

**Referee Report on “The Optimal Port Privatization Levels under Inter-port Competition:  
Considering Both Horizontal and Vertical Differentiation”**

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**Summary**

This study develops an inter-port competition model where one private port and one public port supply horizontally and vertically differentiated services. Using this model, it explores how the socially optimal ownership structure in the public port, in particular, how the differentiation between the ports works on determining the optimal degree of privatization. First, the paper examines the Cournot competition between the ports. It is shown that the optimal ownership structure in the public port becomes closer to full private ownership as the relative service quality of the private port rises. Second, proceeding to the Bertrand competition case, the paper shows the similar result.

**Major Comments**

- (1) In the introduction, the authors emphasize an important role of horizontal and vertical differentiation played in determining the optimal degree of privatization of state-owned ports. On the other hand, they do not describe how important an explicit consideration of the differentiation is under inter-port competition and what kind of new insights we can draw from the analysis. All we can read from the introduction section is that the contribution of the paper is to extend Cui and Notteboom (2017) by incorporating the two types of differentiation. At least to me, this extension does not seem important.
- (2) In addition to comment (1), I do not know whether it is plausible (i) that ports engage in Cournot competition and (ii) that there is vertical and horizontal differentiation under the inter-port competition. The authors should explain how the plausibility of (i) and (ii) can be supported, relating to some real examples, and empirical and theoretical results.
- (3) Measuring the operation costs of customers using ports 1 and 2 by  $T_1$  and  $T_2$  is highly understandable and agreeable. On the other hand, I cannot totally accept the introduction of  $T = T_1 - T_2$  to capture the relative service quality of port 1. I guess the authors believe that introducing  $T$

leads to some normalization. However, the belief is completely wrong. Indeed, the Cournot and Bertrand equilibria when  $T$  is applied are different from those when  $T_1$  and  $T_2$  are separately used. Let me present the Cournot equilibria of the former and latter cases. Plugging  $T = T_1 - T_2$  into equation (12) yields the equilibrium cargo volume in port 1,

$$q_1 = \frac{(1 + \delta)(\alpha - c_1) - \beta(\alpha - c_2) - (1 + \delta)T_1 + (1 + \delta)T_2}{2(1 + \delta) - \delta\beta^2}.$$

If the first-order conditions of ports 1 and 2 are calculated by using  $T_1$  and  $T_2$ , we have

$$q_1 = \frac{(1 - \beta + \delta)\alpha - (1 + \delta)c_1 + \beta c_2 - (1 + \delta)T_1 + \beta T_2}{2(1 + \delta) - \delta\beta^2},$$

which is not the same as the above equation. Accordingly,  $T$  does not correspond to any normalizations (in other words, relative service quality of port 1). Taking this into account, how can we interpret  $T$ ? Honestly speaking, I do not think that  $T$  is meaningful.

- (4) The failure to use  $T$  as a normalization device is easily explained. In a duopoly in which firms produce differentiated goods with different marginal-cost technologies, we usually redefine the demand size  $\alpha$  by  $\tilde{\alpha}_i = \alpha - c_i$ , that is, the demand size less the marginal cost of firm  $i$ . This typical method allows us to simply express the profit of firm  $i$  as  $\pi_i = p_i q_i$  (not as  $\pi_i = (p_i - c_i)q_i$ ). Of course, the reason why we can do this is that only the difference between the heights of the residual demand curve and the marginal cost curve does matter for the determination of the best-response of each firm. More essential is the units of variables: both  $\alpha$  and  $c_i$  measured in terms of dollars per output of good  $i$ . However,  $T = T_1 - T_2$  does not have the same structure:  $T_1$  is measured in terms of dollars per cargo volume at port 1, while  $T_2$  is measured in terms of those per cargo volume at port 2! So, we cannot regard  $T$  as a useful tool like  $\tilde{\alpha}_i$ . In addition,  $T = T_1 - T_2$  is as much weird computation as ‘3 (pounds) – 2 (inches).’ For a good usage of normalization, see Zanchettin (2006; JEMS).
- (5) The authors assume that a representative user of ports 1 and 2 has Singh and Vives’ (1984) type of utility function. I am not quite sure whether it is a plausible assumption. First, though this question may be a little bit trivial, why does the consumer use both ports? Once Singh and Vives’ utility function is introduced, the consumer should use the services provided by ports 1 and 2. However, transportation is typically subject to increasing return to scale: the average charge is likely to be lower when cargos are transported in the gross than when they are separately

transported. Second, what do the author mean by  $\beta$ ? In other words, what is the horizontal differentiation between ports? The degree of port service differentiation does not come to mind.

