\pi^L = (p_I^L - \underline{c})q_I^L + (p_R^L - \overline{c})q_R^L - (P^W - r)(q_I^L + q_R^L) - R(k^{\min})$$

### *2.3.2* Bilateral Oligopoly in the LNG market

Suppose now $n$ LNG importers enter the market. Each one has a long term contract with a upstream producer[6]. The difference with the bilateral monopoly case is that now the LNG importers compete on the final market. The retail market is the only stage at which there is competition because the long-term contracts between downstream suppliers and upstream producers insulate producers from competition.
We make the simplifying assumption that LNG is a homogeneous product and therefore is sold at the same price by the $n$ importers[7].
As before, we assume that the quantity of gas imported via pipe is given by the capacity of the pipeline so that the whole increase in the demand for gas is met by LNG importers. Then, inverse demand functions for industrial and residential consumers are respectively: $p_I^L = a_I - q_I^L$ and $p_R^L = a_R - b_R q_R^L$. The quantity sold by the $i^{th}$ importer to industrial consumers solves:

$$\max(a_I - q_I^L)q_I^{L_i} - (P^W + \underline{c} + r)q_I^{L_i}$$

where $q_I^L = nq_I^{Li}$. Similarly for the quantity sold to residential consumers.

Thus, the quantities sold by $i^{th}$ importer as functions of wholesale price are:

$$q_I^{L_i} = \frac{a_I - \underline{c} - r - P^W}{(n+1)} \quad \text{and} \quad q_R^{L_i} = \frac{a_R - \overline{c} - r - P^W}{b_R(n+1)}$$

Then, each producer solves the following problem:

$$\max\left[\frac{a_I - \underline{c} - r - P^W}{(n+1)} + \frac{a_R - \overline{c} - r - P^W}{b_R(n+1)}\right](P^W - l - C^e)$$

and the resulting wholesale price is:

$$p_W^{L_i} = \frac{(a_I - \underline{c})b_R + (a_R - \overline{c})}{2\gamma} + \frac{(C^e + l - r)}{2}$$

The quantity demanded by the $i^{th}$ importer to the producer is smaller than the quantity in the bilateral monopoly case. However, the wholesale price charged by the producer is the same as

[6] Note that we are implicitly assuming that there is a sufficient number of LNG producers.
[7] However, the model could be extended to allow for differentiated products.

before. This is so because each producer still behaves as a monopolist with the downstream supplier despite the reduction in demand. The larger number of importers is reflected is the equilibrium quantities and price in the downstream market where now the $n$ importers compete each other. The quantity sold by importer i to industrial consumers is:

$$q_I^{L_i} = \frac{(a_I - \underline{c})(\gamma+1) - (a_R - \bar{c})}{2\gamma(n+1)} - \frac{(C^e + l + r)}{2(n+1)}$$

and the quantity for residential consumers is:

$$q_R^{L_i} = \frac{(a_R - \bar{c})(\gamma + b_R) - (a_I - \underline{c})b_R}{2b_R\gamma(n+1)} - \frac{(C^e + l + r)}{2b_R(n+1)}$$

Aggregate quantity and the resulting market price are given by:

$$q_I^L = \sum q_I^{L_i} = n\left[\frac{(a_I - \underline{c})(\gamma+1) - (a_R - \bar{c})}{2\gamma(n+1)} - \frac{(C^e + l + r)}{2(n+1)}\right]$$

$$p_I^L(n) = a_I - q_I^L = a_I - n\left[\frac{(a_I - \underline{c})(\gamma+1) - (a_R - \bar{c})}{2\gamma(n+1)} - \frac{(C^e + l + r)}{2(n+1)}\right]$$

$$= \frac{2\gamma(n+1)a_I - n(a_I - \underline{c})(\gamma+1) + n(a_R - \bar{c})}{2\gamma(n+1)} + \frac{n(C^e + l + r)}{2(n+1)} \quad (6)$$

Similarly, the price for residential consumers is given by:

$$p_R^L = a_R - b_R n q_R^{L_i} =$$

$$= \frac{2\gamma(n+1)a_R - n(a_R - \bar{c})(\gamma + b_R) - n(a_I - \underline{c})b_R + n(C^e + l + r)\gamma}{2\gamma(n+1)} \quad (7)$$

As expected, LNG price both for industrial consumers (eq.6) and for residential consumers (eq. 7) are decreasing in $n$: an oligopoly structure in the LNG downstream market results in a lower price than a monopoly structure because, even if there is no competition among LNG producers, there is competition among LNG importers. Indeed, the final price derived in eq.6 is lower than the price we derived in the bilateral monopoly case (see eq. 4) for $n$ larger than 1 as can be seen from the following inequalities:

$$p_I^L(n) - p_I^L(1) \le 0 \Leftrightarrow (a_I - \underline{c})(\gamma+1) - (a_R - \bar{c}) - (C^e + l + r)\gamma > 0$$

that is always satisfied because it is the condition that guarantees positive production.

