E C O N O M I C S B U L L E T I N

Innovative Interaction in Mixed Market: An Effect of Agency Problem in State-Owned Firm

Shinjiro Miyazawa
The University of Tokyo

Abstract

I investigate an innovative interaction before a market competition in a mixed duopoly, where a state-owned firm and a private firm compete with each other. I find that although it reduces the effort level of the state-owned firm, an agency problem can improve the expected social welfare in some cases. I also find that setting the minimum wage level higher, which has an effect to lower the responsibility of bureaucratic managers, can be desirable from the viewpoint of expected social welfare in some cases.

I am grateful to Shingo Ishiguro, Toshihiro Matsumura, Keizo Mizuno, Dan Sasaki, Noriyuki Yanagawa, and the participants of the seminars conducted at The University of Tokyo for their helpful comments and suggestions.
Citation: Miyazawa, Shinjiro, (2008) "Innovative Interaction in Mixed Market: An Effect of Agency Problem in State-Owned Firm." *Economics Bulletin*, Vol. 12, No. 10 pp. 1-8
Submitted: March 12, 2008. **Accepted:** March 21, 2008.
URL: http://economicsbulletin.vanderbilt.edu/2008/volume12/EB-08L30001A.pdf

1 Introduction

The agency problem due to bureaucratic managements is one of the most important problems in many countries. People often criticize the bureaucratic management for its inefficiency and then some of them request to privatize state-owned firms in order to improve the efficiency of management. In fact, the Liberal Democratic Party, which attached considerable emphasis to privatizing the national postal mail, savings, and insurance services in order to improve the efficiency of management, achieved a significant victory in the 2005 elections to the House of Representatives in Japan.

Although eliminating the agency problem can improve the efficiency of management in a state-owned firm as likely as not, it also affects the managerial incentive of private competitors in the mixed market, where a state-owned firm and a private firm compete with each other. I investigate an innovative interaction before a market competition in a mixed duopoly. I find that although it reduces the investment level of the state-owned firm, the agency problem due to the bureaucratic management can improve the expected social welfare in some cases.

I also investigate the effect of a bureaucratic system concerning a minimum wage level. Ordinarily, setting minimum wage level higher is considered as a system for guaranteeing a lowest life level ex-post. However, it also has an effect to tighten the constraint of minimum wage and cause the agency problem more likely. Therefore, when a slight degree of agency problem improves the expected social welfare, a positive level of minimum wage is optimal even from the ex-ante viewpoint. It is often considered that managers in certain state-owned firms are less responsible to bad performances. My result implies, however, that the less responsibility can be desirable from the viewpoint of expected social welfare.

Needless to say, several studies investigate agency problems in state-owned firms. De Fraja (1993) studies the problem using a complete contracting approach. He shows that in a good state of the world, state-owned ownership always leads to a higher degree of productive efficiency. This is because the benefit of enhancing productive efficiency is higher for the public owner than for the private owner. Schmidt (1996), on the other hand, analyzes the problem by employing an incomplete contracting approach. In his study, he supposes that the government cannot offer any long-term contingent contracts. Given this assumption, although public ownership always leads to allocative efficiency in any technological environment, it cannot induce the enhancement of productive efficiency. Hart, Shleifer, and Vishny (1997) and Corneo and Rob (2003) analyze the problems by using multi-task models. Hart, Shleifer, and Vishny (1997) show that incentive contracts increase the cost-reducing investments but lower the quality of services. Corneo and Rob (2003), on the other hand, show that public owners offer less intensive incentive contracts when the agents derive a private benefit from one task (cooperative task). Although these studies examine various effects on both ex-ante investment and ex-post allocation, they do not consider the effects on strategic interactions between public and private sectors.

Analyses on the strategic interaction in mixed markets have been a popular subject in recent years.[1] The most remarkable aspect in a mixed market is that even when the goal of

[1]The studies on mixed markets originated with the works of Merrill and Schneider (1966) and Harris and Wiens (1980). In recent years, the strategic interactions in the mixed market have been analyzed in various contexts. For example, Matsushima and Matsumura (2003) analyze the location-setting pattern in a mixed oligopoly market, Fjell and Heywood (2004) analyze optimal subsidy levels and effects of privatization of the state-owned

the state-owned firm is to maximize the social welfare, the state-owned firm's decision can be suboptimal in the sense that a change of the decision can improve the social welfare through a strategic interaction between the state-owned and private firms. It follows that providing a commitment device to change the decision can improve the social welfare.[2] In my study, the agency problem derived from limited liability of bureaucrats works as a device.[3]

The rest of this article is organized as follows. In Section 2, I formulate the basic model. Next, I investigate the effect of the agency problem in a state-owned firm and that of limited liability in Section 3. Finally, in Section 4, I provide the concluding remarks.

