Yardstick Competition and Franchise Bidding: A Comparative Analysis based on Asymmetric Information

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Abstract

In order to improve the country's monopolistic environment, the Japanese government took several deregulation measures during the last decade. However, industrial monopolies remain regionally; some new mechanism has therefore become necessary to induce the regional monopoly firms improve the situation.

In this paper, we focus on two mechanisms, "yardstick competition" and "franchise bidding," which are often used to control the monopolistic behavior of firms, and compare the functionalities of the mechanisms based on asymmetric information.

We conclude that franchise bidding is more desirable than yardstick competition in controlling the monopoly behavior of firms in the Japanese regional public utility industries.

keywords: yardstick competition, franchise bidding, asymmetric information, hidden action, hidden information

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1. Introduction

How do we go about offering incentives to regional monopoly firms in this age of post-deregulation? Two mechanisms are often used to control the functioning of regional monopoly firms in Japan. One is yardstick competition, and the other is franchise bidding. In yardstick competition, "the reward to one firm depends on its performance relative to that of other firms" (Armstrong et al., 1994). In franchise bidding, "the right to operate a natural monopoly industry could simply be auctioned to the firm that offers to supply at the lowest price" (Armstrong et al., 1994).

The theoretical studies of these two mechanisms followed much after their real cases had actually taken place in previous years. The important works in this field are Shleifer (1985), who studied about yardstick competition, and Demsetz (1968) and Williamson (1976), who examined franchise bidding. During the course of these theoretical studies, some studies pointed out certain problems inherent in the mechanisms. One of the most critical problems pointed out is collusion among firms, which arises from the information asymmetry between the regulators and firms. In case of asymmetric information, the regulators have to pay information rent to the firms that hold private information, even though the regulators can adopt optimal policy mechanisms. This is the issue focused on in this paper. We also try to compare the two mechanisms from an information asymmetry perspective.

As Mizutani (2007) has pointed out, we too note some examples of yardstick competition in the Japanese regulatory practices. Studies have been conducted on the effects of yardstick competition in the Japanese rail industry by Mizutani (1997), Mizutani et al. (2009), and Harada (2012). These studies found that yardstick competition could induce firms to reduce their costs by using econometric tools to estimate their cost functions.

This mechanism was initially developed by those who practiced it, and theoretical studies followed much later. The first study in this field, carried out by Shleifer (1985), showed that a regional monopoly firm's investment to reduce costs could reach the socially optimal level through yardstick competition. Shleifer (1985) used the *hidden action* model, where the firms' cost-reduction effort (investment) is their private information. Auriol and Laffont (1992) believe that a duopoly is more desirable than a monopoly even with a duplication of fixed costs owing to the effects of yardstick competition.

However, there are three critical problems with the Shleifer model. First, the model requires enormous information about the cost functions, and so the regulatory costs become very large. Second, the model assumes homogeneity, which is rarely satisfied in the real world.

Third, there is a high likelihood of collusion among firms.

Shleifer (1985) recognized the second problem (the assumption of homogeneity is rarely satisfied), but concluded that even if the assumption of homogeneity is not satisfied, yardstick competition is more desirable than a full-cost pricing.

Meran and Hirschhausen (2009) focused on the first problem (the need for enormous information), and found that a modified yardstick competition (MYC) based on total costs can lead to similar result as the Shleifer model.

Tangeras (2002) focused on the third problem (collusion among firms), and concluded that collusion among firms would destroy the essential effects of yardstick competition. Subsequently, Chong and Huet (2009) analyzed this problem with a model based on one illustrated by Laffont and Tirole (1993); they made a comparative study of the two mechanisms, yardstick competition and franchise bidding, examining the collusion among firms. They defined the collusion of two firms as each firm telling a lie expecting the other also to tell a lie. They concluded that yardstick competition with compensation is more desirable than yardstick competition with fines or franchise bidding under certain conditions.

If the regulators do not observe collusion but impose a penalty only after the discovery of collusion, the problem becomes critically serious. Collusion renders the essential effects of yardstick competition meaningless, and the regulators may have to design mechanisms to offer incentives to firms.

