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Environmental Policy and Consumer Awareness on the Impact of Privatization

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Abstract: This study tries to combine the environmental policy and privatization to establish a mixed oligopoly model with pollution abatement and consumption externality. The public enterprise is one of the upstream pollution abatement manufacturers and downstream retailers have to face the problem of consumption externality. It gets the following two major results: First, in a maximum social welfare condition, the more retailers exist, the more possibility to perform privatization; on the other hand, if there are few retailers and more upstream private firms exist, then it is still good for privatization. Second, in a maximum social welfare condition, when the consumption externality decreases, the downstream retailers can also become less and privatization, or the upstream private firms has to become more.

Key words: Environmental policy, consumer awareness, privatization

INTRODUCTION

Recently, the economics changes dramatically. There are so many private firms have been nationalized. For example, the United real estate's companies, like Freddie Mac and Fannie Mae were nationalized during the financial crisis in 2008. In the meanwhile, the US government also overcharged the auto industry and the financial industry so that those industries can survive better.

On the other hand, the environmental protection and green marketing have become important issues. The United Nations held the climate conference in Cancun, Mexico, on November 29, 2010. After this agreement, the 100 billion green climate fund has been funded to combat the greenhouse effect and to help the developing countries protecting their forest. In the same year, The United Nations also held the meeting for biological diversity in Nagoya to encourage most of the countries to participate the sustainable development Conference in 2012. The above events show how important this issue could be. The awareness of consumer for the environmental protection is arising, the excessive packaging of products or non-environmentally friendly products cause tremendous environmental pollution which is not accepted by consumers due to they do not want to pay extra for consumption externalities. When any country export those non-eco related products exports may be subject to the environment trade policy sanctions. Such as, EU regulates electronic products must contain

more than 10% recycled plastic. EU also regulates the carbon dioxide emissions. For those countries which produced higher carbon dioxide, they have to pay heavy taxes. Therefore the issue of using recycled resources and the reducing carbon dioxide become important issues in trade policy.

This study attempts to join the point of view of environmental policy and focus on issues related on privatization. And this is the main reason for the author to writing this study.

From the Literature Review, most of the researches focused the privatization by using the mixed oligopoly model. There are also many issues related with pollution. Simpson (1995) derivates Cournot duopoly to discussion the optimal pollution problem to concluded that if firms have different production costs, the optimal pollution tax rate may exceed pollution marginal damage. Yin (2003) said, when the external potential pollution exists, if the number is large, sewage charges levied on these pollution firms (effluent levies) does not necessarily lead to social deadweight loss. In order to explore the relationship between privatization and the environmental pollution, (Ohori, 2004, 2006; Barcena-Ruiz and Garzon, 2006; Wang and Wang, 2009) compare with mixed and pure oligopoly under the environment policy. Beladi and Chao (2006) survey privatization issues related to how to improve the environment and the possible reasons maybe lack of efficiency of public firm led the failure of the pollution control¹. Wang and Chiou (2010) found out that the public firm may neither cut the production nor improve the

¹Vickers and Yarrow (1991) say that management inefficiencies lead to pollution abatement and control efficiency of the public firm worse than the private ones, Bradburg (1995) say that the public firm's high labor production costs lead to poor efficiency of pollution abatement

environment by using different environmental marginal damage function. Kato (2006) compared the tradable and non-tradable of emission permit in mixed oligopoly model to the impact of welfare. Cato (2008) observed the pollution emissions generated in the production process, the results show that, even if there are many producers in the market, the mixed oligopoly social welfare is still better than pure oligopoly when the externality is sufficiently large. Barcena-Ruiz and Garzon (2006) designed firms' pollution abatement. Canton *et al.* (2008) based on the pollution abatement to design the vertical production issues related to the optimal environmental tax according to those upstream wholesales who do the pollution abatement.

Therefore, to maximize and sustain the social welfare of the government's environmental policy, this study wants to take the environmental pollution into the mixed oligopoly model account. The purpose of the public firm is to maximize the welfares, therefore, there is only one public upstream wholesaler but many private upstream wholesalers in vertical industrial system of production. In this case, all of the upstream firms do the pollution abatement in the meanwhile downstream retailers face problems of the consumer externality. The purpose of this research is to discover the impact of the policy on the environmental pollution tax policy and the behavior of different firms to cope with the problem of the privatization.

