Overview

In order to ease the fiscal crisis originating from tight export policy towards Europe, Russia attempted for expansion towards Northeast Asian market. The far-east energy development has been realized via PNG supply contract between Russia and China in May 2014. Europe’s sanction against Russia increased the significance of Northeast Asian market expansion for Russia, putting an end to gas supply contract stalemate between China and Russia. The Russian-Chinese pipeline consuruction is signed $400 billion ‘Power of Siberia’, designed to supply natural gas to China after more than a decade of negotiations.

Northeast Asian market is gaining a spotlight as an alternative to export towards Europe, and Korea and Japan participation is a key factor for the additional development in the following regions: Chayandinskoye field, Kovyktinskoye field, Sakhalin gas field. Thus, countries like Korea and Japan, where there are great demands for natural gas but dependence on import is large, have many options to choose in obtaining Russia gas supply. In parallel to LNG export, Russia is pushing towards diversification of export methods by way of expanding towards Northeast Asian market. With Russia and China PNG supply contract being fulfilled, Korea and Japan is also poised to consider Russia’s PNG introduction.

Russia has been proceeded negotiations with Korea and Japan under consideration of North Korea as transit country. Since the Northeast Asian Pipeline network can indicates strategic relations of these countries, construction options need to be evaluated. This paper is first step towards the analysis of economic and geopolitics issues on the pipeline options in this region.

Methods

We use network game model to calculate the value of the link in the pipeline supply chain. The Link-Based Flexible Network Allocation Rule developed by Jackson(2005) as a solution of game is employed to capture the change of power structure by options. This solution concept can reflect the externalities and flexibility which doesn’t be considered in previous Cooperative Game and Shapley Value in the Hubbert and Ikonnikova(2011) accounting for the network structures that might have formed(Nagayama and Horita, 2014). We designs the possible network, which means that it isn’t realized yet, among the Russia, China, South Korea, North Korea and Japan, and then calibrate the value of the link and relative bargaining power between countries.

An allocation rule is a function $Y : G \times V \rightarrow \mathbb{R}^n$ such that $\sum_i Y_i(g,v) = v(g)$ for all $v$ and $G$. Jackson (2005) introduces the solution concept of flexible networks. An allocation rule $Y$ is a flexible rule if $Y_i(g,v) = Y_i(g^N, \emptyset)$ for all $v$ and efficient $B$ relative to $v$. A network $G \in G$ is efficient relative to value function $v$ if $v(g) \geq v(g')$ for all $g' \in G$. Thus, efficient networks are value-maximizing networks(Jackson, 2005; Nagayama & Horita, 2014). The Link-Based Flexible Network Allocation Rule is defined as

$$v^{LBFR}_i(g,v) = \frac{v(g)}{\theta(g)} \sum_{i=1}^{\#g} \frac{\theta(g) - \theta(g-i)}{\binom{n-1}{2}} \left( \frac{\#g!}{\binom{n-1}{2}} - \#g - 1 \right)$$

where $\#g$ denotes the number of links in $g$. Relative bargaining power proposed by Hubert and Ikonnikova(2011) can be defined as follows. Since the value of a given network is $v(g)$ and the allocation of value to a given player $i$ is $Y_i^{LBFR}(g,v)$, the Relative Bargaining Power of player $i$ is defined as

$$RBP_i^{LBFR}(g,v) = \frac{v_i^{LBFR}(g,v)}{v(g)}$$

The six links which compose Network in each scenario are Russia-China(RC), China-South Korea(CKr), Russia-
North Korea(RKp), North Korea-South Korea(KpKr), South Korea-Japan(KrJ) and Russia-Japan(RJ). Each scenario postulates network composed of coalition of links. All scenarios are presumed Russia to be a supplier and China, South Korea and Japan to be importers. 7 scenarios is built according to participation of importers and linkage structure of each link.

As each scenario shows, there is different network made by different linkage structure with same participating nations. Each scenario reflects network structure which has different linkage. It is more reality that grand coalition and complete network is not the most efficient, thus, alternative network which could form in the supply chain need to be included in the network game. This is a reason why Link-Based Flexible Network Allocation Rule is selected for allocating value in the network game.

Results

Network value increased when the additional link took place with participation of the other players, compared to Status quo. Through this we can find the form of cooperative game in which the players heightened the coalition value by cooperating with each other.

The values of links are evaluated and the relative bargaining powers are yield to gain the implication for each country. The linkage structure turns power structure of coalition and Relative Bargaining Power (hereinafter RBP) of each country in the supply chain. RBP indicates the share of each country possesses in each network scenario. The allocated value to the country differs based on the marginal contribution of each country because the necessity of each one varies based on the network structure. As a result, relative share is allocated differently in the network, which can be seen as a relative bargaining power. Through this, the analysis on the power structure within the network can be done regardless of the total value of the network. Basically, the necessity of a country is based on the geographical location, in which the network structure form makes geographic locational importance different.

In case of Russia, RBP was shown to be the highest when it halved the link value like Status quo and Exp-Korean. China achieves maximum RBP in West Stream due to the fact that China is at the center of the network. In case of South Korea and North Korea, RBP was shown at the maximum rate in North-expanded. This means that they could heighten both RBP and value allocated only when Japan is designated as a lower-stream state. RBP of Japan is shown to be the highest when it connects with Russia directly.

Conclusions

This paper is for the first approach to evaluate the value of the link and bargaining power of each country in the possible Northeast Asian pipeline network based on the Link-Based Flexible Network Allocation Rule.

The result shows that there is an increase in network value in the other scenarios compared to Status quo, which explains why there has been an on-going discussion among the other states in Northeast Asian countries after the contract being made between Russia and China.

The pipeline coalition that can be seen in this region could affect the value allocation to the states within the network based on the selection to linkage. This was pointed out as the network structure, and in case of Northeast Asian region, network game approach has been the useful method to reflect network externalities and flexibility.

Understanding the power structure among the states that lies within the linking structure has been conducted by evaluating the bargaining power and the value allocation to each country based on pipeline linking structure. The pipeline infrastructure construction is dependent on geographic condition, and with supply and demand being specified, it is inevitable that the power structure is created within the coalition. It would be not enough to evaluate only the economic aspect, the cost and benefit from the pipeline contract to understand this. In this research, the difference in bargaining power in each state depending on geographic location (upper-stream state and lower-stream state) could be found through pipeline linkage structure model through network game.

References