2. A Basic Model

For a basic model, we first summarize the conditions of the model illustrated by Chong and Huet (2009). Chong and Huet (2009) assume two monopoly markets separated by region. Each market has a one-unit demand, and the demand is inelastic. There are two firms, denoted by $i = 1,2$, and both firms are capable of producing the good.

C_i, which denotes the production cost of firm i, is defined as

$$C_i = \beta_i - e_i \qquad (1)$$

β_i is firm i's productivity parameter; both the firms have the same productivity parameter $\beta_1 = \beta_2 = \beta$. Chong and Huet (2009) consider β an exogenous parameter, determined by $\beta = \overline{\beta}$ *or* $\underline{\beta}$ $(\overline{\beta} > \underline{\beta})$; $\underline{\beta}$ has a probability of v, and $\overline{\beta}$ a probability of $1 - v$. The term e_i represents the cost-reduction effort, which involves disutility, represented by the term $\varphi(e_i)$ (with the assumption of $\varphi(e_i) > 0$、$\varphi'(e_i) > 0$、$\varphi''(e_i) > 0$). Specifically, the cost level of a firm is determined by its exogenous productivity parameter and endogenous effort on cost reduction.

Both the markets are monopolies by nature, and so there are regulators. The regulators face an asymmetric information problem; they have no information on the productivity parameter of firms. We can therefore conclude that Chong and Huet (2009) used the *hidden information* model, where the firms' productivity parameter is the private information of the firms' insiders only.

The regulators reimburse the firms' their production cost C_i, and, in addition, grant them a subsidy t_i as reward for their cost-reduction effort. The regulators do not have any information about the true disutility $\varphi(e_i)$, and firm i can obtain information on rent U_i, defined by $U_i = t_i - \varphi(e_i)$.

To overcome the asymmetric information problem, the regulators adopt certain policies that compel the firms to report their true cost parameter, and very often choose between yardstick competition and franchise bidding, the details of which are given below.

In yardstick competition, the firms are assumed to have the right to operate the monopoly market, while the regulators take their comparison of the parameters reported by the firms as a "yardstick." Assuming two firms, if the parameters reported by both firms are consistent with each other, the regulators consider them as true, and then reimburse the costs and grant a subsidy based on the reported parameters[2]. If the reports are inconsistent, the regulators consider parameter $\underline{\beta}$ to be true, and then reimburse the costs and grant a subsidy based on $\underline{\beta}$. Besides, the regulators grant a compensation (denoted A) to the firm reporting $\underline{\beta}$ and impose a fine (denoted P) on the firm reporting $\overline{\beta}$.

In franchise bidding, the regulators are assumed to define the rights to operate the monopoly market and then grant the rights to the firms that report the lowest cost. For example, if two firms report the same parameter, the two firms will get the right to operate their respective markets. If the two firms report different parameters, the firm reporting the lower cost $\underline{\beta}$ will get the right to operate both markets.

Chong and Huet (2009) assumed no information rent for firms in franchise bidding, because the subsidy is auctioned off through the bidding process, finally reaching the level of no information rent ($t_i = \varphi(e_i)$). Even in this case, a firm would enter the bidding process because its participant constraint ($U_i = t_i - \varphi(e_i) \geq 0$) is satisfied.

Chong and Huet (2009) give some steps of the regulatory process. First, the regulators determine the policy to be taken in the market. The market productivity parameter is then

[2] They assume that the regulators know the socially optimal cost-reduction effort level (e^*). Therefore, they grant firms subsidy to force them make socially optimal efforts ($t_i = \varphi(e^*)$).

determined from the probability shown above, such that both the firms would know the parameter. Next, the regulators offer the contract and commit to it. Each firm determines whether to accept the contract, and if a firm accepts the contract, the firm reports the parameter to the regulators. In due course, the production, reimbursement, and subsidization functions occur in accordance with the contract.

Even when a low cost parameter $\underline{\beta}$ is realized, each firm will have an incentive to tell a lie and report the low productivity parameter $\overline{\beta}$ with the expectation that the other firm too will report the low productivity parameter $\overline{\beta}$. We interpret this as a collusion in which both firms tell a lie.

The result obtained from the model is given below.