Basic model hypothesis: It assumes that this is a mixed oligopoly with one public firm and n private wholesales firms and m private retails firms in the domestic market. All the firms, both the public and the private firms, produce homogeneous products with Cournot competition in the market. The total utility functions is $U = Q - SQ^2/2 + 1$:

Where:

$$Q = q_0 + \sum_{i=1}^n q_i = \sum_{j=1}^m q_j$$

is the aggregate market demand, q_0 , q_i and q_j are the respective production quantities of the public firm and other private firms. s is response the consumer awareness, the bigger the consumption, the higher the cost of the manufacture of packaging and shipping waste disposal. It assumes that the $s > 1$, 1 is the utility of numerate goods. The market demand is $p = 1 - sQ$ where p stands for the market price. There are the same cost structure²

of the public and other private firms are, respectively³ $C(q_i) = q_i^2/2 + f$, $l = 0$, i where f is the fixed cost, there is no any shipping or storing cost in the downstream market but the unit of wholesale price w . Following Barcena-Ruiz and Garzon (2006), there is the unit product with unit pollution and partial pollution abatement α_i , $l = 0$, i in the upstream market, the pollution abatement cost is quadratic form $q_i^2/2$. The government charge the residual pollution $q - a$ with tax rate t , the total tax revenue is:

$$T = t[(q_0 - a_0) + \sum_{i=1}^n (q_i - a_i)]$$

The environment damage function is setting as:

$$ED = \frac{[(q_0 - a_0) + \sum_{i=1}^n (q_i - a_i)]^2}{2}$$

It assumes that the public firm is a maximum social welfare firm before privatization.

The profit functions of firms are:

$$\pi_0 = wq_0 - \frac{1}{2}q_0^2 - t(q_0 - a_0) - \frac{1}{2}a_0^2 - f \tag{1}$$

$$\pi_i = wq_i - \frac{1}{2}q_i^2 - t(q_i - a_i) - \frac{1}{2}a_i^2 - f \quad i = 1, \dots, n \tag{2}$$

$$\pi_j = (p - w)q_j, \quad j = 1, \dots, m \tag{3}$$

It is assumed that the consumer surplus is $CS = (1 + s)Q^2/2$. Then, the domestic social welfare function is the summation of all the firms' profit functions plus the consumer surplus, the total tax revenue and mines the environment damage function. Thus it could be express their objective function as:

$$SW = CS + \pi_0 + \sum_{i=1}^n \pi_i + \sum_{j=1}^m \pi_j + T - ED \tag{4}$$

In the following section, discussion proceeds to the interaction among firms and the government's optimal policy within mixed or pure oligopolistic equilibrium.

DECISION OF THE PRODUCT AND THE OPTIMAL TAX RATES

Mixed oligopoly: To achieve the market equilibrium, the respective optimal production quantities for the public

²Fjell and Pal (1996) and White (1996) also assumed that all the firms, including the public and the private ones, have the homogeneous cost function

³De Fraja and Delbono (1989) also assumed that all the firms, including the public and the private ones, have increasing marginal cost function. Under this assumption, that the completely state-owned enterprise supplies all the market demand is not the optimal policy

firm and other private firms; the retail firm maximum problem is to solve:

$$\frac{\partial \pi_j}{\partial q_j} = -2sq_j + 1 - w - \sum_{h=1}^{m-1} q_h = 0, \quad j=1, \dots, m, \quad h \neq j \quad (5)$$

From Eq. 5 and homogeneous goods setting, the retail quantity is:

$$q_j^* = \frac{1-w}{s(m+1)}, \quad j=1, \dots, m \quad (6)$$

according to Eq. 6, the retail profit, the derived demand for wholesales price and the total profits for the retail market are:

$$\pi_j = s \left[\frac{1-w}{s(m+1)} \right]^2, \quad j=1, \dots, m, \quad w = 1 - \frac{s(m+1)}{m} Q$$

$$\sum_{j=1}^m \pi_j = sm(q_j)^2 = \frac{sQ^2}{m}$$

By the way, the profits of the public and private firms in the wholesale market are:

$$\pi_0 = \left[1 - \frac{s(m+1)}{m} Q \right] q_0 - \frac{q_0^2}{2} - t(q_0 - a_0) - \frac{a_0^2}{2} - f$$

$$\pi_i = \left[1 - \frac{s(m+1)}{m} Q \right] q_i - \frac{q_i^2}{2} - t(q_i - a_i) - \frac{a_i^2}{2} - f, \quad i=1, \dots, n$$

the wholesales firm maximum problem is to solve:

$$\frac{\partial SW}{\partial q_0} = 1 - \left[\frac{s(2m+3)}{2m} + 1 \right] q_0 - \left[\frac{s(2m+3)}{2m} + 1 \right] \sum_{i=1}^n q_i + a_0 + \sum_{i=1}^n a_i = 0, \quad i=1, \dots, n \quad (7)$$

