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Mixed Oligopoly, Privatization and Strategic Trade Policy: a Note

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Abstract

In debates over privatization and global competition mixed Cournot oligopoly models have been used to show that the presence of a state-owned enterprise in the host country is always associated with a distortionary effect that may justify privatization even if the public firm is just as efficient as its private counterparts. This study argues that this result is valid only under Cournot competition and Cournot competition is not a plausible modelling assumption in this context because in this type of market the firms' simultaneous play strategies lack credibility.

JEL: D43, L33, L13

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1 Introduction

A standard result in the mixed oligopoly¹ literature associates the presence of a public enterprise in an imperfect market with a distortionary effect that may justify privatization even if the public firm is as efficient as its private counterparts. The introduction of international competition into the mixed Cournot oligopoly model leads to a more stronger result. In the presence of foreign competitors, the host country with a mixed market structure can always improve its welfare by privatizing the public enterprise and using a production subsidy (Pal and White 1998).

In a discussion of strategic trade policy, Bhagwati (1987) warns readers to be careful about the findings in that literature because “their policy recommendations are extremely sensitive to parametric assumptions and the nature of competition”. We believe this warning applies equally to the mixed oligopoly literature, where the type of competition has a crucial impact on the outcomes. Nevertheless, researchers who have applied these models have done little to check the robustness of

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¹A setting where a public firm with an objective that differs from maximizing the firm's profit competes with a limited number of private firms in provision of goods and services.

their results with respect to the timing assumption or to present a justification for their modeling assumptions².

This paper builds on the analysis by Pal and White (1998). We show that privatization improves welfare only if firms are engaged in Cournot competition. Then we extend the basic quantity-setting game to a preplay stage where each firm can choose not only the action but also the time of action. Our findings indicate that adopting a simultaneous play strategy, which is the key assumption of Cournot model, is inconsistent with the firms' preferences over the timing of action hence it lacks credibility. This allows us to provide an alternative explanation for the welfare gain of privatization in an international Cournot mixed oligopoly model.

2 The Basic Model

Consider a country with a domestic market for a homogeneous good produced by a single state-owned public firm, m domestic private firms and n foreign private firms. Demand is linear, $p = a - Q$, where Q is the total output, $Q = q_0^d + \sum_{i=1}^m q_i^d + \sum_{j=1}^n q_j^f$, q_0^d is the output of the public firm, $q_i^d, i = 1, \dots, m$ is the output of the i 'th domestic private firm and $q_j^f, j = 1, \dots, n$ is the output of the j 'th foreign firm. All firms share an identical production technology represented by a quadratic cost function, $c(q) = c + (k/2)q^2$ where $k > 0$ is a constant. As the number of firms is fixed and we are not dealing with entry/exit problem, we may set $c = 0$, with no loss of generality.

The domestic government uses a complete set of trade policy instruments including a subsidy of s per unit of a domestic firm's output and an import tariff of t per unit of foreign firm's output. If π_i^d denotes the profit function of i 'th domestic private firm and π_j^f denotes the profit function of j 'th foreign firm we have

$$\pi_i^d = [a - (q_0^d + \sum_{i=1}^m q_i^d + \sum_{j=1}^n q_j^f)]q_i^d - (k/2)(q_i^d)^2 + sq_i^d \quad i = 1, \dots, m, \quad (1)$$

$$\pi_j^f = [a - (q_0^d + \sum_{i=1}^m q_i^d + \sum_{j=1}^n q_j^f)]q_j^f - (k/2)(q_j^f)^2 - tq_j^f \quad j = 1, \dots, n \quad (2)$$

The domestic government and public enterprise maximize social welfare, defined as the un-weighted sum of the consumer surplus plus domestic firms' profits and tariff revenue less the cost of the subsidy:

$$W = CS + \pi_0^d + \sum_{i=1}^m \pi_i^d + t \sum_{j=1}^n q_j^f - s(q_0^d + \sum_{i=1}^m q_i^d) \quad (3)$$

where $\pi_0^d = p(Q)q_0^d - (k/2)q_0^{d2} + sq_0^d$ is the public firm's profit.

We assume a game that constitutes of two phases: regulation phase and action phase. In the regulation phase, the government anticipating the firms' behavior in the second phase, commits itself

²Exceptions to this are Pal (1998) Matsumura (2003) and Fjell and Heywood (2004).

to selected rates of its policy instruments to maximize domestic welfare. Then in the action phase, firms compete in quantities knowing the government's announced policy.

We consider three regimes which differ with respect to the behavior of the public firm and the timing of its move. Let label N as a standard international oligopoly regime where the public firm is privatized e.i. it maximizes its own profit, and competes with other firms under Cournot-Nash assumptions. In a mixed market structure there are two possible settings described and labelled as follows:

- (a) S , for mixed oligopoly with a dominant public firm: the action phase constitutes of two periods. In period 1, the public firm taking the selected rates of s and t as given sets its output to maximize (3) anticipating the private firms competition at the later stage. In period 2, $m + n$ domestic and foreign private firms choose their outputs to maximize their own profits knowing the announced levels of s and t and q_0^d .
- (b) C , for a mixed Cournot oligopoly in which the public firm sets its output simultaneously with private firms to maximize domestic welfare at the action phase.

