International trade and strategic privatization

Juan Carlos Bárcena-Ruiz* and María Begoña Garzón

Departamento de Fundamentos del Análisis Económico. Universidad del País Vasco

Abstract

The literature on mixed oligopoly does not consider that there is strategic interaction between governments when they decide whether to privatize their public firms. In order to analyze this question we consider two countries; in each country there is one public firm and n private firms. Firms have a constant marginal cost of production and the public firm is less efficient than the private firms. In this framework, we show that when the marginal cost of the public firms takes an intermediate value only one government privatizes its public firm and that government obtains a lower social welfare than the other.

Key words: international trade, public firms, privatization.

JEL classification: L33, Q28.

* Correponding author: Departamento de Fundamentos del Análisis Económico, Universidad del País Vasco. Avenida Lehendakari Aguirre, 83; 48015 Bilbao, Spain. Phone: (34) 94 601 38 29; Fax: (34) 94 601 37 74. E-mail: jepbaruj@bs.ehu.es

1. Introduction

One of the questions analyzed by the literature on mixed oligopoly is the decision by governments on whether to privatize their public firms. This analysis usually considers one country and one public firm (see, for example, De Fraja and Delbono, 1989, 1990; White, 1996; Pal and White, 1998) and there is thus no strategic interaction between governments. To fill this gap in literature, we shall analyze whether public firms are privatized when there is strategic interaction between governments.

The literature on mixed oligopoly (see De Fraja and Delbono, 1989, 1990) shows that when the cost function is convex, the government privatizes the public firm if the number of private firms is high enough; when the number of private firms is low enough, the government always prefers the mixed oligopoly. On the other hand, Bárcena-Ruiz and Garzón (2001a) show that, when firms have a constant marginal cost of production and the public firm is less efficient than the private firms, the government privatizes the public firm if the inefficiency of that firm is high enough; this inefficiency depends on the marginal cost of the public firm, on the number of private firms and on market size.

The preceding analysis has been extended to study whether governments privatize their public firms when there is international trade. See, for example, Fjell and Pal (1996), White (1996) and Pal and White (1998). It must be noted that these authors consider only one public firm and assume that firms sell their product only in one country (that in which firms are located). Bárcena-Ruiz and Garzón (2001b) assume a market comprising two countries and that there is only one public firm. They show that the decision by the government whether to privatize its public firm depends on the number of private firms located in each country; moreover, if both countries have the same number of private firms, the public firm will never be privatized. Although all these papers consider international trade in a framework of mixed oligopoly, they assume that there is only one public firm and, thus, there is no strategic interaction between governments when deciding whether to privatize their public firms.

In this paper we consider a market comprising two countries, with free trade. In each country there are one public firm and n private firms. Firms have a constant marginal cost of production and the public firm is less efficient than the private firms. Each government has to decide whether to privatize its public firm. We obtain that the two governments privatize their public firms when the marginal cost of the public firms is high enough since, in this case, the producer surplus has a greater weight in social welfare than the consumer surplus. When the marginal cost of the public firms is low enough the result is reversed; i. e. neither government privatizes its public firm. Lastly, when the marginal cost of the public firms takes an intermediate value only one government privatizes its public firm, and that government obtains lower social welfare than the other. In this last case, for some configuration of the parameters of the model, the profit of the public firm is greater than the profit of each private firm.

The paper is organized as follows. Section 2 presents the model. Section 3 shows the results and, conclusions are drawn in section 4.

2. The Model

We consider a world market comprising two countries, A and B. In each country there are one public firm and n private firms producing a homogeneous good. The government of each country has to decide whether to privatize its public firm or not. If one government privatizes, in that country there are $n+1$ private firms.

The inverse demand function for the product in country k is:

$$p = a - 2(q_{k0} - \sum_{i=1}^{n} q_{ki}), k = A, B,$$

where p is the price of the good in the world market, q_{k0} is the amount of the good produced by the public firm 0 in country k, and q_{ki} is the amount of the good produced by

private firm i in country k ($k=A$, B; $i=1$, ..., n). Therefore, the world inverse demand function for the product is:

$$p = a - q_{A0} - \sum_{i=1}^{n} q_{Ai} - q_{B0} - \sum_{i=1}^{n} q_{Bi} \; .$$

We consider that there is free trade and, thus, consumers from both countries can buy the product independently of the location of the firms. The two countries have the same inverse demand function and, therefore, the consumer surplus in country k, denoted by CS_k, is:

$$CS_k = \frac{1}{4} (q_{A0} + \sum_{i=1}^{n} q_{Ai} + q_{B0} + \sum_{i=1}^{n} q_{Bi})^2, \; k=A, B.$$