$$\frac{\partial SW}{\partial a_0} = q_0 - 2a_0 + \sum_{i=1}^n (q_i - a_i) = 0, \quad i=1, \dots, n \quad (8)$$

$$\frac{\partial \pi_i}{\partial q_k} = 1 - \frac{s(m+1)}{m} q_0 - \left[\frac{2s(m+1)}{m} + 1 \right] q_i - \frac{s(m+1)}{m} \sum_{k=1}^{n-1} q_k - t = 0, \quad i=1, \dots, n, \quad k \neq i \quad (9)$$

$$\frac{\partial \pi_i}{\partial a_i} = t - a_i = 0 \quad (10)$$

From Eq. 7-10 and homogeneous goods setting, the results of the wholesale quantities and pollution abatements are:

$$q_0^* = \frac{m[(2+2s-n)m - (n-2)s] + mnt\{(4+n)s + [2+(3+n)s]m\}}{(m+3s+2ms)(m+s+ms)} \quad (11)$$

$$a_0^* = \frac{2m - nt(3+2m)s}{2(m+3s+2ms)} \quad (12)$$

$$q_i^* = \frac{m(m+s) - mt\{(3+n)s + [1+(2+n)s]m\}}{(m+3s+2ms)(m+s+ms)}, \quad i=1, \dots, n \quad (13)$$

$$a_i^* = t, \quad i=1, \dots, n \quad (14)$$

According to Eq. 11 to 14 results into the social welfare function and maximizing the objective of the government, or the social welfare it can achieve the optimal tax rate of pollution abatement:

$$t = \frac{2m \left(\frac{2m^3(-1+n) + m^2(n(5+n) + m(-4+n(2+n)))s}{4m^4(1+2n) + 2m^3(2(1+n)(7+2n) + m(10+n(15+4n)))s} + \frac{m^2(62+n(53+2n(9+n)) + 2m^2(17+n(17+n(7+n)) + 4m(23+n(21+n(8+n))))s^2}{+2m(1+m)(24+9n+m(34+13n+m(12+5n)))s^3 + (1+m)^2(3+2m)^2(2+n)s^4} \right)}{\dots} \quad (15)$$

and social welfare level:

$$SW = \frac{m \left(\frac{4m^3(-2+n+n^2) + 2m^2(2+n)(2(1+n)(5+n) + m(2+n(5+n)))s}{8m^4(1+2n) + 4m^3(2(1+n)(7+2n) + m(10+n(15+4n)))s} + \frac{m^2(2+n)(22+6m^2 - (-3+n)n + 4m(7+n))s^2 + 4(1+m)^2(3+m)(2+n)s^3}{+2m^2(62+n(53+2n(9+n)) + 2m^2(17+n(17+n(7+n)) + 4m(23+n(21+n(8+n))))s^2}{+4m(1+m)(24+9n+m(34+13n+m(12+5n)))s^3 + 2(1+m)^2(3+2m)^2(2+n)s^4} \right)}{\dots} \quad (16)$$

From Eq. 15 it can achieve the sub-game perfect Nash equilibrium (SPNE). And further related analysis shows that:

$$q_0 - q_i = \frac{m(2+n)s(m+s+ms)(2m(5+3m+n) + (3+2m)(1+2m-n)s)}{A} > 0$$

$$a_0 - a_i = \frac{m(2+n)(2m^3(1+s)(2+(3+n)s) - 3s^3 - ms^2(1+m(3+n)+6s)) + m^2s(8+s(6-n^2-3s))}{A} > 0$$

where:

$$A = \left(\begin{aligned} &4m^4(1+2n) + 2m^3(2(1+n)(7+2n) + m(10+n(15+4n)))s \\ &+ m^2(62+n(53+2n(9+n)) + 2m^2(17+n(17+n(7+n)) + 4m(23+n(21+n(8+n))))s^2 \\ &+ 4m(23+n(21+n(8+n)))s^3 \\ &+ 2m(1+m)(24+9n+m(34+13n+m(12+5n)))s^3 \\ &+ (1+m)^2(3+2m)^2(2+n)s^4 \end{aligned} \right)$$

As a result of the previously literature, public firm maximum the social welfare goals will be more production and do more pollution abatement than private firm.

