

## Referee Report on “The optimal port privatization levels under inter-port competition: considering both horizontal and vertical differentiation”

The submitted paper considers competition between two “ports” under the standard demand functions which are derived by the standard utility function (e.g., Singh and Vives, 1984):

$$U(q_1, q_2) = \alpha(q_1 + q_2) - \frac{q_1^2 + q_2^2 + 2\beta q_1 q_2}{2},$$

where  $\alpha$  is a demand parameter and  $\beta \in (0, 1)$  is the degree of product/service homogeneity. The submitted paper introduces two costs of customers: the port charge of port  $i$ ,  $p_i$ , and the operational cost at port  $i$ ,  $T_i$ . In sum, the full price at port  $i$  is  $p_i + T_i$ . Owing to the additive property of the full price, the submitted paper sets the full prices of ports 1 and 2 as follows:

$$\begin{aligned}\theta_1 &= p_1 + T, \\ \theta_2 &= p_2,\end{aligned}$$

where  $T \equiv T_1 - T_2$ , which represents the service quality advantage (SQA) of port 2. The utility maximization problem leads to the inverse demand functions:

$$\begin{aligned}\theta_1 = \alpha - q_1 - \beta q_2, & \Rightarrow p_1 = \alpha - T - q_1 - \beta q_2, \\ \theta_2 = \alpha - q_2 - \beta q_1, & \Rightarrow p_2 = \alpha - q_2 - \beta q_1.\end{aligned}$$

The consumer surplus is given by

$$S = \frac{q_1^2 + q_2^2 + 2\beta q_1 q_2}{2}.$$

The profits of the ports are

$$\begin{aligned}\Pi_1 &= (p_1 - c_1)q_1 = (\alpha - T - q_1 - \beta q_2 - c_1)q_1, \\ \Pi_2 &= (p_2 - c_2)q_2 = (\alpha - q_2 - \beta q_1 - c_2)q_2,\end{aligned}$$

where  $c_i$  is the marginal cost of port  $i$  ( $i = 1, 2$ ). The objective of port 1 is to maximize its own profit,  $\Pi_1$ . The objective of the partially privatized public port (port 2) is to maximize the weighted sum of its own profit and *the consumer surplus*:

$$G = \delta \Pi_2 + (1 - \delta)(\Pi_2 + S), \tag{1}$$

where  $\delta$  is the degree of privatization. The total surplus (social welfare) is

$$W = \Pi_1 + \Pi_2 + S.$$

Under the model, the submitted paper derives the optimal degree of privatization, that is, it derives the value of  $\delta$  that maximizes  $W$ . The submitted paper also considers price competition by rearranging the inverse demand functions.

If the net efficiencies of the two ports ( $c_1$  and  $c_2 - T$ ) are equivalent, port 2 produces more than port 1 because the former takes into account the consumer surplus as well as its own profit. The weight of port 2's objective function on the consumer surplus,  $S$ , decreases with the degree of privatization,  $\delta$ . This implies that port 2 becomes less aggressive as the value of  $\delta$  increases. The effect of  $\delta$  depends on the service quality advantage (SQA) of port 2,  $T$ .

The main results are Propositions 1 (quantity competition outcome) and 3 (price competition outcome), those of which have similar properties: The optimal degree of privatization is negatively correlated with the service quality advantage (SQA) of port 2 (note that Propositions 2 and 4 are just corollaries of Propositions 1 and 3). If the efficiency/SQA of port 2 is low, the social planner whose objective is to maximize  $W$  sets a high  $\delta$  to diminish production by port 2. This is because the production shift from port 2 to port 1 induces efficiency improvement in the industry, leading to a welfare improvement. Therefore, the main results are quite intuitive.

The motivation of the submitted paper is nice given the recent trend of port privatization in the real world. However, the additional contribution and the plausibility of the model are questionable. I would like to comment on the submitted paper.

1. The submitted paper just gives some interpretation to the parameters of the standard duopoly model with firm heterogeneity. The essence of the competition in this paper was discussed by many papers although those related papers do not give concrete contexts to their models (e.g., Fujiwara, 2007 *Journal of Economics*). The model structure in the submitted paper is quite similar to those related papers in that the market structure in the submitted paper has been discussed in the related papers although the contexts are different. You should refer to those related papers carefully.
2. In addition, I am not sure whether the demand structure in the submitted paper properly captures the essence of port competition. The representative consumer (the representative port user) in the submitted paper is the only user of the "ports." So, it would be reasonable to interpret the port user as the exporter in the country. I do not think that the demand system does not nicely capture the important aspects of port competition (e.g., port users from third countries, exporters from foreign countries). In the related papers listed in the submitted

paper, for instance, Czerny et al. (2013) incorporates demands for two competing international ports by both domestic users in each country and third-country users who are represented by Hotelling line. I think that the demand structure in the submitted paper is too simple.

3. The objective of partially privatized public port is not so standard in the context of mixed oligopoly. The exceptions are Fanti and Buccella (2018 *Japan and the World Economy*) and the papers listed in their paper. You should carefully discuss why you employ the objective function because such a different formulation of the objective in itself causes different outcomes.

4. At least, the following two papers in Introduction are not listed in **References**:

Cui, H., Notteboom, T., 2017. Modelling emission control taxes in port areas and port privatization levels in port competition and co-operation sub-games. *Transportation Research Part D: Transport and Environment* 56, 110-128.

Matsushima, N., Takauchi, K., 2014. Port privatization in an international oligopoly. *Transportation Research Part B: Methodological* 67, 382-397.

5. There are several typos:

The first line in Section 3.1 (page 6): “Under simultaneous quality ...” → “Under simultaneous quantity ...”.

The second line in the second paragraph of Section 3.1 (page 6): “social welfare. With these” → “the consumer surplus. With these”.

The second inequality in Assumption 1 (page 7):  $T \leq c_2 - c_1$  would be  $T \geq c_2 - c_1$ .

## References (not listed in the submitted paper)

Fanti, L., Buccella, D., 2018. Corporate social responsibility and the choice of price versus quantities. *Japan and the World Economy* 48, 71-78.

Fujiwara, K., 2007. Partial privatization in a differentiated mixed oligopoly. *Journal of Economics* 92, 51-65.