First, if the regulators do not follow a policy, the firms would always report the low productivity parameter $\overline{\beta}$. Therefore, it is necessary that the regulators have a policy.

Under yardstick competition, if the regulators set an appropriate compensation, the firms' dominant strategy equilibrium would be to report the true parameter. However, the possibility of a firm reporting a lie would remain, because the firm would not gain anything from reporting the truth even when the regulators imposed a fine.

Under franchise bidding, if the regulators could set an appropriate subsidy, reporting the truth will be the firms' dominant strategy equilibrium. However, as mentioned above, and assumed by Chong and Huet (2009), the whole subsidy is auctioned off through the bidding process and the firm cannot obtain any information rent. Consequently, a firm will have no merit in operating two markets, and may therefore have an incentive to report the low productivity parameter $\overline{\beta}$.

Chong and Huet (2009) concluded that yardstick competition with compensation is more desirable than yardstick competition with fines or franchise bidding.

3. The Model Applied to the Japanese Market

In this section, we consider applying the model illustrated by Chong and Huet (2009) to the Japanese monopoly market. This model assumes a one-unit demand that is inelastic, and therefore do not consider demand fluctuations. These conditions can apply very well to the regional bus market in Japan. For example, there are some cases of outsourcing bus operation to private firms in Japan. In this case, the private firms are not responsible for income generation, but the regional governments are. The governments reimburse the operating costs and grant subsidies to the bus operators. Against this background, we made a few

modifications to the original model and applied it to the Japanese bus market.

3.1. Modifying the Yardstick Competition Settings

First, the biggest difference between the original model and the Japanese market is in the settings of yardstick competition. In the Japanese bus market, when yardstick competition is considered, there is no penalty or compensation, unlike in the model of Chong and Huet (2009). In Japan, yardstick competition is used to set a cap on prices. The average operating cost of all firms is the yardstick to calculate the standard cost of the market. Therefore, yardstick competition in Japan is not for penalty or compensation, but is based on the average operating cost of all the firms. In this paper, we call this the average-based yardstick competition. Hereafter in this paper, we will analyze the effects of the average-based yardstick competition.

In the original model illustrated by Chong and Huet (2009), if $\tilde{\beta}_i = \tilde{\beta}_j$ ($\tilde{\beta}_i$: the parameter reported by firm i), then $C_c = \tilde{\beta}_i - e_c$、$t_i = t_c$ (C_c, e_c, t_c: the value offered by the regulator and described in their contract). If $\tilde{\beta}_i \neq \tilde{\beta}_j$, then $C_c = \underline{\beta} - e_c$、$t_i = t_c + A(\tilde{\beta}_i = \underline{\beta})$、$t_i = t_c - P(\tilde{\beta}_i = \overline{\beta})$. A is the compensation granted to the firm that reports the truth, and P the penalty levied on the firm that reports a lie. Therefore, if the two firms report the same parameter, the regulator would assume that both the firms are telling the truth. If the two firms report inconsistent parameters, the regulator would assume that the firm reporting $\underline{\beta}$ is telling the truth and the firm reporting $\overline{\beta}$ telling a lie, because there is no incentive for the firm that realizes $\overline{\beta}$ to report $\underline{\beta}$. Therefore, both the cost reimbursement and subsidy are based on $\underline{\beta}$ (the firm reporting $\underline{\beta}$ is granted a compensation, and the one reporting $\overline{\beta}$ is levied a fine).

Unlike the original model, in average-based yardstick competition, the average operating cost of all firms is used as the yardstick. Therefore, any reimbursement is based on the average, and no compensation or penalty is considered in calculating the subsidy, as represented mathematically below.

$C_c = (\tilde{\beta}_i + \tilde{\beta}_j)/2 - e_c$、$t_i = t_c$

Here, t_c is set to satisfy the firm's participant constraint.

Proposition 1 *In the average-based yardstick competition, reporting $\overline{\beta}$ is the dominant strategy for a firm.*

See Table 1 below. We try to indicate that the condition of telling the truth is the dominant strategy for all firms. However, in reality, this condition has never existed, and reporting $\overline{\beta}$ is

the dominant strategy for all firms. We found that the average-based yardstick competition cannot work under the conditions of the original model (for a more detailed proof for the proposition, see the appendix.)

