A theoretical study on yardstick competition and franchise bidding based on a dynamic model

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A theoretical study on yardstick competition and franchise bidding based on a dynamic model

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Abstract

This study aimed to develop a dynamic model based on the static model of Harada and Yamauchi (2014), which compares yardstick competition with franchise bidding.

We focus on collusion among firms, which is one of the differences between dynamic and static models. As a result, we showed that Shleifer-style yardstick competition, which can work well under the static model, cannot work well under the dynamic model. On the other hand, franchise bidding may work well under certain conditions. Thus, we showed that franchise bidding is superior to yardstick competition.

Keywords: yardstick competition, franchise bidding, collusion, dynamic model, hidden action, hidden information

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1. Introduction

In recent years, regulatory reforms have been conducted in markets in which strong official intervention had been carried out previously. These reforms have been aimed at generating more efficiency by introducing competition. However, perfect competition has not been achieved in many markets. In particular, incentive design for the private sector has become a problem in the presence of asymmetric information between regulators and private companies.

As for incentive design after regulatory reform, incentive regulations, such as yardstick competition or franchise bidding, have been adopted. These regulations were adopted in practice at first and theoretical studies followed them. There has been an accumulation of knowledge through the publications of many such theoretical studies.

The study of yardstick competition and franchise bidding has developed separately in different research fields. Yardstick competition has been studied mainly in information economics and franchise bidding in mathematics. However, in recent years, knowledge from information economics has been applied to franchise bidding. Thus, a comparison using a common analytical model has become possible.

Currently, there are not many studies that compare these two mechanisms to analyze which should be adopted under a particular market condition. Harada and Yamauchi (2014) consider such a background and divide two cases by the asymmetric information cause: one is hidden information and the other is hidden action. Then, they investigate the effectiveness of both mechanisms in each model.

However, their analysis uses a static model whereas we would usually assume that the relationship between regulator and company does not end in only one time. We should assume that the regulation game is repeated multiple times. Therefore, in this study, we develop the static model of Harada and Yamauchi (2014) into a dynamic model.

The structure of the rest of this paper is as follows. In Section 2, we provide a literature survey of the theoretical study of the two mechanisms. In Section 3, we provide details of the model and in Section 4, we present the insights from our model. We conclude in Section 5.

2. Literature Review

The theoretical study of yardstick competition was begun by Shleifer (1985), whose model illustrated a situation in which there is information asymmetry from a hidden action. Hidden actions mean that regulators cannot observe efforts to reduce production costs by regulated firms. Under this situation, there is no means to adopt the “cost-plus” pricing mechanism. The regulated firm does not have incentive to reduce costs because its profit always equals zero under the cost-plus mechanism. In addition, Shleifer (1985) examines the "price-cap" method, in which a firm's price is set at the mean cost of all firms, except the firm itself. This method is known as yardstick competition, under which firms voluntarily perform socially desirable cost reduction. Thus, Shleifer (1985) concludes that an incentive design by yardstick competition is effective.

Auriol and Laffont (1992) support the conclusion of the Shleifer (1985) model. They claim that a duopoly is preferable to a monopoly because the former could lead a cost reduction effort through the indirect competition of yardstick competition. Sobel (1999) points out that yardstick competition could cancel information asymmetry and this could lead to underinvestment by the firm. Thus, Sobel (1999) concludes that regulators should commit strongly to effective regulation.

On the other hand, with regard to the theory of yardstick competition presented by Shleifer (1985), there are some problems with the application of the policy to the real world. One problem is the possibility of collusion among firms. If one firm makes a greater cost reduction effort than another, the firm that makes less effort should fall into a deficit. Yardstick competition is an incentive mechanism to lead firms to make voluntary efforts to avoid such a situation. However, the mechanism does not work when all firms collude to make decisions in which no firm makes a cost reduction effort. Based on this, Tangeras (2002) shows that profit from yardstick competition could be completely lost by collusion if correlation of private information among firms becomes large.

On the other hand, franchise bidding sets franchising rights for utilities, bids rights, and gives them to the most price-competitive company. The study of franchise bidding was begun by Demsetz (1968), who stated that it could prevent the setting of monopoly price. In addition, the possibility of collusion among firm falls with an increase in the number of bidders. This is because an increasing number of bidders would lower the funds distributed among colluding firms.

Williamson (1976) examines the effectiveness of the bidding system presented by Demsetz (1968). Williamson (1976) shows that firms with franchising rights are superior to other firms in terms of financial sustainability. In addition, he states that the contract needs to specify how to handle a future environmental change but this is considerably difficult. Following these studies, franchise bidding is considered an effective regulatory mechanism but there are several problems when applying it as real policy.

Thereafter, many studies of franchise bidding focus on the information asymmetry among bidders and regulators. A famous study by Riordan and Sappington (1987) analyzes the kind of policy regulators should adopt to allow monopolistic firms to produce efficiently. They suggest a bidding system that uses a revealing mechanism to choose an effective company. In the revealing mechanism, price and subsidy are set to meet the participation constraint condition and the incentive-compatible constraint condition of the most efficient bidder. It is well known that the price and subsidy realized in the revealing mechanism differ from the social optimum. This is interpreted as information rent. In addition, Laffont and Tirole (1987) and McAfee and McMillan (1987) analyze the issue using a model of private information of the monopolistic firm. These two studies conclude that cost and the effort to reduce cost differ from the social optimum by using the franchise bidding system.

Chong and Huet (2009) is the study whose theme is closest to this study. They compare franchise bidding with yardstick competition in the dynamic model and calculate conditions to prevent collusion. Their results show that firms have incentive to leave collusion under yardstick competition with compensation but have no incentive to leave collusion under yardstick competition with a fine or under franchise bidding. We should note that yardstick competition with compensation or with a fine differs from the yardstick competition illustrated by Shleifer (1985), which is based on the mean cost of firms.

