論文の内容の要旨

【論文題目】

Geopolitics of Trans-boundary Infrastructure:

A Network Game Analysis of Natural Gas Pipeline Plans

（ネットワークゲームを用いた越境インフラストラクチャーの地政学的分析：

国際天然ガスパイプライン計画が相対的交渉力に与える影響）

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Natural gas is an important source of relatively low-emission and low-cost, non-nuclear, readily abundant energy, but the difficulty of storage and transportation adds a geopolitically and geostrategically complex aspect to the international trade of this resource. Most of global natural gas trade is through natural gas pipelines, which is an infrastructure that is strictly specific to the transportation of natural gas, and thus the very structure of its network can dictate the strategic relationship among countries involved in its trade.

This thesis has applied a network game model in which these pipeline networks are modeled as graphs and respective value functions, and employed the Link-based Flexible Network (LBFN) Allocation Rule as the solution concept. The LBFN Allocation Rule is an improvement over the Myerson Value, which is a network game application of the Shapley Value. This thesis interpreted the LBFN Allocation as the relative power structure, or the "Relative Bargaining Power" among these natural gas trading countries.

This thesis then conducted calculations and performed analyses on the case of trade between Russia, Ukraine, Belarus and Western Europe. The calibration was partially borrowed from existing work by Hubert and Ikonnikova (2011) which analyzed the same countries and employed a cooperative game model and the Shapley Value as the solution concept.

The results were then compared to Hubert and Ikonnikova (2011) in order to evaluate the analytical flexibility that the Network Game Model and the Link-based Flexible Network Allocation rule have over the Cooperative Game Model and the Shapley Value as a solution concept. While the latter was unable to model Ukraine and Belarus as consumers of natural gas as well as transit countries, and was also unable to model Western Europe as a strategic importing player, the Network Game Model allowed for this, as well as identified the power that each of the pipelines bestowed upon the players that governed these pipelines. A comparison was made between a setup using the Network Game and the Link-based Flexible Network Allocation Rule in which the

conditions closely replicated that of Hubert and Ikonnikova (2011) and the setup proposed in Nagayama and Horita (2012) in order to confirm that under similar conditions, the two models would yield similar results.

Further, this thesis searched for empirical evidence by assuming that a change in pipeline network structure or a "credible" pipeline plan affects the Relative Bargaining Power of countries within the network structure, and that the change in Relative Bargaining Power would be reflected upon the negotiations that these natural gas trading countries have. Both qualitative and quantitative analyses were conducted in order to confirm the degree to which the model employed in this paper is able to explain the complex string of events.

The paper was indeed able to identify a change in the relative price of natural gas between Western Europe and the two transit countries (Ukraine and Belarus) in the years after the announcement of the Nord Stream Pipeline, which was in line with what is predicted by the Relative Bargaining Power computed by the LBFN Allocation Rule for the Status Quo Scenario and the scenario in which Nord Stream Pipeline is built.

The paper was able to (i) model transboundary natural gas trade as a Network Game, (ii) apply the LBFN Allocation Rule and conduct computations, and (iii) find empirical evidence that the change in natural gas pipeline structure had an influence on bargaining power and the relative natural gas prices.