2 Basic Model

Consider a mixed market where a state-owned firm (firm 0) competes with a private firm (firm 1). The government assigns a bureaucrat to the manager of firm 0, while a private owner manages firm 1 directly. Each of the bureaucratic manager and the private owner decides his effort (or innovative investment) level $e \in [0, \bar{e}]$, which is measured in terms of the units of disutility he incurs and is not observed by the others, before the market competition. Let e_0 and e_1 be the effort levels of the bureaucratic manager and private owner, respectively. Each of them acquires a good technology with probability $v(e)$ independent of the other's effort level. Impose an ordinary set of assumptions as follows; (i) $v' \geq 0$ and $v'' < 0$ for all $e \in [0, \bar{e}]$, (ii) $v(0) = 0$ and $v(\bar{e}) = 1$, (iii) $v'(0) = +\infty$ and $v'(\bar{e}) = 0$, and (iv) v'' is continuous. The technological environments in the market competition are divided into four combinations: gg, gb, bg, and bb. For example, gb indicates that the bureaucratic manager acquires the good technology and the private owner does not. Every valuation depending on the environments is expressed with a superscript $s \in \{gg, gb, bg, bb\}$. Before the inputs of efforts, the government offers a wage contract contingent on the technology the bureaucratic manager acquires, (w^g, w^b). Assume that the bureaucrat can receive $\underline{w}$ units of utility and is protected by limited liability. Further, assume that the government cannot disclose and commit the contract. This assumption, in effect, implies that the government and the private owner decide their (targeted) effort levels, simultaneously.

The bureaucratic manager maximizes the expected wage income net of his effort level and the private owner maximizes the expected profit of firm 1 net of his effort level, while the government maximizes the expected social welfare, which is the sum of consumer's surplus

firm in a mixed oligopoly market, and Chang (2005) analyzes optimal trade and privatization policies in an international duopoly where a state-owned firm competes with a more efficient foreign firm. Matsushima and Matsushima (2004) and Ishibashi and Matsumura (2006) analyze cost-reduction and R&D competition in a mixed duopoly market, although they do not consider an agency problem in a state-owned firm.

[2]Several studies use the aspect of mixed market in their investigation. De Fraja and Delbono (1989) and Matsumura (1998), for example, use it in the quantity-setting competition and show that privatization in mixed oligopoly and partial privatization in a mixed duopoly, respectively, can improve social welfare. Ishibashi and Matsumura (2006) use the effect in R&D competition and show that committing less investment by imposing a budget constraint improves social welfare.

[3]When it can commit contracts, the government uses a contract to control the equilibrium outcome. Barros (1995) considers the contract as a strategic commitment device and shows the difference in incentive schemes between state-owned and private firms. Although he presents insightful results concerning optimal incentive schemes in mixed markets, he do not consider any agency problem.

and profits of both firms net of the effort levels and taxation costs for public funds.[4] Assume that the taxation cost for the wage payment of \$ 1 is \$ $\zeta(\geq 0)$. Then the expected social welfare is given by

$$E[CS^s + \pi_0^s + \pi_1^s \mid e_0, e_1] - e_0 - e_1 - \zeta\{v(e_0)w^g + (1 - v(e_0))w^b\},$$

where CS^s and π_i^s ($i = 0, 1$) are the consumer's surplus and firm i's profit, respectively, under a technological environment of $s \in \{gg, gb, bg, bb\}$. Note that the taxation cost for production costs is reflected to the outcomes of CS^s and π_i^s ($i = 0, 1$). Assume that attaining the good technology improves the gross social welfare, $Z^s \equiv CS^s + \pi_0^s + \pi_1^s$, i.e., $Z^{kg} > Z^{kb}$ and $Z^{gl} > Z^{bl}$ for any k and l in $\{g, b\}$.