- (6) In what follows, I would like to provide my main critiques on the paper, in particular, on its modelling. The authors emphasize an importance of horizontal and vertical differentiation under inter-port competition. Despite the emphasis, they fail to properly incorporate the important point into their model. Following the authors' formulation, let me decide to use  $T$  (again, though I do not think it is sensible). Then redefine the utility function as follows:

$$\tilde{U}(q_1, q_2) = \alpha_1 q_1 + \alpha_2 q_2 - \frac{1}{2}(q_1^2 + q_2^2 + 2\beta q_1 q_2),$$

where  $\alpha_1 = \alpha - T - c_1$  and  $\alpha_2 = \alpha - c_2$ . Hereafter, we refer to  $\alpha_i$  as the net demand size of port  $i$ 's service. This definition allows us to simplify the profits, social welfare, and the payoff of port 2 as

$$\begin{aligned}\Pi_i(p_i, q_i) &= p_i q_i, & W(q_1, q_2) &= \tilde{U}(q_1, q_2), \\ G(p_1, p_2, q_1, q_2) &= \Pi_2(p_2, q_2) + (1 - \delta) \left( \tilde{U}(q_1, q_2) - p_1 q_1 \right),\end{aligned}$$

respectively. We can characterize the Cournot equilibrium by plugging the inverse demand functions into  $\Pi_1(p_1, q_1)$  and  $G(p_1, p_2, q_1, q_2)$  and by maximizing them. Analogously, we can characterize the Bertrand equilibrium by using the demand functions. Solving for the first-order conditions under Cournot competition yields

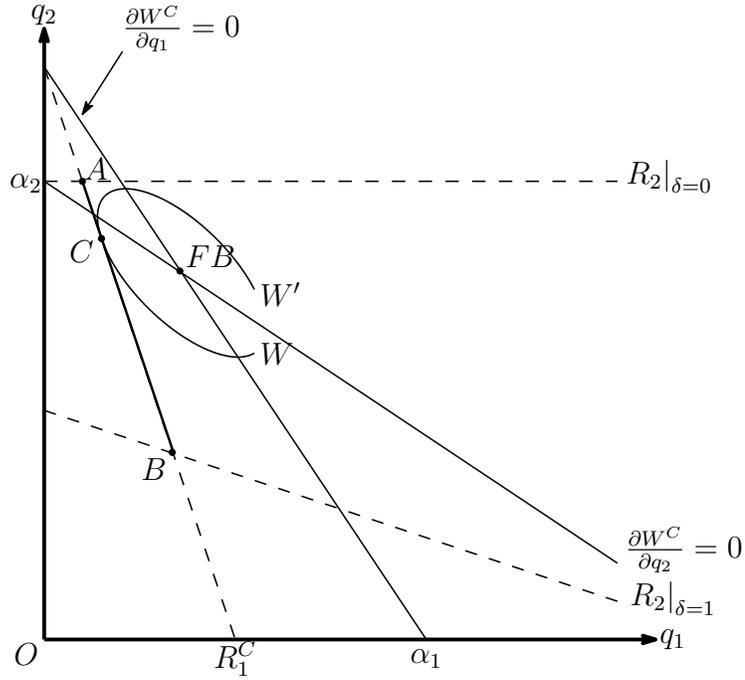
$$\begin{aligned}\tilde{q}_1^{C*}(\alpha_1, \alpha_2, \delta) &= \frac{(1 + \delta)\alpha_1 - \beta\alpha_2}{2(1 + \delta) - \beta^2\delta}, \\ \tilde{q}_2^{C*}(\alpha_1, \alpha_2, \delta) &= \frac{2\alpha_2 - \beta\delta\alpha_1}{2(1 + \delta) - \beta^2\delta}\end{aligned}$$

It is straightforward to see that  $\tilde{q}_i^{C*}(\alpha - T - c_1, \alpha - c_2, \delta)$  is the same as  $q_i^{C*}$  in equation (12).

The Bertrand equilibrium outcomes are

$$\begin{aligned}\tilde{p}_1^{B*}(\alpha_1, \alpha_2, \delta) &= \frac{[1 + (1 - \beta^2)\delta]\alpha_1 - \beta\alpha_2}{2(1 + \delta) - \beta^2\delta}, \\ \tilde{p}_2^{B*}(\alpha_1, \alpha_2, \delta) &= \frac{\delta[-\beta\alpha_1 + (2 - \beta^2)\alpha_2]}{2(1 + \delta) - \beta^2\delta},\end{aligned}$$

It follows from easy computation that  $\tilde{p}_i(\alpha - T - c_1, \alpha - c_2, \delta) + c_i$  is equal to the price in equation (16). Consequently, we can elicit several important facts from the above results. First,



the authors' model is equivalent to the differentiated mixed duopoly with asymmetric demand sizes, which have been already examined by many existing studies. From this viewpoint, there is no gainsaying that the paper provides small pieces of contribution. Second, in determining the optimal privatization policy, important are not the relative service quality  $T$  and the demand size  $\alpha$ , but the net demand sizes  $\alpha_1$  and  $\alpha_2$ .  $T$  and  $\alpha$  are just components of  $\tilde{\alpha}_i$ ! Thus, it is not essential at all that the optimal privatization policy is separately discussed in accordance with  $T$  and  $\alpha$ .