If instead we compare the LNG price with the price of natural gas imported via pipe we can see that LNG oligopoly price is smaller if:

$$p_I^L(n) - P_I^* = \frac{2\gamma(n+1)a_I - n(a_I - \underline{c})(\gamma+1) - n(a_R - \bar{c})}{2\gamma(n+1)} + \frac{n(C^e + l + r)}{2(n+1)}$$
$$- \frac{4a_I\gamma - (a_I - \underline{c})(\gamma+1) + (a_R - \bar{c})}{4\gamma} - \frac{C^e}{4} \le 0$$

Rearranging and simplifying this expression we find that the price of LNG
is smaller than the price of the gas imported via pipe when:

$$(a_I - \underline{c})(\gamma+1) + (a_R - \bar{c}) - (C^e + l + r)\gamma - \gamma\frac{(n+1)}{(n-1)}(l+r) \ge 0$$

This condition is more stringent than the one above and we don't know whether it is satisfied. However, since the last term on the left hand side is decreasing in $n$, the inequality is more likely to be satisfied for n large. This implies that under the assumption that extraction cost is equal for LNG and gas imported via pipe, it is the size of liquefaction cost $l$ and regasification cost $r$ together with the number of LNG importer that determines when LNG price can become competitive with respect to price of natural gas imported via pipe.

So far we have analyzed the price for industrial consumers. If we look at the demand of residential consumers the price is:

$$p_R^L(n) = \frac{2\gamma(n+1)a_R - n(a_R - \bar{c})(\gamma + b_R) + n(a_I - \underline{c})b_R}{2\gamma(n+1)} + \frac{n(C^e + l + r)}{2(n+1)}$$

and the comparison between LNG price for residential consumers and the price of gas imported via pipe leads to analogous results to those derived for industrial consumers.

We have assumed that second period demand is $Q^2 = (1+s)\cdot Q^1$. As long as the gas imported via pipe has a lower price, the pipeline works at full capacity, i.e. $Q^1 = Q_R + Q_I$, and the residual demand for LNG importers is $Q^2 - Q^1 = s\cdot(Q^1)$. So far we have derived quantities and prices under the simplifying assumption that $s = 1$. So far we have derived quantities and prices under the simplifying assumption that $s = 1$. A more general formulation can be immediately found by simply multiplying all quantities by $s$. All qualitative results remain unchanged.

*LNG importer's decision to entry*

In the previous sections we have assumed that LNG importers entry the market but we still have to check under which condition entry is profitable and therefore takes place. LNG importer $i$ will enter the market if profits, net of the cost of building the regasification terminal $R(k)$, are positive. Let $k^{\min}$ be the capacity that minimizes the cost of building regasification terminal. Then, the following condition must be satisfied:

$$\pi^{Li} \geq 0 \Leftrightarrow (p_R^L - p_W^{Li} - \bar{c} - r)q_R^{Li} + (p_I^L - p_W^{Li} - \underline{c} - r)q_I^{Li} \geq R(k^{\min})$$

*A simplified setting with only one group of consumers*

To facilitate the comparison between LNG and gas via pipe let consider a simplified model where there is only one group of consumers with demand function given by: $P = a - Q$ and commercial cost equal to $c$. In this simplified setting the price of gas imported via pipe would be $P = \frac{3a + c + C^e}{4}$ and the price of LNG with an oligopolistic market would be:

$$p^L = \frac{2a + n(a + c + r + l + C^e)}{2(n+1)}$$

LNG importer profits are

$$\pi^{Li} = \frac{(a - c - r - l - C^e)^2}{4(n+1)^2} - R(k^{\min})$$

and importer enters the market only if $\frac{(a - c - r - l - C^e)^2}{4(n+1)^2} \geq R(k^{\min})$, or $2\sqrt{R(k^{\min})} \leq \frac{(a - c - r - l - C^e)}{(n+1)}$