The variables CS^s, π_0^s, and π_1^s depend on the feature of technology and the structure of market competition, definitely. However, the following analysis on strategic effects of the innovative decisions depends on (i) whether the private owner's strategy in the stage of innovative decisions is strategic substitute or implement to the government's strategy and (ii) whether the private owner's strategy in the stage is under- or over-investment from the viewpoint of expected social welfare, only, not on the feature of technology and the structure of market competition. Then focus on four combination cases; strategic substitutability and under-investment (Case 1), strategic substitutability and over-investment (Case 2), strategic complementarity and under-investment (Case 3), and strategic complementarity and over-investment (Case 4).

Given a level of e_0, the first-order condition for the private owner's maximization problem is given by

$$v'(e_1)\left[v(e_0)\left(\pi_1^{gg} - \pi_1^{gb}\right) + (1 - v(e_0))\left(\pi_1^{bg} - \pi_1^{bb}\right)\right] = 1,$$

while that for the expected welfare maximization with respect to e_1 is given by

$$v'(e_1)\left[v(e_0)\left(Z^{gg} - Z^{gb}\right) + (1 - v(e_0))\left(Z^{bg} - Z^{bb}\right)\right] = 1.$$

Note that the second-order conditions are satisfied when assuming $\pi_1^{kg} > \pi_1^{kb}$ for any k in $\{g, b\}$. Therefore, the private owner's strategy is substitute (complement) to the bureaucratic manager's if and only if $\pi_1^{bg} - \pi_1^{bb} > \pi_1^{gg} - \pi_1^{gb}$ ($\pi_1^{gg} - \pi_1^{gb} > \pi_1^{bg} - \pi_1^{bb}$), and is under- (over-) investment from the viewpoint of expected social welfare if $CS^{kg} + \pi_0^{kg} \geq CS^{kb} + \pi_0^{kb}$ ($CS^{kg} + \pi_0^{kg} \leq CS^{kb} + \pi_0^{kb}$) for any $k \in \{g, b\}$ and $CS^{kg} + \pi_0^{kg} > CS^{kb} + \pi_0^{kb}$ ($CS^{kg} + \pi_0^{kg} < CS^{kb} + \pi_0^{kb}$) for a $k \in \{g, b\}$.[5]

[4] This assumption on the government's objective follows Caillaud, Guesnerie, Rey, and Tirole (1988).

[5] Whether the private owner's strategy is under- or over-investment depends on the effort level in firm 0 when the relationship between $CS^{kg} + \pi_0^{kg}$ and $CS^{kb} + \pi_0^{kb}$ is opposite for $k = g$ and $k = b$. I ignore such peculiar cases for analytical simplicity.

3 Agency Problem Derived from Limited Liability

Given a level of e_1, the government's maximization problem is given by

$$\begin{aligned}\max_{e_0,\,(w^g,w^b)} \quad & E[Z^s \mid e_0, e_1] - e_0 - e_1 - \zeta\{v(e_0)w^g + (1 - v(e_0))w^b\} \\ \text{s.t.} \quad & v(e_0)w^g + (1 - v(e_0))w^b - e_0 \geq \underline{w} \\ & v'(e_0)(w^g - w^b) = 1 \\ & w^g \geq 0 \,\text{and}\, w^b \geq 0,\end{aligned}$$

where the constraints are individual rationality (IR), incentive compatibility (IC), and limited liability (LL) constraints.[6] Investigating the effect of limited liability on the equilibrium expected social welfare, I have the following result (See Appendix A.1 for a precise proof).

Proposition 1 *(i) When $\zeta = 0$, the limited liability does not affect the equilibrium expected social welfare. (ii) When $\zeta > 0$, the agency problem derived from limited liability could improve the equilibrium expected social welfare in the cases of Case 1 and Case 4, while it definitely damages the equilibrium expected social welfare in the cases of Case 2 and Case 3.*

When the taxation for the wage payment is costless, the wage payment is just a transfer from the profit of firm 0 to the utility of bureaucratic manager. Therefore, the limited liability does not cause any agency problem and then does not affect the equilibrium expected social welfare.