3 The Results

Comparison of SPN equilibria in pure strategies in all above regimes leads to the following results:

Proposition 1) *In an international mixed Cournot oligopoly with strategic trade policy, privatization of the domestic public enterprise always enhances welfare of the domestic country. However, if the public enterprise acts as a Stackelberg leader in a quantity-setting game, privatization leaves unchanged the level of welfare of the domestic country as well as the optimal levels of tariff and subsidy. Furthermore, with a dominant public enterprise and strategic trade policy at equilibrium before and after privatization, all domestic firms produce where price is equal to marginal cost.*

(See Appendix for the proof).

Fjell and Pal (1996) state that “the marginal cost of the public firm equals the market price *if and only if* there is no foreign firm in the domestic market, or $n = 0$ ”. As we see in proposition 1, the public firm may follow marginal cost pricing even in the presence of a foreign firm provided that a complete set of trade and industrial policies instruments are available that matches all possible sources of distortion raised by the oligopolistic behavior of private firms. Also proposition 1 demonstrates the crucial role played by the timing assumption in Pal and White (Propositions 4.1 and 6.2, 1998). It asserts that when the government uses strategic trade policy, privatization improves welfare of the home country with a mixed market structure only if the public enterprise acts as a Cournot player. But if it has a first-mover advantage, we cannot expect any gain from privatization. In other words, the welfare gain of privatization can be fully explained by the timing assumption.

4 Towards a Rationale for the Timing Assumption

We focus now on an international mixed oligopoly in its simplest form. There is just one firm of each type; one domestic public firm, one domestic private firm and one foreign private firm. To make our model exactly the same as that of Pal and White (1998, Section 3), we set $t = 0$ i.e. the home government only uses a production subsidy.

Following Hamilton and Slutsky (1990), consider a hypergame consisting of two stages - a preplay stage and a basic stage as explained before- in order to study simultaneous versus sequential play (See Figure 1). In the preplay stage, firms decide at the same time whether to choose actions in the basic game at the first opportunity and move early, denoted by E , or to wait until observing their rival's action and move late, denoted by L . So the set of action times is $T = (E, L)$ and a combination of timing decisions is $\psi \equiv (\tau_0, \tau_p, \tau_f)$ where $\tau_i \in T$ and the subscripts $i \in \{0, p, f\}$ where $0, p$ and f stand for domestic public enterprise, domestic private firm and foreign firm respectively. The set of all possible timings is Ψ .

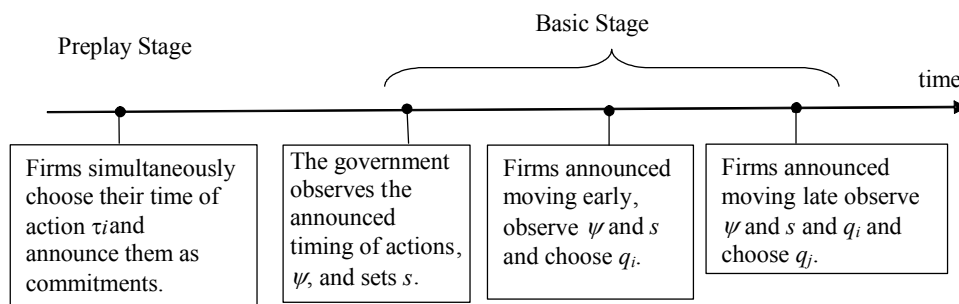


Figure 1: The extended game

The strategy of each firm $S_i = (\tau_i, q_i^\psi(s))$ is the product of T and Φ_i where Φ_i is the set of functions that maps the information set of each firm into the action set of that firm, A_i . Thus the strategy profile is $S = \Pi S_i$.

We do not need to consider all possible strategies of firms at the basic game in order to solve the game, because Nash equilibrium in subgames eliminates non-equilibrium output choices. Therefore, we can confine ourselves to Nash equilibria in subgames denoted by e^ψ . If there exists a unique SNP equilibrium for the extended game, that would be a self-enforcing equilibrium that Pareto dominates other feasible strategies at that subgame and dictates the natural order of play in the basic stage.

Proposition 2) *In an extended game of international mixed oligopoly with subsidization, the natural order of play is public Stackelberg leadership game.*

For simplicity in exposition, suppose $\alpha = 10$ and $k = 1$. Although this sounds restrictive, the results remain valid when α and k take any positive values. Table 1 shows the Nash equilibria in the subsequent subgames in this simple example.