Table 1 The pay-off when $\underline{\beta}$ is realized

	$\underline{\beta}$	$\overline{\beta}$
$\underline{\beta}$	$t_c-\varphi(e_c)$、$t_c-\varphi(e_c)$	$t_c-\varphi(e_c-\Delta\beta/2)$、$t_c-\varphi(e_c-\Delta\beta/2)$
$\overline{\beta}$	$t_c-\varphi(e_c-\Delta\beta/2)$、$t_c-\varphi(e_c-\Delta\beta/2)$	$t_c-\varphi(e_c-\Delta\beta)$、$t_c-\varphi(e_c-\Delta\beta)$

Table 2 The pay-off when $\overline{\beta}$ is realized

	$\underline{\beta}$	$\overline{\beta}$
$\underline{\beta}$	$t_c-\varphi(e_c+\Delta\beta)$、$t_c-\varphi(e_c+\Delta\beta)$	$t_c-\varphi(e_c+\Delta\beta/2)$、$t_c-\varphi(e_c+\Delta\beta/2)$
$\overline{\beta}$	$t_c-\varphi(e_c+\Delta\beta/2)$、$t_c-\varphi(e_c+\Delta\beta/2)$	$t_c-\varphi(e_c)$、$t_c-\varphi(e_c)$

We tried to find out why the average -based yardstick competition cannot work under the conditions of the original model with asymmetric information. We show that the original model focuses on hidden information because a regulator has no information on the productivity parameter. On the other hand, the average-based yardstick competition is related to Shleifer's (1985) model. Shleifer (1985) is the model of hidden action where the cost-reduction effort is the private information of firms. Therefore, we apply the policy based on hidden action to the model based on hidden information. We then modify the original model's condition to bridge the gap between the policy and the model.

In the modified model, we assume that a firm's cost level is determined only by the effort decided endogenously by the firm. The realized parameter is always $\overline{\beta}$, and if the firm makes an effort of e_i, then $\underline{\beta}$ is realized. Therefore, any difference in cost level depends only on the effort made by the firm endogenously. Since the degree of effort made by firms constitutes private information, this model focuses on the hidden action. The regulators take a policy decision based on each firm's observed cost C_i, using yardstick competition based on the average operating cost of all firms; the reimbursed cost is $C_c=(\mathrm{C}_i+\mathrm{C}_j)/2$.

Proposition 2 *Under the modified model where the cost level of each firm is determined by only the effort decided endogenously by the firm, there can be some cases where the average-based yardstick competition may be able to induce the firm to make an effort to reduce its costs.*

We show the pay-off table of the modified model below (Table 3). We determine the condition when making an effort to reduce the cost is the dominant strategy for all firms. We show that if the condition $\varphi(e_c) \leq \frac{\Delta\beta}{2}$ is satisfied, making an effort is the dominant strategy for all firms. In other words, if the subsidy that firms get when making an effort $(\Delta\beta/2 = (\overline{\beta} - \underline{\beta})/2)$ exceeds their disutility of effort, making an effort is the dominant strategy for all firms. However, we should note that because the above condition consists of non-political factors, it would depend on the exogenous factor of whether the regulators can induce making an effort the dominant strategy for all firms.

These results suggest that the average-based yardstick competition cannot lead to an incentive for a firm under hidden information, but may be able to do so for a firm under hidden action. Nonetheless, this will depend only on the above exogenous factor.

Table 3 Pay-off of the modified model

	$\underline{\beta}$(= Make an effort)	$\overline{\beta}$(= Make no effort)
$\underline{\beta}$	$t_c-\varphi(e_c)$、$t_c-\varphi(e_c)$	$t_c-\varphi(e_c)$、t_c
$\overline{\beta}$	t_c、$t_c-\varphi(e_c)$	t_c、t_c

3.2. Modifying the Franchise-bidding Setting

Chong and Huet (2009) assume that a subsidy is auctioned off to reach the level where the participant constraint is satisfied under a franchise-bidding mechanism. They show that such franchise bidding cannot achieve the purpose of inducing firms to tell the truth. Laffont and Tirole (1993) argued that a firm needs to obtain an information rent to satisfy its incentive-compatible constraint even if the regulators realize the optimal bidding mechanism. Therefore, we assume that the subsidy is not auctioned off through a bidding process, but is calculated

by the regulators to satisfy the incentive-compatible constraint of firms.