On the other hand, when the taxation for the wage payment is costly, the government has an incentive to reduce the wage payment. In this case, the limited liability can cause an agency problem, which results in reducing the targeted effort levels in firm 0 responding to any effort levels in firm 1. However, the reduction of the targeted effort levels in firm 0 could improve the expected social welfare for the reason below. Since the government maximizes the expected social welfare, a slight reduction in e_0 from the equilibrium level without any agency problem keeps the expected social welfare unchanged. On the other hand, since the private owner maximizes the expected profit net of his effort level, the equilibrium effort level is ordinarily nonidentical to the level maximizing the expected social welfare. An increase (a reduction) in e_1 improves (damages) the expected social welfare when the private owner's strategy is under-investment from the viewpoint of expected social welfare, and it does oppositely when his strategy is over-investment from the viewpoint of expected social welfare. Therefore, the reduction of the targeted effort levels in firm 0, affecting the effort levels in firm 1, damages the expected social welfare in the case of Case 2 and Case 3, but could improve the expected social welfare in the case of Case 1 and Case 4. I provide an example of Case 1 with specifying the technology and the market structure in Appendix A.2.

People often criticize the "inefficiency" of bureaucratic managements and request to reform (or especially privatize) state-owned firms. It is true that the taxation costs for bureaucratic managements damage the expected social welfare and can cause an agency problem in state-owned firms. However, in mixed market, the agency problem due to the bureaucratic management affects private competitors' decisions of innovative investment, and consequently

[6] The IC constraint can be written by a first-order condition fashion as above following from the assumption on $v(e)$.

improves the expected social welfare in equilibrium in some cases. Therefore, when the reform (or privatization) of state-owned firms is considered, this type of innovative interaction between public and private sector should be also examined.

I have investigated the equilibrium outcomes given non-negative wage limitation. I now consider a bureaucratic system setting a minimum wage level $w_{\min} \geq 0$. Suppose that the government can commit any bureaucratic systems.[7] Then, the LL constraints in G's problem are altered by

$$w^g \geq w_{\min} \text{ and } w^b \geq w_{\min}.$$

Then, I have the following.

Proposition 2 *Setting $w_{\min} > 0$ could improve the expected social welfare in the cases of Case 1 and Case 4, while it definitely damages the equilibrium expected social welfare in the cases of Case 2 and Case 3.*

An increase in $w_{\min}$ tightens the LL constraint of $w^b \geq 0$, and consequently lowers the targeted effort level in firm 0 so long as the IR constraint is binding. Thus setting $w_{\min} > 0$, reducing the targeted effort level in firm 0, could improve the expected social welfare in the cases of Case 1 and Case 4. People often consider that managers in some state-owned firms are less responsible to bad performances. The result implies, however, that the less responsibility can be desirable from the viewpoint of expected social welfare.

4 Concluding Remarks

When the taxation for the wage payments is costly, the government has an incentive to reduce the wage payments. In this case, the limited liability of bureaucratic managers can cause an agency problem, which results in reducing the targeted effort levels in the state-owned firm responding to any effort levels in private firms. However, either when the private owner's strategy is substitute to the government's one and is under-investment from the viewpoint of expected social welfare or when the private owner's strategy is complement to the government's one and is over-investment from the viewpoint of expected social welfare, the distortion due to the agency problem could improve the expected social welfare through an strategic interaction between the government and private owner. Therefore, when the reform (or privatization) of state-owned firms is considered, this type of innovative interaction should be also examined.

I also investigate the effect of a bureaucratic system concerning a minimum wage level. Ordinarily, setting minimum wage level higher is considered as a system for guaranteeing a lowest life level ex-post. However, it also has an effect to tighten the constraint of minimum wage and cause the agency problem more likely. Therefore, when a slight degree of agency problem improves the expected social welfare, a positive level of minimum wage is optimal even from the ex-ante viewpoint. It is often considered that managers in certain state-owned firms are less responsible to bad performances. My result implies, however, that the less responsibility can be desirable from the viewpoint of expected social welfare.

[7] It seems to be expedient to assume that committing to systems is sustainable, although committing to contracts is not. However, I consider that designing a system requires very complex political procedures and that the government cannot change the system in the short run.

Appendix A

A.1 Proof of Proposition 1

(i) Obvious following from the explanation in the text.

