

## **Title: Cost-reduction innovation under mixed economy**

### **Discussion Paper No. 2015-68**

Thank you for your detailed and helpful comments. We would improve and clarify the manuscript accordingly. The followings are our replies and ways to reflect your comments.

This paper analyzes an oligopolistic industry where one firm is a regular private firm that maximizes its own profit while the second one is a (semi-) public firm that maximizes its own profits and some of the public's consumers' surplus. The innovation in this paper is that each firm dealing in cost reduction innovation which affects only its own costs. The main result is that the degree of the public ownership stimulates the output and innovation of the (semi-) public firm. Another interesting result is that the total output of the industry increases as the degree of the public ownership is increasing.

My comments are as follows:

1. Let's consider the two equations that follow eq. (9):

$$\text{Max}_{I_A} \Pi_A = q_A^2 - \frac{\tau}{2} q_A^2 + \frac{\tau}{2} q_B^2 - \frac{1}{2} I_A^2,$$

$$\text{Max}_{I_B} \pi_B = q_B^2 - \frac{1}{2} I_B^2.$$

The  $q_A$  and  $q_B$  are with no asterisk. But, the above two equations are the outcome of replacing  $q_A$  and  $q_B$  [from (5) and (6)] by equation (9). In addition, elaboration of the mathematical process will be helpful.

**Reply:** To be more precise, asterisks would be added in  $q_A$  and  $q_B$  in the two equations mentioned above. Also, we would try to provide more detailed elaboration of the mathematical process in the paper as suggested.

2. The object function of the (semi-) public firm is:

$$\Pi_A = \pi_A + \frac{\tau}{2} (q_A^2 + q_B^2 - 2\gamma q_A q_B)$$

Where the term:

$$CS = \frac{1}{2}(q_A^2 + q_B^2) + \gamma q_A q_B$$

is the consumers' surplus.

It is not clear why the total consumers' surplus is multiplied by  $\tau$  (the government share). It is reasonable that the government cannot affect the firm's decision when  $\tau$  is less than 50%, and it is possible to consider the total consumers' surplus when  $\tau$  is above 50%.

**Reply:** Notice that the total consumers' surplus is multiplied by  $\gamma$  but not  $\tau$  in the paper, while they stand for the degree of substitutability and the government share in the (semi-) public firm, respectively. Reasonably, consumers benefit from a higher degree of substitutability of the two goods. Generally speaking, a higher degree of substitutability implies more fierce competition in the market, thus leading to a lower price. Therefore, higher degree of substitutability corresponds to more consumer surplus, and that is why the total consumers' surplus is multiplied by  $\gamma$ .

3. It is well known that public firm is less efficient than a private owned firm. In this paper it is assumed that the level of efficiency is the same in both types of firms. I wondered what are results when the private owned firm is more efficient in general and in the innovation processes in particular.

**Reply:** We neglect the difference of efficiency between private firm and public firm, since it is not the major concern of the research. As stated by Barcena-Ruiz (2012), it is not necessarily that public firm is less efficient than a private owned firm. To simplify the analysis, we assume that public firm is as efficient as private firm in the paper. The assumption is the same as that in the study of Barcena-Ruiz (2012).

Meanwhile, it is worth investigating what would happen when private firm is more efficient than public firm. Based on the results of this paper, we would try to relax the assumption in further analysis as recommended in the comment.

4. The variable "I" gets the title "innovation" but does not possess any characteristics

of innovation, such as "patents", imitation, knowledge spill-over etc. It is actually investment in equipment to reduce the unit cost.

In conclusion: The paper is well written and the development of the model is done professionally. My main reservation is about the contribution of this paper to the existing theory. It is a nice extension of the current knowledge mainly by applying public firms' models into the well-known models of duopoly. My recommendation is to revise the paper and especially to consider my second and third remarks.

**Reply:** In this paper, the variable "I" represents innovation input, which is the same as many related literature like Gretz, Highfill, and Scott (2012). Here we neglect the characteristics of innovation, such as patents and imitation, to capture the effects of mixed oligopoly on innovation investment. As is known, R&D investment does help to reduce the unit cost or enhance the quality of production, which are similar to the effects of investment in equipment. For classification, we would try to introduce more characteristics of innovation in further studies.

Barcena-Ruiz, J.C. (2012). Privatization when the public firm is as efficient as private firms, *Economic Modelling*, 29(4), pp. 1019-1023.

R.T. Gretz, J. Highfill, and Scott R.C. (2012). R&D subsidy games: a cost sharing approach vs. reward for performance, *J Technol Transf*, 37, pp. 385-403.