By comparing the price of gas imported via pipe and LNG price we have the following inequality:

$$P \geq p^L(n) \Leftrightarrow \frac{3a + c + C^e}{4} \geq \frac{2a + n(a + c + r + l + C^e)}{2(n+1)}$$

$$\Leftrightarrow \frac{(r + l)}{(n-1)} \leq \frac{(a - c - r - l - C^e)}{(n+1)}$$

LNG price is lower than the price of gas imported via pipe only if liquefaction and regasification and costs are sufficiently small. If we look at the condition for positive profits it is easy to see that a sufficient (tough not necessary) condition for LNG price being lower than price of gas imported via pipe is: $(n-1)2\sqrt{R(k^{\min})} \geq (r + l)$ where $R(k^{\min})$ is the yearly cost of the regasification terminal. In other words a sufficient condition is that the unit cost of liquefaction and regasification must be low relative to the yearly cost of building the regasification facility. Observe that since the left term is multiplied by $n-1$ the condition is more likely to be satisfied for $n$ large.

### *2.3.3* Bilateral Oligopoly with an active spot market for LNG

Spot transactions for LNG are becoming more and more important. In this section we change our last scenario to consider the possibility that each importer buys part of the gas on the spot market. The demand for natural gas is subject to important seasonal fluctuations: for example a very cold winter increases demand for a few months. Then, it may not be easy to forecast correctly the long-term demand and importers may find themselves in the need of more quantity than expected. We consider a setting where importers have long-term contracts with producers but now we add the possibility to buy LNG also on the spot market to meet unexpected increase in demand.

To simplify matters we maintain also in this subsection the assumption that there is only one group of consumers, the residential consumers, so that we can drop the subscripts. We further modify the "basic" LNG demand function to take into account temporary fluctuations of the quantity demanded in the following way:

$$Q = (a - P) + \tilde{x}[(\alpha - P)]$$

where $\tilde{x} \in \{0,1\}$ is a binary random variable that takes value 1 when there is an increase in gas demand and 0 otherwise. For example, we could have $\tilde{x} = 0$ in the summer and $\tilde{x} = 1$ in the winter. Importers long-term contract guarantee the "standard" quantity $(a - P)$ while the additional quantity, if any, must be bought on the spot market. This can be due for example, to the fact that it takes time to change the quantity specified in the long-term contract so that LNG importers buys it on the spot market even if the price is higher[8] . In this setting each importer has an additional demand for the spot market equal to:

$$q_i^s = \frac{\alpha - r - \bar{c} - p^{ws}}{(n+1)}$$

Then, producers face a total demand on the spot market given by $Q^s = \frac{n(\alpha - r - \bar{c} - p^{ws})}{(n+1)}$. From this we can derive the inverse demand: $p^{ws} = \alpha - r - \bar{c} - \frac{(n+1)}{n} Q^s$ .

It is likely that producers have capacity constraint and that production cost is increasing as full capacity is approached. We capture this by assuming that producer i cost function is a step function with marginal cost equal to $\underline{C}^e$ for $q \le q^{Li}$ where $q^{Li}$ is the quantity of the long-term contract, and marginal cost equal to $\overline{C}^e$ for $q > q^{Li}$ with $\overline{C}^e > \underline{C}^e$. Producer $i$ maximizes:

$$\max q_i^s (p^{ws} - \overline{C}^e - l) = q_i^s [\alpha - r - \bar{c} - \frac{(n+1)}{n}(q_1^s + q_2^s + ... + q_i^s + ... + q_n^s) - \overline{C}^e - l]$$

From first order condition we obtain:

$$q_i^s = \frac{n(\alpha - r - \bar{c} - \overline{C}^e - l)}{(n+1)^2}$$

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8 Recall that we have assumed that importers have regasification capacity in excess of the quantity sold, i.e. in excess of the quantity specified in the long-term contract.

and from this we derive the spot wholesale price:

$$p^{ws} = \frac{\alpha - r - \bar{c} + n\bar{C}^e + nl}{(n+1)}$$

Let $\Delta C^e = \bar{C}^e - \underline{C}^e$ and $\Delta a = a - \alpha$. If we compare the spot price with the wholesale price in a long-term contract we obtain:

$$p^w - p^{ws} = \frac{(a - r - l - \bar{c} - \underline{C}^e)}{2} - \frac{(\alpha - r - \bar{c} + nl + n\bar{C}^e)}{(n+1)} =$$

$$= \frac{(n-1)(\alpha - r - \bar{c} - \underline{C}^e) + 2(n+1)\Delta a - 2n(l + \Delta C^e)}{2(n+1)}$$