(ii) When the IR constraint is held with equality, the expected social welfare given a level of e_1 is written as

$$E[Z^s \mid e_0, e_1] - e_0 - e_1 - \zeta(e_0 + \underline{w}).$$

Obviously, when the LL constraints are not imposed, the IR constraint is held with equality in optimum and then the effort level in firm 0 given a level of e_1, r_0, satisfies

$$v'(r_0)\left[v(e_1)\left(Z^{gg} - Z^{bg}\right) + (1 - v(e_1))\left(Z^{gb} - Z^{bb}\right)\right] = 1 + \zeta.$$

On the other hand, when the LL constraints are imposed, r_0 satisfies

$$v'(r_0)\left[v(e_1)\left(Z^{gg} - Z^{bg}\right) + (1 - v(e_1))\left(Z^{gb} - Z^{bb}\right)\right] = 1 + \zeta - \gamma\frac{v''(r_0)}{v'(r_0)}, \tag{A1}$$

$$(\lambda - \zeta)v(r_0) + \gamma v'(r_0) = 0, \tag{A2}$$

$$(\lambda - \zeta)(1 - v(r_0)) - \gamma' v'(r_0) \leq 0, \tag{A3}$$

where $\lambda \geq 0$ and $\gamma \geq 0$ denote the Lagrange multipliers on the IR and IC constraints, respectively. Note that the constraint $w^g \geq 0$ is never binding and then (A2) holds since I have $w^g > w^b$ following from the equation of the IC constraint and the assumptions on $v(e)$. The first condition (A1) is reduced by using the equation of the IC constraint. When the constraint $w^b \geq 0$ is not binding, (A3) holds with equality, which implies $\lambda = \zeta$ and $\gamma = 0$. In this case, the result is equivalent to that without the LL constraints.

When the constraint $w^b \geq 0$ is slightly binding, γ is slightly larger than 0 and λ is slightly smaller than ζ. Then it is possible to be $\gamma > 0$ and $\lambda > 0$. In this case, the optimum effort level given e_1 is less than that in the cases where the LL constraints are not imposed or not binding and the IR constraint is held with equality.

Define $EW(e_0) = E[Z^s \mid e_0, R_1(e_0)] - e_0 - R_1(e_0) - \zeta(e_0 + \underline{w})$, where

$$R_1(e) = v'^{-1}\left(\frac{1}{v(e)\left(\pi_1^{gg} - \pi_1^{gb}\right) + (1 - v(e))\left(\pi_1^{bg} - \pi_1^{bb}\right)}\right).$$

is the private owner's response function derived from the first-order condition for the private owner's problem. Let (e_0^d, e_1^d) be the set of equilibrium effort levels in the cases where the LL constraints are not imposed or not binding. Then the effect of marginal reduction in e_0 from e_0^d is reduced as follows.

$$-\frac{dEW(e_0^d)}{de_0} = -\frac{dR_1(e_0^d)}{de_0}\left[v'(e_1^d)\left[v(e_0^d)\left(Z^{gg} - Z^{gb}\right) + (1 - v(e_0^d))\left(Z^{bg} - Z^{bb}\right)\right] - 1\right].$$

Table 1: In this table the equilibrium valuables under an example with with $a = 10$, $b = 0.2$, $\theta^g = 0$, $\theta^b = 1$, and $\zeta = 0.1$ is presented. Obviously, these valuables satisfy the conditions for Case 1.

	$s = gg$	$s = gb$	$s = bg$	$s = bb$
Z^s	43.01	41.38	37.03	34.28
π_1^s	1.877	0.373	4.224	1.678
$CS^s + \pi_0^s$	41.14	41.01	32.81	32.60

Here, $\frac{dR_1(e_0^d)}{de_0}$ is negative (positive) in the case of Case 1 and Case 2 (Case 3 and Case 4) and the value of the terms in the brackets is positive (negative) in the case of Case 1 and Case 3 (Case 2 and Case 4). Therefore, $-\frac{dEW(e_0^d)}{de_0}$ is positive (negative) in the case of Case 1 and Case 4 (Case 2 and Case 3).

