Price-setting mixed duopoly, partial privatisation and subsidisation

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Abstract

This paper examines partial privatisation in a price-setting mixed duopoly model to reassess the welfare effect of production subsidies. It is shown that the result of this study is basically the same as that of the existing quantity-setting mixed market model.

Keywords: Partial privatisation; Price competition; Subsidisation

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1. Introduction

Recently, many researchers have done a lot of work on privatisation of public firms (e.g., Gronberg and Hwang, 1992; Anderson et al., 1997; Bosi et al., 2005; Chang, 2005; Chao and Yu, 2006; Han and Ogawa, 2008; Capuano and De Feo, 2010; Ohnishi, 2012; Bárcena-Ruiz and Garzón, 2017). White (1996) investigates how production subsidies influence the privatisation decision in a quantity-setting mixed oligopoly market and presents the following three main results. First, if production subsidies are utilised before and after privatisation, privatisation does not change economic welfare. Second, if production subsidies are utilised only before privatisation, there is a reduction in economic welfare. Third, the production subsidy contributes to overall efficiency in a mixed oligopoly market because of cost distribution effects. Poyago-Theotoky (2001) and Myles (2002) show that the optimal production subsidy is identical irrespective of whether (i) a public firm moves simultaneously with n private firms, (ii) it acts as a Stackelberg leader, or (iii) all firms behave as profit-maximisers.

The analysis by Fershtman (1990) examined a mixed duopoly model in which the government owned a partial share of a firm that was the Cournot competitor of a private firm. Since then, many researchers have contributed to the theoretical analysis of partial privatisation of state-owned public firms (e.g., Matsumura, 1998; Lu and Poddar, 2007; Saha and Sensarma, 2008; Artz et al., 2009; Wang et al., 2009; Heywood and Ye, 2010; Ohnishi, 2010, 2016; Wang and Lee, 2010; Chen, 2017; Heywood et al., 2017; Fridman, 2018). Tomaru (2006) studies partial privatisation in quantity-setting mixed oligopoly competition with subsidies and shows that the optimal subsidy and economic welfare are identical regardless of the level of privatisation of a public firm. In this paper, we examine a price-setting mixed market model to reassess the subsidy effect of partial privatisation.

The rest of this paper proceeds as follows. In Section 2, we describe the basic setting. Section 3 presents the result of this study. Finally, Section 4 concludes the paper.

2. Basic setting

Consider an industry composed of a private firm (firm 1) and a partially privatised firm (firm 0) which is jointly owned by both the public and private sectors. Both firms produce imperfectly substitutable goods. Throughout this paper, subscripts 0 and 1 represent firm 0 and firm 1, respectively. In addition, when i and j are used to represent firms in an expression, they should be understood to refer to 0 and 1 with $i \neq j$. We do not consider the possibility of entry or exit. The basic setting is taken from Bárcena-Ruiz (2007). Firm *i*'s demand function is given by

$$q_i = \frac{a(1-b) - p_i + bp_j}{1-b^2} \tag{1}$$

where $a > 0$, $0 < b < 1$, and p_i is firm *i*'s price. For simplicity, we assume $b = 0.5$. Firm *i*'s profit is given by

$$\pi_i = (p_i - c + s)q_i \tag{2}$$

where c denotes the total cost for each unit of output and s is the subsidy for each unit of output. Firm 1 aims to maximises (2). We assume $0 < c < a$ to assure that the firms' production levels are positive.

Economic welfare is given by

$$W = CS + \pi_0 + \pi_1 - s(q_0 + q_1) \tag{3}$$

where $CS = a(q_0 + q_1) - (q_0^2 + q_0 q_1 + q_1^2)/2 - p_0 q_0 - p_1 q_1$ represents consumer surplus.

Firm 0's objective function is given by

$$\begin{aligned} U_0 &= \lambda W + (1-\lambda)\pi_0 \\ &= \lambda\left[(a-c)q_0 + (a-c)q_1 - \frac{q_0^2 + q_0 q_1 + q_1^2}{2}\right] + (1-\lambda)(p_0 - c + s)q_0 \end{aligned} \tag{4}$$

where $\lambda \in [0,1]$ represents the level of privatisation. That is, if $\lambda = 0$ firm 0 is purely private, whereas if $\lambda = 1$ it is purely public.