In the original model, if $\tilde{\beta}_i = \tilde{\beta}_j$, each firm operates its market, where the reimbursed cost is $C_c=\beta_i-e_c$ and subsidy $t_i=t_c$. If $\tilde{\beta}_i \neq \tilde{\beta}_j$, the firm reporting $\underline{\beta}$ will be operating both the markets, and the reimbursed cost will be $C_c=\underline{\beta}-e_c$ and the subsidy $t_i=t_c$. The subsidy t_c will be satisfied only with a participant constraint. In our modified franchise-bidding mechanism, we follow the framework of this mechanism, but add the assumption that t_c will be satisfied with an incentive-compatible constraint.

As illustrated below, we conduct two analyses. The first is the original model illustrated by Chong and Huet (2009), and the second is the modified model illustrated above.

Proposition 3 *Under the original model, the dominant strategy for a firm is to tell the truth if the regulators can set an appropriate subsidy.*

See the pay-off table below (Table 4). We show the condition when telling the truth is the dominant strategy for all firms. If the condition $2\varphi(e_c)-\varphi(e_c-\Delta\beta)\leq t_c \leq \varphi(e_c+\Delta\beta)$ is satisfied, telling the truth is the dominant strategy for all firms. Now, we further show that such a t_c can exist from the assumption of the form of φ. Therefore, the regulators can realize this dominant strategy equilibrium by setting an appropriate subsidy.

Table 4 The pay-off when $\underline{\beta}$ is realized

	$\underline{\beta}$	$\overline{\beta}$
$\underline{\beta}$	$t_c-\varphi(e_c)$、$t_c-\varphi(e_c)$	$2(t_c-\varphi(e_c))$、0
$\overline{\beta}$	0、$2(t_c-\varphi(e_c))$	$t_c-\varphi(e_c-\Delta\beta)$、$t_c-\varphi(e_c-\Delta\beta)$

Table 5 The pay-off when $\overline{\beta}$ is realized

	$\underline{\beta}$	$\overline{\beta}$
$\underline{\beta}$	$t_c-\varphi(e_c+\Delta\beta)$、$t_c-\varphi(e_c+\Delta\beta)$	$2(t_c-\varphi(e_c+\Delta\beta))$、0
$\overline{\beta}$	0、$2(t_c-\varphi(e_c+\Delta\beta))$	$t_c-\varphi(e_c)$、$t_c-\varphi(e_c)$

Proposition 4 *Under the modified model, the dominant strategy for the firm is to make an effort if the regulators can set an appropriate subsidy.*

See the pay-off table below (Table 6). We give the condition when telling the truth is the dominant strategy for all firms. If the condition $t_c \geq 2\varphi(e_c)$ is satisfied, making an effort is the dominant strategy for all firms. We should also note that such a t_c can exist. Therefore, the regulator can realize this dominant strategy equilibrium by setting an appropriate subsidy.

Table 6 The pay-off of the modified model

	$\underline{\beta}$(= Make an effort)	$\overline{\beta}$(= Make no effort)
$\underline{\beta}$	$t_c-\varphi(e_c)$、$t_c-\varphi(e_c)$	$2(t_c-\varphi(e_c))$、0
$\overline{\beta}$	0、$2(t_c-\varphi(e_c))$	t_c、t_c

3.3. Discussion

All the results discussed above are shown in Table 7. We show that modifying the conditions or settings of each policy from the original model would result in different conclusions. A yardstick competition based on the average operating costs of all firms (which we call the average-based yardstick competition) cannot induce firms to tell the truth. However, franchise bidding can induce firms to tell the truth if the regulator can set an appropriate subsidy although information rent is paid to the firm.