It is easy to see that either price can be lower according to parameter values and, in particular, according to the size of $\Delta C^e$ and $\Delta a$. If we set $\Delta C^e = 0$ and $\Delta a = 0$, the spot price is always lower than the long-term contract price since $(\alpha - r - \bar{c} - \underline{C}^e) > 0$. We know that $\Delta C^e$ can never be negative, while we don't know with certainty the sign of $\Delta a$ even if we would expect it to positive though small. (A negative $\Delta a$ would indicate that seasonal fluctuations are larger than "standard" demand) Then, if $\Delta a$ is small so that seasonal fluctuations are relatively large with respect to "regular" demand and the increase in production cost $\Delta C^e$ is large the spot price is higher than the price of long-term contract. Note that importers have idle capacity regasification so that they can take advantage of a spot price lower than the price of long-term contract to buy additional quantity. However, the analysis of strategic storage goes beyond the scope of the present model.

### *2.3.4* Competition between gas imported via pipe and LNG

In our last scenario we consider a situation where production cost of LNG have decreased to an extent such that LNG has lower cost than natural gas imported via pipe. This could be the result of two different situations. First, a conspicuous reduction in production, liquefaction, transportation, regasification costs of LNG. In alternative we could compare LNG with the cost of natural gas imported via a new pipeline. At the moment LNG is more competitive only for large distances, but this situation could easily change.

Suppose production costs are equal for LNG and gas imported via pipe and let denote them by $C^e$ Ce. If this is the case and considering that LNG market has a oligopolistic structure LNG price would be smaller than the price of gas imported via pipe. Indeed, if we look at the prices of LNG and of natural gas imported via pipe in the simplified setting with one group of consumers, it is easy to see that if we set $r = 0$ r = 0 and $l = 0$ in the expression for LNG price we have that gas imported via pipe is more expensive than LNG:

$$P^* = \frac{3a + c + C^e}{4} > \frac{2a + n(a + c + C^e)}{2(n+1)} = p^L$$

However, since natural gas is a homogeneous product if there is no capacity constraint it must be sold at the same price. This implies that LNG importers can profitably increase the quantity specified in the long-term contract "stealing" consumers to the importer via pipe. This in turn induces the importer via pipe to reduce its price until $P_I^* = p_I^L$. In other words, the importer of gas via pipe and the $n$ n LNG importers would compete in the same market facing a demand function equal to $Q^2 = (1+s)(a-P)$ where we keep the assumption $s = 1$ so that $Q^2 = 2(a-P)$ and $P = a - \frac{1}{2}Q$, where $Q = q_1^L + q_2^L + ... + q_n^L + q_{n+1}^P$ and $q_{n+1}^P$ is the quantity of the importer via pipe that we can assimilate to the other LNG importers. In this case the price of gas would be:

$$p(n+1) = \frac{(n+1)(a + c + C^e)}{2(n+2)}$$

It is easy to see that this is the lowest price that we derived in all scenarios.

This result is not surprising given that we have assumed away all liquefaction and regasification costs for LNG and now there is only one market for natural gas with no distinction between gas imported via pipe and LNG. This in turn implies that the number of firms in the market is higher and there is more competition in the downstream market.

## 3 Empirical analysis

In this paragraph the assumptions contained in the model will be tested with respect to the structure and the perspectives of the developing LNG market. Particular attention will be paid to the price dynamics. Every scenario will be discussed according to its peculiarity and its outcomes. In particular the following hypothesis will be considered:

- the possibility that operators on the LNG market will increase as it is foreseen in the second scenario;
- the perspectives regarding the development of a spot market as it is considered in the third scenario;
- the future cost break-even between LNG and pipe as it is evaluated in the last scenario.

As for the first scenario it is not necessary to test the assumptions on which the game is based since it is evident from the truth that the bilateral monopoly is the structure that best suits the European LNG market. The starting point of the empirical analysis will be represented by gas demand forecasts. The increase in demand is in fact the first condition to ensure the entrance of new competitors on the gas market.

### 3.1 Gas demand on the European gas market

Gas demand forecasts show a considerable increase from the present consumption level to the one foreseen in year 2030[9].