The private firms have a constant marginal cost of production which is normalized to zero. The public firm is less efficient than the private firms, so if it is privatized there is an improvement in efficiency.[1] The marginal cost of production of the public firm is constant and equal to c, where $0 < c < c^* = a/(3+2n)$.[2]

The profit function of firm i, located in country k, is:

$$\boldsymbol{p}_{ki} = (a - q_{A0} - \sum_{i=1}^{n} q_{Ai} - q_{B0} - \sum_{i=1}^{n} q_{Bi} - c_i) q_{ki}, \; i = 0, ..., n; \; k=A, B; \; c_i=0, \; \forall i \neq 0; \; c_0 = c. \quad (1)$$

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[1] This assumption is usually employed in the mixed oligopoly literature to avoid a trivial solution. If the public firm is more or equally efficient than the private firms the public firm would produce a quantity such that the market price equals its marginal cost, resulting in a public monopoly (see Pal, 1998 and Estrin and de Meza, 1995). Empirical evidence shows both the superior efficiency of private firms relative to comparable public firms (Mueller, 1989; Vining and Boardman, 1992), and the improvement in efficiency after privatization (Kikery *et al.* 1992; Megginson *et al.* 1994).

[2] Without loss of generality, we assume that $c < c^*$ to avoid irrelevant cases.

The social welfare function considered by government k comprises the consumer surplus in country k, CS_k, and the producer surplus in country k, PS_k. As usual, the producer surplus in country k is $PS_k = \sum_{i=0}^{n} \pi_{ki}$. Thus, the social welfare function considered by government k can be expressed as:

$$W_k = CS_k + PS_k, \; k=A, B. \tag{2}$$

The objective of this paper is to analyze whether the public firms are privatized when there is strategic interaction between governments. Therefore, we propose a two stage game with the following timing. In the first stage, each government decides, simultaneously, whether to privatize its public firm. In the second stage, each firm chooses its output level. We solve the game by backward induction from the last stage of the game to obtain a subgame perfect Nash equilibrium.

3. Results

In this section we shall analyze the decision by one government whether to privatize its public firm when the other government also has to decide whether to privatize its public firm. Given that there are two public firms that can be privatized, one in each country, there are four subgames in the first stage that, by symmetry, can be reduced to three. These three subgames are the following: neither of the governments privatizes its public firm (denoted by superscript *NN*), one government does not privatize while the other does (denoted by superscripts *NP* and *PN*, respectively), and the two governments privatize their public firms (denoted by superscript *PP*).

3.1. Neither government privatizes its public firm

In the second stage of the game, private firm i located in country k chooses the output level, q_{ki}, that maximizes its profit function; the public firm 0 located in country k chooses

the output level, q_{k0}, that maximizes the social welfare function of government k. Solving these problems simultaneously, we get the following result.

Lemma 1. When there is one public firm in each country, in equilibrium, the output level of the firms, the consumer surplus, the profit of the firms, the producer surplus and social welfare in each country are, respectively:

$$q_0^{NN} = \frac{a - c(1+2n)}{2}, \ q_i^{NN} = c, \ CS^{NN} = \frac{(a-c)^2}{4}, \ \pi_0^{NN} = 0, \ \pi_i^{NN} = c^2, \ PS^{NN} = n\,c^2,$$

$$W^{NN} = \frac{(a-c)^2 + 4nc^2}{4}, \ i=1, \ldots, n.$$

3.2. Only one government privatizes its public firm

In the second stage of the game, each private firm chooses the output level that maximizes its profit function; public firm 0 located in country k ($k \neq h$, k, $h = A$, B) chooses the output level, q_{k0}, that maximizes the social welfare function of government k. Solving these problems simultaneously, we get the following result.

Lemma 2. When there is only one public firm, in equilibrium, the output level of the firms, the consumer surplus, the profit of the firms, the producer surplus and social welfare in each country are, respectively:

$$q_0^{NP} = \frac{3a - 4c(1+n)}{5+2n}, \ q_i^{NP} = q_j^{PN} = \frac{a+2c}{5+2n}, \ CS^{NP} = CS^{PN} = \frac{(a(2+n)-c)^2}{(5+2n)^2},$$

$$\pi_0^{NP} = \frac{(3a-4c(1+n))(a-c(3+2n))}{(5+2n)^2}, \ \pi_i^{NP} = \pi_j^{PN} = \frac{(a+2c)^2}{(5+2n)^2},$$

$$PS^{NP} = \frac{a^2(3+n) - ac(13+6n) + 4c^2(3+6n+2n^2)}{(5+2n)^2}, \ PS^{PN} = \frac{(n+1)(a+2c)^2}{(5+2n)^2},$$

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$$W^{NP} = \frac{a^2(7+5n+n^2)-ac(17+8n)+c^2(13+24n+8n^2)}{(5+2n)^2},$$

$$W^{PN} = \frac{a^2(5+5n+n^2)+2acn+c^2(5+4n)}{(5+2n)^2}, \quad i=1, \ldots, n; \, j=0, \ldots, n.$$

3.3. The two governments privatize their public firms

In the second stage of the game, private firm i located in country k chooses the output level, q_{ki}, that maximizes its profit function. Solving these problems simultaneously, we get the following result.

