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ANALYSIS OF COMPETITION & STRATEGIC INVESTMENTS IN THE LNG MARKET

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EXECUTIVE SUMMARY

The motivation for this thesis was the dramatic development in recent years of the LNG (Liquefied Natural Gas) trade, as an energy shipping market, and LNG's growing role in the world energy scene. LNG is an alternative way to transport natural gas by sea. Natural gas is liquefied under very low temperatures and transported with specialised LNG ships. The LNG chain also includes liquefaction plants located nearby the exporting ports, and regasification terminals located at the importing ports.

The LNG market is presented in this thesis and its special characteristics are described. This presentation covers, among other, LNG technology issues, the LNG market drivers, and the development of the LNG trade, while a focus is placed on LNG shipping. Another worth-mentioning aspect of LNG is its important role for the security of gas supply worldwide. LNG is highly influenced by geopolitics, rather than only market and economic factors.

The LNG market presents important idiosyncrasies, such as few players (an oligopolistic market), where the decisions of a market player are likely to significantly influence the position of other players, and the investments are capital intensive, while moreover it is a market in its early stages and under development. Game theory is identified as a methodology that can propose optimal strategies for the players involved in business contexts, but also in strategic interactions of geopolitical nature.

Game theory is concerned with how rational individuals make decisions when they are mutually interdependent. A strategic game is a model of interacting decision-makers. Game theory has found application in various fields in the last 50 years. A brief presentation of the game theoretic analysis framework is made, together with its aims and limitations, that further clarify the expectations from game theoretic models and from the outcome of the present thesis.

A literature review is undertaken concerning game theory and its applications. It covers the books that were studied to acquire the background game theoretic knowledge required for the purposes of this thesis, as well as papers and essays, which provide a fast-track overview of game theory and insights to its usefulness. Also, a number of papers are reviewed, in which game theory is applied to topics relevant to the present thesis, while analyses of the LNG market with the use of other methodologies are reviewed as well.

The first main set of contributions of this thesis is developed under the title "Analysis of competition and strategic investments in the LNG shipping business". The LNG market players considered in this context are providers of LNG shipping services (independent shipowners / LNG shipping companies). The analysis of competition and strategic investments in the LNG shipping business is undertaken using game theoretic concepts of progressive complexity. Appropriate examples and illustrations are employed to demonstrate the applicability of these concepts to realistic interaction settings in an LNG shipping market context.

This research contribution is innovative as it applies game theoretic structures and concepts for the analysis of competition and strategic investment problems that private investors are facing in the evolving and challenging LNG shipping business. Moreover, it is important because of the lack in the literature of methodological approaches answering such questions. It is not a research objective to provide readily available solutions to real problems faced by current or future stakeholders in the

LNG business. Instead, the main contribution is the development of a whole new rationale and of a novel framework of methodological analysis in this field. This methodological approach is a useful supplement to the intuition of a market player, as it helps in identifying right strategies given certain conditions.

A second main set of contributions of this thesis is developed under the title "The role of LNG in the formulation of national gas supply strategy". The decision makers are countries and governments, rather than private investors. Given its geopolitical dimension, as well as its importance for the security of gas supply regionally and internationally, LNG concerns decision-makers on a national planning level and in the formulation of gas supply strategies. As shipping companies are concerned with the development of competition and investment decision-making in the shipping segment of the LNG trade, national level decision-makers are facing similar challenges regarding the construction of regasification terminals to meet importing needs in their regions or liquefaction plants to serve their exporting strategic plans.

The game theoretic "scenario bundle method" is proposed as a decision-making, planning, and analysis tool for use by ministries, national or regional (e.g. EU level) authorities, national or international companies, and think-tanks, among other, in anticipation of future developments and in response to crisis events related to gas supply.

Two scenario bundle sets are developed for this purpose based on real-world regional strategic interactions, although it is not an objective to provide readily applicable solutions to such actual interactions. Scenario Bundles Set I concerns the security of gas supply and the role of LNG for the Greek market in a time horizon of 4 years. Scenario Bundles Set II is more complex and concerns the Caspian - Black Sea - SE European Gas Corridors and the LNG parameter in the year 2015.

The application of the scenario bundle method in the context of the security of gas supply demonstrates the usefulness of this tool in addressing national gas supply strategy questions. This methodology allows strategy formulation by taking into account the commercial objectives of the involved players, and considering geopolitical interaction, regional conflicts and crisis situations, or other major uncertainties regarding energy prospects. The LNG parameter is highlighted as a source of diversification in gas supplies to promote security. LNG as a trade option is far more flexible in response e.g. to political and commercial changes or crises.

The scenario bundle approach helps in identifying critical parameters in a systematic way, as a result of concrete logical steps. This analysis gives confidence that even in more complex scenarios, an analyst would reach useful conclusions of practical value, that could not be the outcome of intuition or of a qualitative assessment of the strategic interaction.

Overall, this thesis addresses the analysis of competition and strategic investments in the LNG shipping business, and similar interactions which demonstrate the role of LNG in the formulation of national gas supply strategy. The methodological tool used in both cases is game theory, which is proposed as a novel approach to the analysis of competition in this evolving energy shipping market and of strategic decision-making for actors involved in LNG. Also, suggestions for further research are made inspired by this research work.