*Table 1 – Gas demand forecasts to 2030*

| **SECTORS** | **2007** | **2010** | **2015** | **2020** | **2025** | **2030** |
|---|---|---|---|---|---|---|
| Residential | 165,20 | 175,50 | 189,10 | 199,60 | 206,80 | 212,90 |
| Commercial | 59,60 | 63,20 | 68,40 | 72,60 | 76,80 | 80,70 |
| Industrial | 156,90 | 167,50 | 183,70 | 197,10 | 209,10 | 220,70 |
| Generation | 176,40 | 194,80 | 237,20 | 280,60 | 317,50 | 363,90 |
| **Total EU 30** | **558,10** | **601,00** | **678,40** | **749,90** | **810,20** | **878,20** |
| Other Balcans | 3,3 | 5,4 | 6,3 | 7,3 | 7,8 | n.d. |
| **Total EU 35** | **561,4** | **606,4** | **684,7** | **757,2** | **818,0** | **n.d.** |

Source: GI & EU, 2007. Bcm.

During the same period European import needs will increase because of the depletion of existing gas fields. By year 2025 Europe will in fact require almost 686 Bcm coming from external suppliers.

*Table 2 – Import necessity for Europe (30 countries)*

| | **2010** | **2015** | **2020** | **2025** |
|---|---|---|---|---|
| Demand 30 | 601,0 | 678,4 | 749,9 | 810,2 |
| Production 30 | 191,2 | 158,8 | 140,2 | 124,3 |
| **Import needs** | **409,8** | **519,6** | **609,7** | **685,9** |

Source: IEFE, 2008.

It is then of paramount importance to look for new supplies coming both from traditional export countries and new exporters. In this context LNG could significantly contribute to European security of supply.

In the next paragraphs the effects of LNG development on gas prices will be analyzed following the previously presented theoretical model.

### 3.2 Bilateral Oligopoly in the LNG market

In the current LNG market structure[10] (bilateral monopoly) where a single gas importer buys gas from a single gas exporter. In this scenario the model tells us that LNG is more expensive than piped gas.

[9] It has to be considered that gas demand forecasts significantly change according to different sources. In rare cases such as in one of the scenario recently elaborated by the European Commission gas demand is supposed to slightly decline due to the energy efficiency policies and to the development of renewable sources. Anyway gas production in traditional export countries is destined to decline leaving and signed contracts to expire leaving scope for the entrance of new operators on the market.

[10] Of course for “market” we mean every European country’s market structure.

The second scenario considers the same price to importers since producers still operate as monopolists for every single buyer. Nevertheless price decreases on the retail market provided that several LNG importers enter the market. The higher the number of new importers, the lower the final price.This scenario turns into a price for LNG that is lower than the price of piped gas. In particular the difference between LNG price and piped gas price decreases if the number of LNG operators increases and LNG costs decrease, otherwise the LNG incumbent would earn a rent and retail price would not be shrunk. In other words the entrance of new importers on the European LNG market is the fundamental condition in order to make LNG competitive.

As it is shown in Table 3 the number of new regasification plants is quite high. Speculative projects are projects for which the authorization process is yet to be started and whose construction is far from being sure. Planned plants are those for which the authorization has already been given and that often already hold an import contract for a part of their capacity.

*Table 3 – Regasification projects in EU30*

| **Country** | **Existent** | **Under construction** | **Planned** | **Speculative** | **Total** |
|---|---|---|---|---|---|
| Belgium | 1 | 1 | 0 | 0 | **2** |
| Cyprus | 0 | 0 | 0 | 1 | **1** |
| France | 2 | 1 | 0 | 1 | **4** |
| Greece | 1 | 0 | 0 | 0 | **1** |
| Italy | 1 | 1 | 3 | 3 | **8** |
| Netherlands | 0 | 0 | 1 | 1 | **2** |
| Portugal | 1 | 0 | 0 | 0 | **1** |
| Spain | 6 | 0 | 0 | 2 | **8** |
| Sweden | 0 | 0 | 0 | 1 | **1** |
| UK | 1 | 2 | 1 | 2 | **6** |
| Turkey | 2 | 0 | 0 | 0 | **2** |
| **Total** | **15** | **5** | **5** | **10** | **35** |

Source: IEFE, 2008.

Even if only considering planned and under construction investments it is possible to argue that the LNG market will be characterized by the presence of new competitors in the future. Moreover most of the plants are owned by subjects different from gas incumbents, often pretty new operators on the gas market. Therefore the assumption taken in the model regarding the development of an (at least) oligopolistic market in the LNG sector can be regarded as being valid and prices are supposed to decrease in the future. The possible decrease in LNG costs will be discussed afterwards.