We then tried to modify the model. A yardstick competition based on averages was suggested by Shleifer (1985), whose model focused on hidden action. However, Chong and Huet (2009) focused on hidden information. Therefore, we modified the original model into the hidden action model. The results show that each mechanism can induce firms to make an effort to reduce costs through incentives. The yardstick competition cannot set an incentive based on policy variables. On the other hand, franchise bidding can set an incentive based on policy variables (through a subsidy). We conclude that franchise bidding is more desirable than yardstick competition when hidden action is more critical to the market.

The regulators need to know which issue is more critical to the market when determining a policy, hidden action or hidden information. For example, as we mentioned earlier, cost differences between firms in the Japanese regional bus market can occur from the cost

reduction effort of each firm[3]. In such a market, hidden action is a more critical issue, and the modified model may be more fitting for it.

Table 7 Conditions for an incentive

	Hidden information		Hidden action
	Chong & Huet (2009)	Changing policies	Modified model
Yardstick competition	(With compensation) $\varphi(e_c) - \varphi(e_c - \Delta\beta) \leq A \leq \varphi(e_c + \Delta\beta) - \varphi(e_c)$	Average based (based on average)	$\varphi(e_c) \leq \frac{\Delta\beta}{2}$
	(With fine) No incentive	No incentive	
Franchise bidding	No incentive	$2\varphi(e_c) - \varphi(e_c - \Delta\beta) \leq t_c \leq \varphi(e_c + \Delta\beta)$	$t_c \geq 2\varphi(e_c)$

4. Conclusion

In this paper, we compared two policies, yardstick competition and franchise bidding. Chong and Huet (2009) concluded that yardstick competition with compensation is more desirable than yardstick competition with fines or franchise bidding. We modified the settings of these policies and conditions of the model from an asymmetric information perspective. We showed that franchise bidding may work under the conditions of the original model, but average-based yardstick competition will not work. We also showed that if hidden action were a more critical issue to the market, franchise bidding would be more desirable than yardstick competition.

Of course, our model has some limitations. The first is our assumption that the regulators can set a subsidy that would satisfy the incentive-compatible constraint. In reality, it may not be as easy as we suggest for the regulators to set an appropriate subsidy. We have to conduct a more detailed study on how the regulator can gain information about the firm's disutility or utility functions. Another limitation is that we did not consider the possibility of a firm's bankruptcy. If a firm loses in bidding it may go bankrupt, and the competitor firm may change its strategy, for example, by bidding an unreasonable cheap amount to beat the competitor. These issues are challenges for our next research.

[3] An example of cost-reduction effort is cutting the staff or expenditure.

Appendix

Proof for Proposition 1

Under the average-based yardstick competition, if the firms' reports are inconsistent, the reimbursement and subsidy are based on the average of the reports $((\overline{\beta}+\underline{\beta})/2)$. If $\underline{\beta}$ is realized, each firm can reduce its efforts by $\Delta\beta/2(=\frac{\overline{\beta}+\underline{\beta}}{2}-\underline{\beta}=\frac{\overline{\beta}-\underline{\beta}}{2})$ when one firm tells a lie, and by $\Delta\beta$ when both firms tell a lie. As shown in the table1, both $t_c-\varphi\ (e_c-\Delta\beta/2)>t_c-\varphi(e_c)$ and $t_c-\varphi(e_c-\Delta\beta)>t_c-\varphi(e_c-\Delta\beta/2)$ are always satisfied. Therefore, reporting $\overline{\beta}$ is the dominant strategy for all firms even when $\underline{\beta}$ is realized. If $\overline{\beta}$ is realized, each firm will have to increase its efforts when reporting $\underline{\beta}$. As shown in the table2, both $t_c-\varphi(e_c+\Delta\beta)<t_c-\varphi(e_c+\Delta\beta/2)$ and $t_c-\varphi(e_c+\Delta\beta/2)<t_c-\varphi(e_c)$ are always satisfied. Therefore, reporting $\overline{\beta}$ is the dominant strategy for all firms when $\overline{\beta}$ is realized. We now have proof that reporting $\overline{\beta}$ is the dominant strategy for all firms on which a parameter is realized.

