Relationship between port charges and capacity investments under uncertain demand: A game theoretical approach

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1. INTRODUCTION

Recently, inter-port competition has been paid attention, especially in East Asian region. Regarding Japanese ports, the number of throughput has not grown during the last decade although the Eastern Asia has developed rapidly (e.g. Culinane and Song,2007.) In other words, Japanese port lost its position in East Asia. How this kind of inter-port competition should be evaluated from the point of social welfare?

To address the problem, the objectives of the study are following: We first construct a non-cooperative game model that represents the inter-port competition under demand uncertainty. We derive the unique Nash equilibrium and obtain some propositions by observing the equilibrium. Then, we apply the model to the case of port competition in East Asia and also show numerical calculations. Lastly, by using these obtained results, we find the policy implications and evaluate the market regarding inter-port competition in Ease Asia and also consider desirable port policies in Japan.

2. PREVIOUS RESEARCH

We find plenty of previous researches on pricing in wholesale electricity market. With respect to papers of port competition, we roughly classify three categories: The first is empirical-based approach, and the second is the model-based approach.

Regarding the first approach, Heaver(1995) is the representative paper. Notteboom and Yap(2012) conduct comprehensive survey, and pick up the factors that consist port competition. Second approach contains variety of methods such as DEA, stochastic frontier, time series, AHP and so on. We will show the detail at the presentation.

The third, Game theoretical approach, is roughly classified into two parts: Cooperative games and Non-cooperative games. Regarding former, we find papers such as Norde et al.(2002), Anderson et al.(2008), Saeed and Larsen(2010). On the contrary, non-cooperative game, we find papers such as Czerny et al (2011), De Borger et al (2008). Our model belongs to this category.

3. MODEL AND NASH EQILIBRIUM

To conduct the research, we develop a game theoretic model proposed by Ishii et al.(2013), which is our previous study, and explain the behaviour of each port from the points of price setting and capacity investment.

Our model has the following settings: 1) demand is stochastic; 2) two ports compete with each other in the market; and 3) the strategy of each port selects a port charge and a quantity of capacity investment. 4) Installed capacity is assumed to be liner.

We solve the problem and derive the equilibrium port charges and levels of capacity investments. The derived equilibriums in our model can be used as a benchmark to determine the throughput of each port, which is thought to be a factor influencing the port's competitiveness and social welfare. We also apply the case of inter-port competition in Ease Asian ports.

<u>The result of the derived equilibrium formulae and their implications will be shown at the conference.</u>

4. CONCLUSION AND FUTURE RESEARCH

The expected contributions are divided into three parts. First, we derive the Nash equilibrium. By observing the features of the equilibrium, we obtain propositions regarding the relationship between port charges and capacity. These propositions provide benchmarks of desirable levels of price and investment.

  Second, we also show the numerical examples by using the data of ports in East Asian region. These numerical calculations enable us to assess degrees of competition, to evaluate market performance, and to find some policy implications regarding port

competition. In addition, we also apply our findings to consider desirable port policies in Japan.

Repeatedly, we will show the details at the presentation.

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