### 3.3 Bilateral Oligopoly with an active spot market

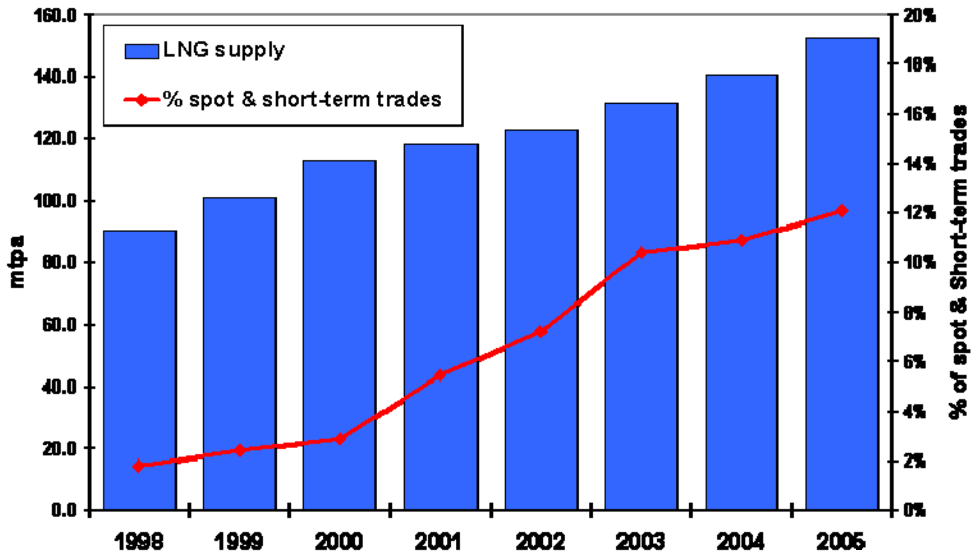
Since very often just part of the regasification capacity is covered by a long term take or pay contract and gas demand is subject to considerable seasonal fluctuations it is possible to assume that part of the requested gas is traded on the spot market.

The Italian natural gas transport society, Snam Rete Gas, has highlighted that, considering the lowest daily demand, likely to occur in spring or fall, and the highest one, occurring in the winter months (generally January or February), the former is on average half of the latter.

Long term import contracts do grant certain flexibility on both monthly and yearly off-takes but, due to unexpected cold winters or warm summers[11], the importer could have the necessity to buy further quantities of gas and to apply to the spot market. Spot transactions are in fact increasing. The theoretical model suggests that LNG price varies according to the size of seasonal demand fluctuations, resulting in a price higher than the one traded on the long term market, in case of huge imbalances between demand and supply. Nevertheless the development of a spot market could play a key role in making exporters compete among each other. Anyway it worth mentioning that competition on the supply side could occur provided liquefaction capacity exceeds LNG demand.

In the reality liquefaction capacity is supposed to be quite smaller than regasification capacity in the future: the latter could double the former (IEFE, 2008).

*Figure 1 – LNG spot trade evolution*




Source: Jansen, 2006.

It should be however considered that the progressive expiry of existing import contracts could free liquefaction capacity and make an active spot market development at least in the period necessary to renegotiate or contract a new supply which could be conspicuous according to high transaction costs.

[11] Gas fired power generation for space conditioning is increasing and is very likely to determine a summer peak, in additino to the winter's one, in gas demand.

As it is shown in Table 4, for instance, in year 2020 liquefaction capacity will be exploited at an utilisation rate of almost 46% compared to the current 90% rate due to old contracts expiry.

*Table 4 – Utilisation rates of liquefaction and regasification capacity to 2020*

| | | 2010 A | 2010 B | 2015 | 2020 |
|---|---|---|---|---|---|
| Liquefaction plants | Total Atlantic Basin | 77,44% | 60,27% | 53,61% | 46,01% |
| | Total Pacific Basin | 90,65% | 79,02% | 57,97% | 30,09% |
| | Total Middle East | 100,58% | 99,79% | 98,40% | 66,92% |
| | Total World | 89,52% | 78,98% | 66,81% | 46,32% |

| | | 2010 A | 2010 B | 2015 | 2020 |
|---|---|---|---|---|---|
| Regasification plants | Total Europe | 71,98% | 74,72% | 60,11% | 52,98% |
| | Total America | 25,61% | 14,10% | 12,91% | 12,49% |
| | Total Asia | 49,35% | 44,86% | 37,60% | 27,90% |
| | Total World | 46,48% | 35,95% | 28,13% | 23,99% |

Source: IEFE, 2008.