Lemma 3. When the two governments privatize their public firms, in equilibrium, the output level of the firms, the consumer surplus, the profit of the firms and social welfare in each country are, respectively:

$$q_i^{PP} = \frac{a}{3+2n}, \quad CS^{PP} = \frac{a^2(1+n)^2}{(3+2n)^2}, \quad \pi_i^{PP} = \frac{a^2}{(3+2n)^2}, \quad PS^{PP} = \frac{a^2(1+n)}{(3+2n)^2},$$

$$W^{PP} = \frac{a^2(2+3n+n^2)}{(3+2n)^2}, \quad i=0, \ldots, n.$$

Once we have solved the different subgames, we have to solve stage one; i. e. we have to analyze whether each government privatizes its public firm.

3.4. The decision by the governments whether to privatize their public firms

By using lemmas 1, 2 and 3 we obtain the following result, which is useful to study the decision by governments whether to privatize their public firms.

Lemma 4. In equilibrium:

i) $q_0^{NN} > q_0^{NP} > q_j^{PP} > q_i^{NP} = q_j^{PN} > q_i^{NN}$, *i=1, ..., n; j=0, ..., n,*

ii) $CS^{NN} > CS^{NP} = CS^{PN} > CS^{PP}$,

iii) $max\{PS^{NP}, PS^{PP}\} > PS^{PN} > PS^{NN}$,

where $PS^{NP} > PS^{PP}$ *if and only if* $c < c^{PS}$, $c^{PS} = \dfrac{a(39 + 44n + 12n^2 - (5 + 2n)\sqrt{57 + 84n + 36n^2})}{8(3 + 2n)(3 + 6n + 2n^2)}$,

$c^* > c^{PS} > 0.$

The results obtained in this lemma are similar to that obtained in the literature on mixed oligopoly (see De Fraja and Delbono, 1989, 1990, and Bárcena-Ruiz and Garzón, 2001). But it must be noted that, in contrast to those papers, we consider two governments and two public firms instead of one government and one public firm; therefore, there is strategic interaction between governments when deciding whether to privatize their public firm.

By comparing the equilibrium output levels obtained in the three subgames, we get that $q_0^{NN} > q_0^{NP} > q_j^{PP} > q_i^{NP} = q_j^{PN} > q_i^{NN}$. Given that public firms choose the output level that maximizes the social welfare function of their governments, they are more aggressive in the product market than private firms. As a result, a public firm produces a greater output level than a private firm and, the more public firms there are in the market the lower the output level of the private firms will be. On the other hand, the output level of a public firm is greater if there are two public firms in the market instead of one, since when there is international trade, public firms behave strategically. When one public firm is privatized, the other public firm reduces its output level since, in this way, the latter increases its profit and the profit of the *n* private firms in its country. Thus, the producer surplus of its country increases, which has a greater weight than the reduction in the consumer surplus of the country.

Given that public firms are more aggressive in the product market than private firms, the highest industry output level is obtained when there are two public firms in the market, and the lowest is obtained when there are none. Therefore, taking into account that the consumer surplus increases with industry output level, we get that: $CS^{NN} > CS^{NP} = CS^{PN} > CS^{PP}$.

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Lemma 4 shows that $\max\{PS^{NP}, PS^{PP}\}>PS^{PN}>PS^{NN}$, and therefore the lowest producer surplus is obtained when there are two public firms in the market. The greatest producer surplus is not always obtained when all the firms are private; when the marginal cost of the public firm is low enough, $c<c^{PS}$, we obtain that $PS^{NP} > PS^{PP}$.

To explain the preceding result we must point out that $\pi_0^{NP}>\pi_i^{NP}=\pi_j^{PN}$ if and only if $c<c_1^{\pi}$, and $\pi_0^{NP}>\pi_i^{PP}$ if and only if $c<c_2^{\pi}$ $(i=1,\ldots, n; j=0,\ldots, n)$, where; $c_1^{\pi}=\dfrac{a}{4(2+n)}$,

$c_2^{\pi}=\dfrac{a((3+2n)(13+10n)-(5+2n)\sqrt{(3+2n)(19+18n)})}{8(1+n)(3+2n)}$ and $0<c<c_2^{\pi}<c_1^{\pi}<c^*$. Therefore, when there is only one public firm in the market, the profit obtained by that firm is greater if its marginal cost of production is low enough $(c<c_2^{\pi})$, because if one public firm is privatized market competition decreases. The total output level of industry decreases, but the output level of each private firm increases while the output level of the public firm decreases, and the profit of the public and private firms increase. Thus, when there is only one public firm in the market, its profit is greater if its marginal cost of production is low enough and, as a result, we obtain that PS^{NP} is greater than PS^{PP} when $c<c^{PS}$.