- (7) Once standing on the position that the authors' model is a simple differentiated duopoly, we can easily see that Propositions 1–4 are quite obvious and some of their claims are incorrect. For some pedagogical purpose, I would like to explain only the Cournot competition case. Figure 1 illustrates how the optimal policy is determined when  $\alpha_2$  is relatively large (i.e.,  $T$  is small). The intersection  $FB$  of schedules  $\partial W^C/\partial q_1 = 0$  and  $\partial W^C/\partial q_2 = 0$  indicates the first-best allocation. The line named  $R_1^C$  is the reaction curve of port 1, whereas the line named  $R_2|_{\delta=k}$  is that of port 2 for  $\delta = k$ . It follows from the monotonicity of port 2's reaction function with respect to  $\delta$  that the possible Cournot equilibria can be expressed by the segment  $AB$ . Anticipating this, the government induces the welfare-maximizing allocation by adjusting the degree of privatization. Apparently, the chosen allocation is point  $C$ , at which the iso-welfare

curve  $WW'$  touches the reaction curve of port 1. Since  $A$  and  $B$  respectively designate the Cournot equilibria under full nationalization and full privatization, it is concluded that partial privatization is optimal. Note that full privatization can be optimal if  $\alpha_1$  is sufficiently large. Indeed, in the case,  $FB$  goes in the south-east direction along the schedule  $\partial W^C / \partial q_2 = 0$ , so that the iso-welfare curve can touch the reaction curve of port 1 below  $B$ . This implies that full privatization is optimal. On the other hand, as easily inferred from the above figure, full nationalization is never optimal. The intuition is very clear. Suppose that port 2 is fully national one. The national port, which concerns with a consumer's utility, has a strong incentive to produce more aggressively than private port 1. As such, the service of port 2 is excessively supplied, because the consumer loves a variety of goods. This sort of distortion can be removed to some degree by replacing the service of port 2 with that of port 1 through a reduction in  $\delta$ .

- (8) Why is the result in comment (7) inconsistent with Proposition 1 and 2? The reason is that the subcases with respect to  $T$  or  $\alpha$  are not proper. For example, Proposition 1 considers three subcases  $T_1^c < T < T_3^C$ ,  $T_2^C \leq T \leq T_4^C$ , and  $T_4^C < T < T_2^C$ . Such a division of subcases is logically wrong. As easily verified,  $T_2^C$  and  $T_4^C$  are dependent on endogenous variable  $\delta$ . This implies that the domains indicated by the inequalities in Propositions changes as  $\delta$  changes. Indeed,  $T = (\alpha - c_1) - (2\beta/3)(\alpha - c_2)$  satisfies  $T_4^C < T < T_2^C$  if  $\delta < \frac{1}{2}$ , but does not otherwise. Moreover, Proposition 1 commits a meaningless statement. According to Proposition 1, the optimal policy is  $\delta = 0$  if  $T_4^C < T < T_2^C$ . However,  $\{T \mid T_4^C < T < T_2^C\}$  is empty for  $\delta = 0$ , since  $T_2^C = T_4^C = (\alpha - c_1) - \beta(\alpha - c_2)$ . I strongly recommend the authors to read some elementary texts of logics.
- (9) The authors presume Matsumura's (1998) type of partial privatization, though it is not mentioned in the paper. Matsumura (1998) defines the objective function of a partially privatized firm by the convex combination of its profit and the welfare. Then, regarding privatization as a reduction in the weight put on the welfare, he tries to investigate the optimal policy chosen by the welfare-maximizing government. This formulation indicates that a fully nationalized firm shares the same objective function with the government. On the other hand, the paper assumes that the governments maximizes the welfare, while the national port maximizes the sum of consumer surplus and its profit. Why do the authors introduce such a twist? More specifically, how can we

supplicate the difference of objective functions between the national port and the government?

### **Minor Comments**

- There is not Cui and Notteboom (2017) in the reference section, though Notteboom and Cui (2017) can be found.
- Matsushima and Takauchi (1998), which is cited in the introduction, cannot be found in the reference section. I guess there is not such a paper, because Takauchi was a high school student in 1998.
- I cannot find Matsumura (1998) in the main body of the paper. The reference section must not include the papers which are not referred. This is a very fundamental rule in writing papers.
- At page 6, it is stated that ‘the public port maximizes a weighted sum of its profit and social welfare.’ This statement is inconsistent with equation (10). Or, do the authors believe that the social welfare is defined by the profit plus the consumer surplus. If so, the social welfare is defined by equation (11), which is contradictory.
- Since the authors consider the possibilities that port 2 can be fully nationalized or privatized, the inequality  $0 < \delta < 1$  at page 6 should be  $0 \leq \delta \leq 1$ .