### 3.4 Competition between LNG and gas imported via pipe

The last scenario in the theoretical model foresees competition between LNG and piped gas. Price is a homogeneous good and for this reason it has to be sold at the same price.

In this case LNG importers can profitably increase their customers' base by stealing consumers to the pipe. The equilibrium price would be the lowest one.

In this paragraph the validity of this assumption is tested.

The table hereunder shows that, for the time being, the average border prices for countries importing via the LNG chain are higher than those for the countries exporting via pipe. The reference goes, in particular, to the average border price for Spain and France (respectively, the first and the second biggest importer of LNG in Europe), that are slightly higher than those of countries that do not resort to LNG (i.e. Germany) or do that just marginally (i.e. Italy).

LNG onerousness appears evident also by reading the table by columns, which shows that supplies from Algeria (via LNG), Qatar and Egypt are significantly more expensive than those reaching the European via pipe.

*Table 5 - Natural gas imports, average border price of some European countries. Data in $/MMBtu.*

| From / To | CIS | Nether. | Norway | Algeria LNG | Qatar LNG | Egypt LNG | Algeria pipe | Average |
|---|---|---|---|---|---|---|---|---|
| **Belgium** | - | 7,70 | 7,83 | 9,82 | - | - | - | **8,45** |
| **France** | 8,44 | 8,57 | 8,59 | 9,72 | - | - | - | **8,83** |
| **Germany** | 8,39 | 8,55 | 8,52 | - | - | - | - | **8,49** |
| **Italy** | 8,34 | 8,57 | - | 9,75 | - | - | 6,02 | **8,17** |
| **Netherlands** | - | - | 8,56 | - | - | - | - | **8,56** |
| **Spain** | - | - | 9.32 | 9,57 | 12,08 | 10,68 | 7,76 | **9,88** |
| **UK** | - | - | 8,42 | - | - | - | - | **8,42** |
| **Average** | **8,39** | **8,35** | **8,54** | **9,72** | **12,08** | **10,68** | **6,89** | |

Source: IEFE elaboration on WGI data (2007).

When assessing the competitiveness of LNG in comparison with pipeline, nevertheless, it must be borne in mind that both represent the sole transport stage of the chain; in fact, also gas extraction costs should be carefully evaluated. With regard to this, extraction costs for Europe’s main supplier of natural gas via pipeline, Russia, have significantly increased in recent years while those incurred by some of the producing countries usually exporting through the LNG chain are slightly lower (Stern, 2005). The latter issue is of great importance in evaluating the competitiveness of LNG over pipeline.

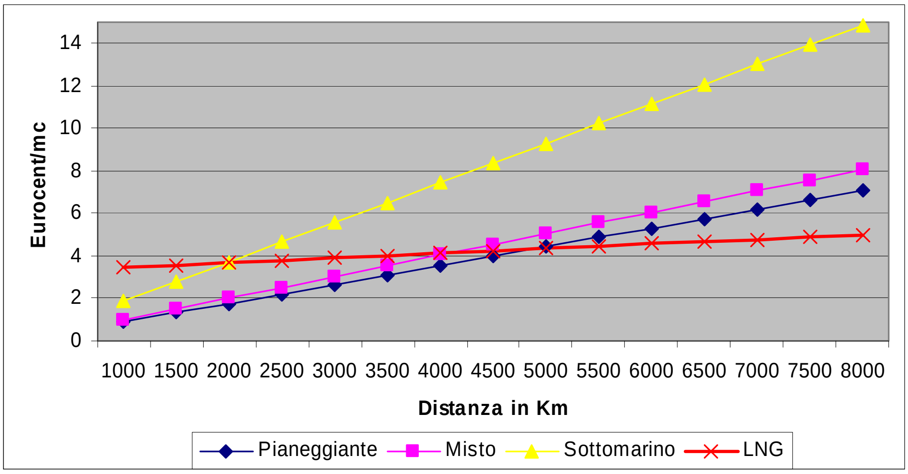
In fact if considering the sole transport the competitiveness of LNG can be appraised from the distance of 2,000-4,500 km according to different types of territories.

As for the whole chain competitiveness it is necessary to start from a few considerations:

- the main gas exporter via pipe in the world is represented by Russia;
- Russian internal demand is destined to sharply rise in the short and long run;
- demand from old and new importers will increase in the future.