Table 1: International mixed triopoly: a numerical example

I) Public firm moves early (E)			
		<i>Foreign Firm</i>	
		<i>Early</i>	<i>Late</i>
<i>Domestic Private Firm</i>	<i>E</i>	[33.96 15.4 1.92]	[34 11.95 2.16]
	<i>L</i>	[34.16 14.39 2.03]	[34 15.36 2.16]

II) Public firm moves late (L)			
		<i>Foreign Firm</i>	
		<i>Early</i>	<i>Late</i>
<i>Domestic Private Firm</i>	<i>E</i>	[33.96 10.29 1.92]	[33.96 8.6 1.92]
	<i>L</i>	[34.06 15.25 1.92]	[33.96 15.4 1.92]

The above payoff matrix shows that the simultaneous play, either in the early period, $e^{(EEE)}$, or in the later period of the basic game, $e^{(LLL)}$, cannot be the SPN equilibrium: in each one of these settings there exists at least one player that can unilaterally change its timing of action in a way that improves its payoffs. The SPN equilibrium of the extended game is $e^{(ELL)}$ where the public firm acts as a Stackelberg leader.

5 Conclusion

The intuition behind the above results is quite simple. If, following the founders of mixed oligopoly models (Merrill and Schneider, 1966), we consider the public enterprise as an instrument to regulate an industry from inside, then we should recall that “the necessary assumption is that the government can credibly commit to its policy choice before the firms make their choices... [this is] reflected by the assumption that the government moves first in the game tree ” (Brander, 1995).

If the firms’ conduct in an international mixed oligopoly is modelled by a public firm Stackelberg leadership game, the public firm is an effective policy instrument comparable with a production subsidy and subsidization is equivalent to the government itself choosing the firm’s output. Therefore assuming that change in ownership structure has no influence on the firm’s organizational efficiency,

the home country cannot gain from privatizing an efficient public enterprise and replacing it with a private firm regulated by a production subsidy.

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Appendix

The model is solved by backward induction. In period 2 of the action phase, maximizing (1) and (2) simultaneously we obtain the Nash equilibrium output for a given policy instruments s and t , and the public firm's output q_0^d ,

$$q_i^d(q_0^d, s, t) = \frac{(a - q_0^d)(k + 1) + s(n + 1 + k) + tm}{(k + 1)(m + n + 1 + k)} \quad i = 1, \dots, m \quad (4)$$

$$q_j^f(q_0^d, s, t) = \frac{(a - q_0^d)(k + 1) - t(m + 1 + k) - sn}{(k + 1)(m + n + 1 + k)} \quad j = 1, \dots, n. \quad (5)$$

In period 1, the public firm maximizes (3) anticipating the private firms' behavior in the second period for a selected rates of s and t . Finally in the regulatory phase, the government, taking into account how firms react to its policy choice, select s and t to maximize (3). The SPN equilibrium value of output per domestic firm and the strategic trade policies are:

$$i)q_0^{dS} = q_i^{dS} = \frac{2a(k+1)}{D}, ii)p^S = \frac{2ka(k+1)}{D}, iii)s^S = \frac{2a(k+1)}{D}, iv)t^S = \frac{ak(k+1)}{D}, \quad (6)$$

It can be checked that the SPN equilibrium solution of the all-private oligopoly setting is exactly the same as a mixed oligopoly with dominant public firm.

In the action phase of a mixed Cournot oligopoly, all firms set their outputs simultaneously for the given rates of t and s . From the simultaneous solution of the FOCs for internal solutions we have,

$$q_0^d(s, t) = \frac{(k+n+1)[a(k+1) - sm] - nmt}{(k+1)Z} \quad (7)$$

$$q_i^d(s, t) = \frac{(k+1)[ak + s(k+n+1) + nt]}{(k+1)Z} \quad i = 1, \dots, m \quad (8)$$

$$q_j^f(s, t) = \frac{ka(k+1) - t[(k+1)^2 + km] - skm}{(k+1)Z} \quad j = 1, \dots, n \quad (9)$$

where $Z = (k+1)(k+n+1) + km$. At the first stage of the game, anticipating the equilibrium behavior of the firms in the next stage, the government maximizes (3) with respect to s, t . The SPN equilibrium values of these variables are obtained from the solution of the government's problem that yields

$$i)s^C = \frac{a(k+1)[2(k+1) + n]}{H}, \quad ii)t^C = \frac{ak(k+1)^2}{H} \quad (10)$$

where $H = 2(k^3 + 1) + (2m+n)(k+1)^2 + 6k(k+1) + mn$. If we plug (10) in (7), (8) and (9), the SPN equilibrium level of the firms' outputs are obtained as

$$i)q_0^{dC} = \frac{a[2(k+1)^2 + k(n+1)]}{H}, \quad ii)q_i^{dC} = \frac{a[2(k+1)^2 + n]}{H}, \quad iii)q_j^{fC} = \frac{ak(1+k)}{H}. \quad (11)$$

From (6-*i*) and (11-*i*) we can conclude that $q_0^{dC} > q_0^{dS}$ and calculating (3) for all scenarios indicates that $W^S = W^N > W^C$.