Pure oligopoly: To achieve the market equilibrium, the respective optimal production quantities for all private wholesale firms are:

$$\pi_i = wq_i - \frac{1}{2}q_i^2 - t(q_i - a_i) - \frac{1}{2}a_i^2 - f, \quad i=1, \dots, n, n+1$$

The other mathematic methods are similar to the analysis of 3.1 under the mixed oligopoly. From Eq. 6, firms want to solve the maximum problems:

$$\frac{\partial \pi_i}{\partial q_i} = 1 - \left[\frac{2s(m+1)}{m} + 1 \right] q_i - \frac{s(m+1)}{m} \sum_{k=1}^n q_k - t = 0, \quad i=1, \dots, n+1, \quad k \neq i \tag{17}$$

$$\frac{\partial \pi_i}{\partial a_i} = t - a_i = 0 \tag{18}$$

From Eq. 17 and 18 it could get the wholesale quantities and pollution abatements are:

$$q_i^* = \frac{m(1-t)}{s(m+1)(n+2)+m}, \quad i=1, \dots, n+1 \tag{19}$$

$$a_i^* = t, \quad i=1, \dots, n+1 \tag{20}$$

According to Eq. (19) and (20) results into the social welfare function and maximizing the objective of the government, or the social welfare it can achieve the optimal tax rate of pollution abatement:

$$t = \frac{m(n(2+n)s + m(2+s+n(2+(3+n)s)))}{2m^2(3+2n) + m(2(2+n)(3+2n) + m(13+n(15+4n)))s + (1+m)^2(2+n)^3s^2} \tag{21}$$

and social welfare level:

$$SW = \frac{m(1+n)(2+n)(2(2+n)s + m(2+(3+n)s))}{4m^2(3+2n) + m(2(2+n)(3+2n) + m(13+n(15+4n)))s + 2(1+m)^2(2+n)^3s^2} - (n+1)f \tag{22}$$

From Eq. 22 it can achieve the sub-game perfect Nash equilibrium (SPNE).

Privatization policy choice: The upstream public firm maintains nationalization or privatized is depend on the level of social welfare. It can be compared with the two different scenarios level as:

$$\Delta SW = SW_p - SW_m$$

to be obtained the best social welfare, the SW with the index word ‘‘P’’ is means the social welfare level of the pure oligopoly; The SW with the index word ‘‘M’’ is means the social welfare level of the mixed oligopoly. From previous analysis, then it will be:

$$SW_m = \frac{m \left(\begin{aligned} &4m^3(-2+n+n^2) + 2m^2(2+n)(2(1+n)(5+n) + m(2+n(5+n)))s \\ &+ m(2+n)(22+6m^2 - (-3+n)n + 4m(7+n))s^2 + 4(1+m)^2(3+m)(2+n)s^3 \end{aligned} \right)}{\begin{aligned} &8m^4(1+2n) + 4m^3(2(1+n)(7+2n) + m(10+n(15+4n)))s \\ &+ 2m^2(62+n(53+2n(9+n)) + 2m^2(17+n(17+n(7+n)))) + 4m(23+n(21+n(8+n)))s^2 \\ &+ 4m(1+m)(24+9n + m(34+13n + m(12+5n)))s^3 + 2(1+m)^2(3+2m)^2(2+n)s^4 \end{aligned}} - (n+1)f$$

then we get that:

$$SW_p = \frac{m(1+n)(2+n)(2(2+n)s + m(2+(3+n)s))}{4m^2(3+2n) + 2m(2(2+n)(3+2n) + m(13+n(15+4n)))s + 2(1+m)^2(2+n)^3s^2} - (n+1)f$$

$$\Delta SW = \frac{m(1+n)(2+n)(2(2+n)s + m(2+(3+n)s))}{4m^2(3+2n) + 2m(2(2+n)(3+2n) + m(13+n(15+4n)))s + 2(1+m)^2(2+n)^3s^2} - \frac{m \left(\begin{aligned} &4m^3(-2+n+n^2) + 2m^2(2+n)(2(1+n)(5+n) + m(2+n(5+n)))s \\ &+ m(2+n)(22+6m^2 - (-3+n)n + 4m(7+n))s^2 + 4(1+m)^2(3+m)(2+n)s^3 \end{aligned} \right)}{\begin{aligned} &8m^4(1+2n) + 4m^3(2(1+n)(7+2n) + m(10+n(15+4n)))s \\ &+ 2m^2(62+n(53+2n(9+n)) + 2m^2(17+n(17+n(7+n)))) + 4m(23+n(21+n(8+n)))s^2 \\ &+ 4m(1+m)(24+9n + m(34+13n + m(12+5n)))s^3 + 2(1+m)^2(3+2m)^2(2+n)s^4 \end{aligned}} \tag{23}$$

By Eq. 23 it cannot be directly observed the sign with positive or negative, this study will draw the Fig. 1 by numerical analysis to get the relation of results.