A.2 An example of Case 1

Firm 0 and firm 1 produce a homogeneous good and the inverse demand function of the good is $p(Q) = a - Q$. Producing a quantity q costs $\frac{1}{2}bq^2 + \theta q$, where θ is either θ^g or θ^b ($0 \leq \theta^g < \theta^b < a$. One dollar of production cost in firm 0 requires ζ dollar of taxation cost. Then in the stage of production, the government, which is the owner of firm 0, maximizes

$$\frac{1}{2}Q^2 + (a - Q)Q - (1 + \zeta)\left(\frac{1}{2}bq_0^2 + \theta^k q_0\right) - \left(\frac{1}{2}bq_1^2 + \theta^l q_1\right)$$

with respect to q_0, and the private owner maximizes

$$(a - Q)q_1 - \left(\frac{1}{2}bq_1^2 + \theta^l q_1\right)$$

with respect to q_1, where $Q = q_0 + q_1$, and θ^k and θ^l are the parameter of technology for firm 0 and firm 1 respectively. Assume

$$(1 + \zeta)ab + (1 + \zeta)\theta^k - (1 + b + \zeta b)\theta^l \geq 0.$$

Then I can show $Z^{kg} > Z^{kb}$, $Z^{gl} > Z^{bl}$, and $\pi_1^{kg} > \pi_1^{kb}$ for $k, l \in \{g, b\}$, and the followings:

$$\pi_1^{bg} - \pi_1^{bb} > \pi_1^{gg} - \pi_1^{gb}$$
$$CS^{kg} + \pi_0^{kg} > CS^{kb} + \pi_0^{kb} \text{ for } k \in \{g, b\}$$

These results implies that it is the case of Case 1 under this specification. I omit the proof of these results but provide an numerical example with $a = 10$, $b = 0.2$, $\theta^g = 0$, $\theta^b = 1$, and $\zeta = 0.1$, instead (See Table 1).

References

Barros, F., 1995, "Incentive Schemes as Strategic Variables: An Application to a Mixed Duopoly," *International Journal of Industrial Organization*, 13(3), 373–386.

Caillaud, B., R. Guesnerie, P. Rey, and J. Tirole, 1988, "Government Intervention in Production and Incentive Theory: A Review of Recent Contributions," *Rand Journal of Economics*, 19, 1–26.

Chang, W. W., 2005, "Optimal Trade and Privatization Policies in an International Duopoly with Cost Asymmetry," *Journal of International Trade and Economic Development*, 14, 19–42.

Corneo, G., and R. Rob, 2003, "Working in Public and Private Firms," *Journal of Public Economics*, 87, 1335–1352.

De Fraja, G., 1993, "Productive Efficiency in Public and Private firms," *Journal of Public Economics*, 50, 15–30.

De Fraja, G., and F. Delbono, 1989, "Alternative Strategies of a Public Enterprise in Oligopoly," *Oxford Economic Papers*, 41, 302–311.

Fjell, K., and J. S. Heywood, 2004, "Mixed Oligopoly, Subsidization and the Order of Firm's Moves: The Relevance of Privatization," *Economics Letters*, 83, 411–416.

Harris, R., and E. Wiens, 1980, "Government Enterprise: An Instrument for the Internal Regulation of Industry," *Canadian Journal of Economics*, 13, 125–132.

Hart, O., A. Shleifer, and R. W. Vishny, 1997, "The Proper Scope of Government: Theory and an Application to Prisons," *Quarterly Journal of Economics*, 112(4), 1127–1161.

Ishibashi, I., and T. Matsumura, 2006, "R and D competition between public and private sectors," *European Economic Review*, 50(6), 1347–1366.

Matsumura, T., 1998, "Partial Privatization in Mixed Oligopoly," *Journal of Public Economics*, 70, 473–483.

Matsushima, N., and T. Matsumura, 2003, "Mixed Oligopoly and Spatial Agglomeration," *Canadian Journal of Economics*, 36(1), 62–87.

Matsushima, T., and N. Matsushima, 2004, "Endogenous Cost Differentials between Public and Private Enterprises: A Mixed Duopoly Approach," *Economica*, 71, 671–688.

Merrill, W., and N. Schneider, 1966, "Government Firms in Oligopoly Industries," *Quarterly Journal of Economics*, 80, 400–412.

Schmidt, K. M., 1996, "Incomplete Contracts and Privatization," *European Economic Review*, 40(3-5), 569–579.