The game model has two stages. In the first stage, the government sets the production

subsidy to maximise economic welfare for a given λ. In the second stage, both firms simultaneously and independently choose their prices. In this paper, we solve for the subgame perfect equilibrium through backward induction.

3. Main result

As usual, the game is solved by backward induction. Starting from the second stage, we obtain the reaction functions in prices of the two firms:

$$R_1(p_0) = \frac{a + 2c - 2s + p_0}{4} \tag{5}$$

$$R_0(p_1) = \frac{a + 2c - 2s - a\lambda - c\lambda + 2s\lambda + p_1}{4 - 2\lambda} \tag{6}$$

Furthermore, from (5) and (6), we derive the second-stage equilibrium prices in terms of s:

$$p_0(s,\lambda) = \frac{5a + 10c - 10s - 4a\lambda - 4c\lambda + 8s\lambda}{15 - 8\lambda} \tag{7}$$

$$p_1(s,\lambda) = \frac{5a + 10c - 10s - 3a\lambda - 5c\lambda + 6s\lambda}{15 - 8\lambda} \tag{8}$$

When setting $s = 0$ in (7) and (8), we obtain $p_0(0,\lambda) \le p_1(0,\lambda)$ with equality if firm 0 is completely privatised. As the level of λ rises from 0 to 1, firm 0 becomes interested in consumer surplus. Firm 0 has an incentive to charge a lower price than firm 1 and to sell more than firm 1 so as to raise consumer surplus. Therefore, without the production subsidy, firm 0's price is lower than firm 1's price while firm 0's output exceeds firm 1's output.

We now consider the first stage of the game. In the first stage, taking into account how firms will react to the subsidy, the government sets the subsidy to maximise (3). We obtain the welfare-maximising subsidy as follows:

$$s^* = \frac{a - c}{2} \tag{9}$$

Since $0 < c < a$, s^* is strictly positive, so that the government will always grant a

positive subsidy.

We obtain the following subgame perfect equilibrium values:

$$p_0(s^*,\lambda) = c = p_1(s^*,\lambda) \tag{10}$$

$$q_0(s^*,\lambda) = \frac{2(a-c)}{3} = q_1(s^*,\lambda) \tag{11}$$

$$\pi_0(s^*,\lambda) = \frac{(a-c)^2}{3} = \pi_1(s^*,\lambda) \tag{12}$$

$$W(s^*,\lambda) = \frac{2(a-c)^2}{3} \tag{13}$$

Note that the optimal subsidy achieves the first-best outcome in which price equals marginal cost. Also note that the equilibrium values do not depend on λ.

Now we can state the following proposition.

Proposition 1: The optimal subsidy, economic welfare, and firms' profits are identical regardless of the privatisation level of firm 0.

From this proposition, we find that our result is the same as that of the quantity-setting market model obtained by Tomaru (2006).

4. Conclusion

We have examined partial privatisation in a price-setting mixed duopoly game to reassess the welfare effect of production subsidies. We have shown that the optimal subsidy and both firms' profits are identical regardless of the share of the partially privatised firm that is owned by the public. In consequence, we have found that our result is basically the same as that of the existing quantity-setting mixed market model.

References

Anderson, S. P., de Palma, A., Thisse, J.-F., 1997. Privatization and efficiency in a differentiated industry. European Economic Review 41 (9), 1635-1654.

Artz, B., Heywood, J.S., McGinty, M., 2009. The merger paradox in a mixed oligopoly. Research in Economics 63 (1), 1-10.

Bárcena-Ruiz, J. C., 2007. Endogenous timing in a mixed duopoly: price competition. Journal of Economics 91 (3), 263-272.

Barcena-Ruiz, J. C., Garzón, M. B., 2007. Capacity choice in a mixed duopoly under price competition. Economics Bulletin 12 (26), 1-7.