Proof for Proposition 2

Under the average-based yardstick competition with the modified model, the reimbursement and subsidy are based on the realized costs of the two firms. If both firms decide to make no effort (and realize $C_i=\overline{\beta}$), each firm will get a reimbursement of $\overline{\beta}$ and subsidy of t_c without any disutility of effort. However, if one of them decides to make an effort (and realize $C_i=\underline{\beta}$), the reimbursement will be $\frac{\overline{\beta}+\underline{\beta}}{2}$, and then the firm making the effort will get an excess reimbursement (above its actual costs by $\frac{\Delta\beta}{2}$). On the other hand, the firm that does not make an effort will get a reduced reimbursement (below its actual costs by $\frac{\Delta\beta}{2}$). Therefore, the firms will decide on whether or not to make an effort taking their excess reimbursement and disutility of efforts into account.

As shown in Table 3, both $t_c-\varphi\ (e_c)\geq t_c-\frac{\Delta\beta}{2}$ and $t_c-\varphi\ (e_c)+\frac{\Delta\beta}{2}\geq t_c$ have to be satisfied to induce firms to make an effort as their dominant strategy. Now, since the first condition can be transformed to $\varphi(e_c)\leq\frac{\Delta\beta}{2}$ and the second can be transformed to $\varphi\ (e_c)\leq\frac{\Delta\beta}{2}$, the necessary condition to induce all firms to make an effort as their dominant strategy is $\varphi(e_c)\leq\frac{\Delta\beta}{2}$.

Proof for Proposition 3

Under franchise bidding, if two firms report the same parameter, then both the firms can get the right to operate their respective markets. If the two firms report different parameters, the firm reporting the lower cost $\underline{\beta}$ will get the right to operate both the markets. If the lower cost parameter $\underline{\beta}$ is realized, the firms may decide which action is more profitable, telling a lie to reduce their effort or telling the truth to get the right to operate both firms.

As shown in Table 4, both $t_c-\varphi(e_c)\geq 0$ and $2(t_c-\varphi(e_c))\geq t_c-\varphi(e_c-\Delta\beta)$ have to be satisfied to induce the firms to tell the truth as their dominant strategy. The above two conditions can be transformed to $t_c \geq \varphi(e_c)$ and $t_c \geq 2(e_c)-\varphi(e_c-\Delta\beta)$, respectively. Since the latter condition is more strict, the condition to induce firms to tell the truth as their dominant strategy is $t_c \geq 2\varphi(e_c)-\varphi(e_c-\Delta\beta)$.

On the other hand, even if the cost parameter $\overline{\beta}$ is realized, both firms have an incentive to tell a lie when the rent obtained from operating the two markets exceeds the increased effort from telling a lie $\Delta\beta$. As shown in Table 5, both $t_c-\varphi(e_c+\Delta\beta)\leq 0$ and $2(t_c-\varphi(e_c+\Delta\beta))\leq t_c-\varphi(e_c)$ have to be satisfied to induce firms to tell the truth as their dominant strategy. The above two conditions can be transformed to $t_c \leq \varphi(e_c+\Delta\beta)$ and $t_c \leq 2(\varphi(e_c+\Delta\beta))-\varphi(e_c)$, respectively. Since the former condition is stricter, the condition to induce firms to tell the truth as their dominant strategy is $t_c \leq \varphi(e_c+\Delta\beta)$.

Therefore, the condition to induce firms to tell the truth as their dominant strategy is $2\varphi(e_c)-\varphi(e_c-\Delta\beta)\leq t_c \leq \varphi(e_c+\Delta\beta)$.

Proof for Proposition 4

Under franchise bidding with the modified model, if two firms realize the same cost level, both the firms will get the right to operate their respective markets. If the two firms realize different cost levels, the firm realizing the lower cost $\underline{\beta}$ would get the right to operate both the markets. Firms decide on whether or not to make an effort by comparing the rents they obtain from operating the two markets with the disutility of their effort.

As shown in Table 6, both $t_c-\varphi(e_c)\geq 0$ and $2(t_c-\varphi(e_c))\geq t_c$ have to be satisfied to induce firms to make an effort as their dominant strategy. The above two conditions can be transformed to $t_c \geq \varphi(e_c)$ and $t_c \geq 2\varphi(e_c)$, respectively. Since the latter condition is stricter, the condition to induce firms to tell the truth as their dominant strategy is $t_c \geq 2\varphi(e_c)$.

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