Next we shall solve the first stage of the game. From lemmas 1, 2 and 3 we obtain that $W^{NN}>W^{PN}$ if and only if $c<c_1$, and $W^{PP}>W^{NP}$ if and only if $c>c_2$, $c^* >c_2>c_1>c^{PS}>0$, where

$c_1=\dfrac{a(25+24n+4n^2-2(5+2n)\sqrt{6+2n+n^2})}{5+104n+84n^2+16n^3}$ and $c_2=\dfrac{a(51+58n+16n^2-(5+2n)\sqrt{77+96n+32n^2})}{2(3+2n)(13+24n+8n^2)}$.

It is easy then to obtain the following result.

Proposition 1. In equilibrium, the two governments privatize their public firms if $c_2 \pounds c < c^*$,

only one government privatizes if $c_1 \pounds c < c_2$ and neither government privatizes if $0 < c < c_1$.[3]

When the marginal cost of public firms is high enough ($c_2 \leq c < c^*$), in equilibrium, both governments privatize. We have seen in lemma 4 that CS^{NP} is greater than CS^{PP} and that, in this zone, PS^{PP} is greater than PS^{NP}. Given that the marginal cost of the public firms is high enough, the producer surplus has a greater weight in social welfare than the consumer surplus. Thus, both governments privatize their public firms.

When the marginal cost of public firms is low enough ($0 < c < c_1$), in equilibrium, neither government privatizes. We have seen in lemma 3 that CS^{NN} is greater than CS^{PN} and that PS^{PN} is greater than PS^{NN}. In this case, as the marginal cost of the public firms is low enough, the consumer surplus has a greater weight in social welfare than the producer surplus. Thus, neither government privatizes its public firm.

When the marginal cost of public firms takes an intermediate value ($c_1 \leq c < c_2$), in equilibrium, only one government privatizes its public firm. As we have seen in lemma 3, in this zone $CS^{NN} > CS^{NP} = CS^{PN} > CS^{PP}$ and $PS^{NP} > PS^{PP} > PS^{PN} > PS^{NN}$. If one government privatizes, the other government does not privatize since CS^{NP} is greater than CS^{PP} and PS^{NP} is greater than PS^{PP}. If one government does not privatize its public firm, the other government does privatize since, although CS^{NN} is greater than CS^{PN}, PS^{PN} is greater than PS^{NN} and, thus, the producer surplus has a greater weight than the consumer surplus in social welfare.

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[3] If firms have a convex production cost function and public firms are more inefficient than private firms the main result of proposition 1 holds. For example, if we assume $C(q_{ki}) = z q_{ki}^2/2$, where $z=1/3$ if the firm is publicly owned and $z=1/4$ if the firm is privately owned, the following equilibrium is obtained: if $n<2$, neither government privatizes; if $2 \leq n < 17$, only one government privatizes; lastly, if $n \geq 17$, both governments privatize. If public firms are equally efficient than private firms we obtain, assuming that $z=1/4$, that if $n \leq 5$ neither government privatizes; if $n>5$ only one government privatizes.

It is easy to see that W^{NP} is greater than W^{PN} when $c_1 \leq c < c_2$. Therefore, there is a prisoner's dilemma since each government wants it to be the government of the other country which privatizes its public firm. Thus, if the game were sequential (i. e. one government decides whether to privatize before the other government does), the government deciding first would not privatize its public firm and the other government would privatize. Therefore, the government deciding first obtains greater social welfare than the other government, and the profit of its public firm is greater.

4. Conclusions

The literature on mixed oligopoly has analyzed the decision by governments whether to privatize their public firms. This analysis usually considers one country and one public firm and, thus, there is no strategic interaction between governments. In this paper, we extend this analysis by assuming that there is strategic interaction between governments. We obtain that when the marginal cost of public firms is high enough the two governments privatize since, as the marginal cost of public firms is high enough, the producer surplus has a greater weight in social welfare than the consumer surplus. When the marginal cost of public firms is low enough, neither government privatizes. Lastly, when the marginal cost of public firms takes an intermediate value only one government privatizes, and that government obtains lower social welfare than the other.

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