Bárcena-Ruiz, J. C., Garzón, M. B., 2017. Privatization of state holding corporations. Journal of Economics 120 (2), 171–188.

Bosi, S., Girmens, G., Guillard, M., 2005. Optimal privatization design and financial markets. Journal of Public Economic Theory 7 (5), 799-826.

Capuano, C., De Feo, G., 2010. Privatization in oligopoly: the impact of the shadow cost of public funds. Rivista Italiana Degli Economisti 15 (2), 175–208.

Chang, W. W., 2005, Optimal trade and privatization policies in an international duopoly with cost asymmetry. Journal of International Trade and Economic Development 14 (1), 19-42.

Chao, C. C., Yu, E. S. H., 2006. Partial privatization, foreign competition, and optimal tariff. Review of International Economics 14 (1), 87-92.

Chen, T. L., 2017. Privatization and efficiency: a mixed oligopoly approach. Journal of Economics 120 (3), 251–268.

Fershtman, C., 1990. The interdependence between ownership status and market structure: The case of privatization, Economica 57 (227), 319-328.

Fjell, K., Heywood, J. S., 2004. Mixed oligopoly, subsidization and the order of firm's moves: the relevance of privatization. Economics Letters 83 (3), 411-416.

Fridman, A., 2018. Partial privatization in an exhaustible resource industry. Journal of

Economics 124 (2), 159–173.

Gronberg, T. J., Hwang, H., 1992. On the privatization of excludable public goods. Southern Economic Journal 58 (4), 904-921.

Han, L., Ogawa, H., 2008. Economic integration and strategic privatization in an international mixed oligopoly. FinanzArchiv 64 (3), 352-363.

Heywood, J. S., Hu, X., Ye, G., 2017. Optimal partial privatization with asymmetric demand information. Journal of Institutional and Theoretical Economics 173 (2), 347–375.

Heywood, J. S., Ye, G., 2010. Optimal privatization in a mixed duopoly with consistent conjectures. Journal of Economics 101 (3), 231-246.

Lu, Y., Poddar, S., 2007. Firm ownership, product differentiation and welfare. The Manchester School 75 (2), 210-217.

Matsumura, T., 1998. Partial privatization in mixed duopoly. Journal of Public Economics 70 (3), 473-483.

Myles, G., 2002. Mixed oligopoly, subsidization and the order of firms' moves: an irrelevance result for the general case. Economics Bulletin 12 (1), 1-6.

Ohnishi, K., 2010. Partial privatization in price-setting mixed duopoly. Economics Bulletin 30 (1), 309-314.

Ohnishi, K., 2012. Price-setting mixed duopoly, privatization and subsidization. Microeconomics and Macroeconomics 1 (1), 20-23.

Ohnishi, K., 2016. Partial privatization in international mixed duopoly with price competition. Hellenic Open Business Administration Journal 2 (1), 57-65.

Ohnishi, K., 2020. Price-setting mixed duopoly, subsidization and the order of firms' moves: the relevance of privatization. MPRA Paper No. 102847, University Library of Munich, Germany.

Poyago-Theotoky, J., 2001. Mixed oligopoly, subsidization and the order of firms' moves: an irrelevance result. Economics Bulletin 12 (3), 1-5.

Saha, B., Sensarma, R., 2008. The distributive role of managerial incentives in a mixed duopoly. Economics Bulletin 12 (27), 1-10.

Tomaru, Y., 2006. Mixed oligopoly, partial privatization and subsidization. Economics Bulletin 12 (5), 1-5.

Wang, L. F. S., Lee, J. Y., 2010. Partial privatization, foreign competition, and tariffs ranking. Economics Bulletin 30 (3), 2405-2012.

Wang, L. F. S., Wang, Y., Zhao, L., 2009. Privatization and the environment in a mixed duopoly with pollution abatement. Economics Bulletin 29 (4), 3112-3119.

White, M. D., 1996. Mixed oligopoly, privatization and subsidization. Economics Letters 53 (2), 189-195.