Proposition 1: To maximum the social welfare, when there are more retailers, the public firm should be privatized; when there are less retailers, there are two cases to discuss: first, if there are less private wholesaler, nationalization is the best policy; second, if there are more private wholesalers, privatization is a better choice.

Prove: by Figure 1 analyses.

Figure 1 shows, to maximize the social welfare, when there are more retailers exist, the public firm should be privatized; when there are less retailers exist, then there are two cases to discuss: first, if there are less private wholesalers, the public firm should be nationalized; second, if there are more private wholesalers, privatization is a better choice and pursuant to proposition 1 results.

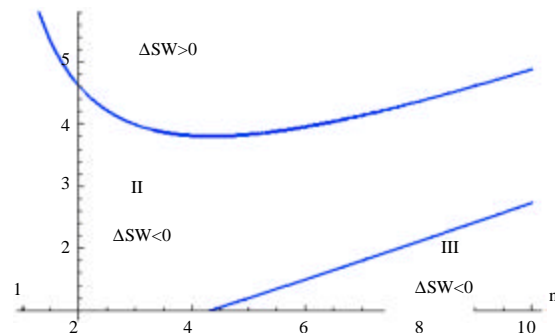


Fig. 1: The privatization policy with the numbers of the private firm (assume that s = 2)

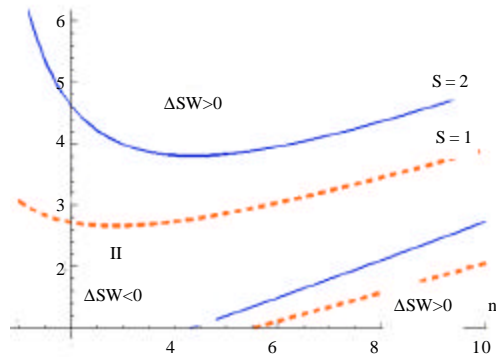


Fig. 2: The privatization policy with the numbers of the private firm and consumption externalities

Shown in the lower half of Fig. 1, the industry is in a lack of sales and higher price when the downstream retail firms fewer exist and worse to the consumer and the social welfare, if there is the fewer numbers of the upstream private firm exist as shown in Fig. 1-II zone, public firm should continue to keep nationalization to increase production and reduce the pollution damage quantities to improve social welfare because of its high level of pollution abatement; if there is the more numbers of the upstream private firm exist as shown in Fig. 1-III zone, if there are the more the upstream private firms exist, public firm should be privatization to decrease production and reduce the total pollution damage quantities to improve social welfare because of the rise of the intermediate goods price. When the increase in the number of downstream firms as shown in Fig. 1-I zone, the market will be a low enough price and consumer surplus exist, public firm should be privatization to reduce the upstream market competition and the environmental pollution to avoid excessive production.

Proposition 2: To maximum the social welfare, the numbers of retail firm of the privatization policy condition will reduce and the numbers of wholesale private firm of the privatization policy condition will rise when the consumer awareness decreasing.

Prove: by Figure 2 analyses.

Figure 2 analyses showed that consumption awareness parameter decreases, the privatization policy required number of downstream firm falls and the privatization policy required number of upstream private firm rises and pursuant to Proposition 2 results.

Figure 2 shows that when consumers pay more attentions on environmental protection, the reserved consumer price will be the lower. Thus the production level will reduce. In the meanwhile, the public firm will

produce more and put more energy on pollution abatement than the private firm. As a result it is a disadvantage to be privatized under the circumstance of maximizing the social welfare. The numbers of the retailers will increase the number to be privatized; in the meanwhile, the chance of wholesaler will decrease the number to be privatized. The consumption externalities are the main consideration in this policy implication.

CONCLUSION AND SUGGESTION

Following the research of Barcena-Ruiz and Garzon (2006) and Fujiwara (2007), this study tried to establish a public-private mixed oligopoly model by adding the factors of consumer pollution externalities and pollution abatement. The specialty in this research is using the point of view with pollution abatement and consumption externality to create this model. The public enterprise is one of the upstream pollution abatement manufacturers and downstream retailers have to face the problem of consumption externality. It gets the following two major results in the study: First, in a maximum social welfare condition, the more retailers exist, the more possibility to perform privatization; on the other hand, if there are few retailers and more upstream private firms exist, then it is still good for privatization. Second, in a maximum social welfare condition, when the consumption externality decreases, the downstream retailers can also become less and privatization, or the upstream private firms has to become more.

This study is based on the assumption of the homogeneous Cournot competition. However, the issues related with heterogeneous consumer goods, heterogeneous factor markets, cross-shareholdings and the incentive package for recruiting higher level managers are not taking into consideration in this research, so that those topics can be further analyzed.

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