Since production from old fields is being depleted it will be therefore necessary to cultivate new (marginal) fields. Investments aimed at increasing gas production are unfortunately higher than old ones due to technical and geological features. The Russian policy regarding production investments is at the moment not clear insofar as numerous head of agreements with international oil companies are continuously under revision and signed contracts regard just small part of forecasted production.

*Figure 2 – LNG/pipe Hoover's diagram*

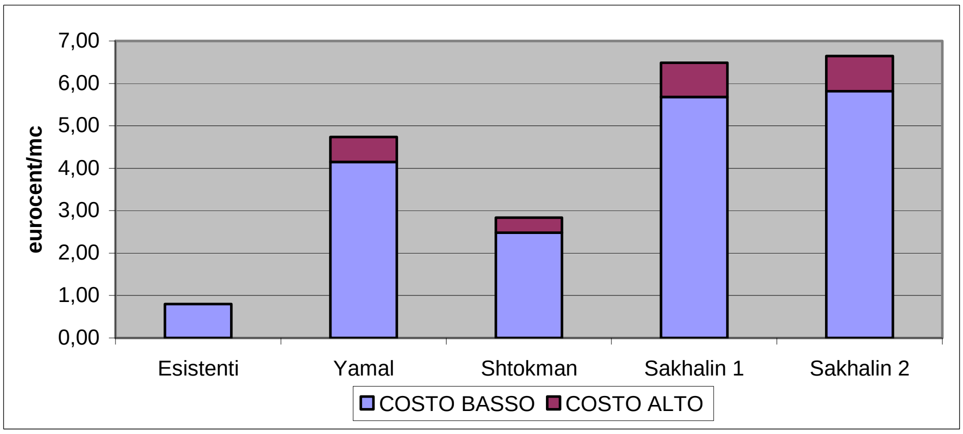



Source: IEFE, 2008.

All these variables contribute to make the piped gas import price to Europe increase as far as the raw material part of the gas value chain is concerned.

In fact, estimations show that production costs from new fields in Russia could be more than 6 times the current ones.

*Figure 3 – Production costs from Russian new fields*




Source: IEFE, 2008.

Considering the whole chain and comparing LNG costs with pipe costs it is then arguable that LNG coming from several exporting countries is likely to be cheaper than piped gas making plausible the assumption adopted in the last scenario of the model.

*Table 6 – LNG and piped gas future costs*

| GAS CHAIN | RUSSIA | EGYPT | QATAR | LIBIA | NIGERIA | ALGERIA |
|---|---|---|---|---|---|---|
| Extraction | 4,2 | 4,1 | 2,6 | 2,6 | 2,6 | 2,6 |
| Liquefaction | - | 1,7 | 1,7 | 1,1 | 2,1 | 2,4 |
| Transport | 4,0 | 0,8 | 1,9 | 0,6 | 1,9 | 0,6 |
| Regasification | - | 1,4 | 1,4 | 1,4 | 1,4 | 1,4 |
| **TOTAL** | **8,2** | **8,0** | **7,6** | **5,7** | **8,0** | **7,0** |

Source: IEFE, 2008.

## 4 Conclusions

The model has analyzed the effect of entry of LNG importers in the market for natural gas under different scenarios. First, we have examined a bilateral monopoly both for the gas imported via pipe and for the LNG that represents the current structure of the gas market, then we have examined the case in which several LNG importers enter the market so that LNG market structure is a (bilateral) oligopoly where each importer has a long term contract with a producer. The long-term contract between producer and importer rules out competition at producers' level. Then, in our third scenario we relaxed the assumption that the quantity specified in the long-term contract is sufficient to meet the whole demand faced by the importer and we assumed an active spot market for the LNG. Finally, we have assumed that LNG liquefaction cost, transportation and regasification cost can be reduced so that LNG can have lower production cost than gas imported via pipe. For each scenario, we have analyzed the market price for LNG and for the gas imported via pipe.

The main result of the model is that entry of LNG importers in the market for natural gas can have a positive competitive effect even if LNG has higher total cost, but only under some stringent conditions. The main of them can be summarized as follows:

- new competitors must enter the LNG market;
- an active spot market should develop;
- LNG cost should decrease.

The empirical analysis has shown that these conditions are very likely to be fulfilled in the future. In fact, projects relating to new regasification plants are numerous all around Europe, spot transactions are increasing and they could account for a higher share of LNG trade in the next year due to the expiry of the existing contracts and LNG costs will be lower than piped gas costs if considering the whole gas value chain and the expected increase in Russian gas production costs.

In the end it is possible to conclude that LNG could play a significant role in the liberalization of the European gas market.

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