Harada and Yamauchi's (2014) analysis is based on the model of Chong and Huet (2009). Harada and Yamauchi (2014) pay attention to so-called "Japanese yardstick competition," which differs from yardstick competition with compensation or a fine or from so-called "Shleifer yardstick competition." Although Japanese yardstick competition is close to Shleifer yardstick competition as both mechanisms are based on mean cost, there is a difference in whether to include the own cost in the mean cost. In addition, Harada and Yamauchi (2014) show that this point affects the effectiveness of regulation, although their analysis uses a static model.

3. Model[2]

3.1 Model of Hidden Information

We assume two monopoly markets separated by region. Each market has demand of one unit, 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

[2] This model is based on Harada and Yamauchi (2014).

$C_i = \beta_i - e_i$ (1)

β_i is firm i's productivity parameter; both 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 $\varphi(e_i) > 0$, $\varphi'(e_i) > 0$, and $\varphi''(e_i) > 0$. Specifically, the cost level of a firm is determined by its exogenous productivity parameter and endogenous effort on cost reduction.

Both markets are monopolies by nature, and thus, there are regulators. The regulators face an asymmetric information problem; they have no information on the productivity parameter of firms. Therefore, we can conclude that Chong and Huet (2009) use the *hidden information* model, in which firms' productivity parameter is the private information of the firms' insiders only.

The regulators reimburse the firms' for their production cost, C_i, and grant them a subsidy, t_i, as reward for their cost-reduction effort. The regulators have no information about the true disutility, $\varphi(e_i)$, and firm i can obtain information 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 we now discuss.

In Japanese-style 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, represented mathematically as:

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

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

Yardstick competition applied to the Japanese regional transport market includes the cost of all firms. On the other hand, yardstick competition suggested by Shleifer (1985) excludes the firm's own cost from the yardstick. Now, we attempt to modify Japanese-style yardstick competition to exclude the firm's own cost. Under

Shleifer-style yardstick competition, the reimbursed cost is $C_{ci}=\tilde{\beta}_j-e_c$.

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

3.2 Model of Hidden Action

We show that the original model focuses on hidden information because the regulator has no information on the productivity parameter. On the other hand, the average-based yardstick competition (Japanese-style and Shleifer-style) is related to Shleifer's (1985) model, which is the model of hidden action in which 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. Then, we 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. As 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 $C_c=(\mathrm{C}_i+\mathrm{C}_j)/2$(Japanese-style) and $C_c=\mathrm{C}_j$(Shleifer-style).

The franchise bidding of the model of hidden action assumes that expenses are reported in order to know whether the company recognizes that it has realized expense parameter $\overline{\beta}$, and itself makes an effort. Then, the company whose expense is reported as lower would obtain the franchising rights for the two markets.

4. Discussion

Here, we provide the steps of the regulatory process. First, the regulators determine the policy to be implemented in the market. Then, the market productivity parameter is determined from the probability shown in Section 3, such that both 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.

The regulation game is repeated infinitely in the dynamic model. Thus, each firm discounts a future profit by discount rate δ. The strategy that each firm adopts is assumed to be a trigger strategy (i.e., if one firm were to leave the collusive arrangement in a certain period, the other firm would leave from the next period).

Here, collusion is defined as follows. Under the model of hidden information, the firm that participates in collusion would report low productivity, even if high productivity was realized. Under the model of hidden action, the firm that participates in collusion would make no effort, and then, allow low productivity to be realized. The firms make their decisions by comparing the present value of future profit when maintaining collusion with that when leaving collusion.

Table 1. Pay-off when $\underline{\boldsymbol{\beta}}$ is realized (Japanese yardstick competition)

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

Table 2. Pay-off when $\overline{\boldsymbol{\beta}}$ is realized (Japanese yardstick competition)

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

Tables 1 and 2 are the pay-off tables for the case of Japanese yardstick competition applied to the static model of hidden information[3]. Because firms are not given

[3] The details of the pay-off table refer to Harada and Yamauchi (2014).

compensation, even if reporting the truth, they would always lie. Under the dynamic model, there is no profit for firms from leaving the collusive arrangement; therefore, they have no incentive to leave. Thus, they would maintain collusion.

Table 3. Pay-off when $\underline{\boldsymbol{\beta}}$ is realized (Shleifer-style yardstick competition)

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

Table 4. Pay-off when $\overline{\boldsymbol{\beta}}$ is realized (Shleifer-style yardstick competition)

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

Tables 3 and 4 are the pay-off tables for the case of Shleifer-style yardstick competition applied to the static model of hidden information. We calculate the condition to sustain collusion from these tables.

Now, collusion is defined as each firm always reporting low productivity, even if high productivity is realized. The present value of the pay-off to sustain collusion is $t_c - \varphi(e_c - \Delta\beta) + \sum_{t=1}^{\infty} \delta^t \left\{v\big(t_c - \varphi(e_c - \Delta\beta)\big) + (1-v)\big(t_c - \varphi(e_c)\big)\right\}$. If we describe this as $t_c - \varphi(e_c - \Delta\beta) = \underline{U}$ and $t_c - \varphi(e_c) = U$, then the condition can be expressed as $\underline{U} + \frac{\delta}{1-\delta}\{v\underline{U} + (1-v)U\}$.

If a firm were to leave the collusive arrangement and report its true productivity, the pay-off in this period would be $t_c - \varphi(e_c - \Delta\beta)$. After the next period, the other firm would report its true productivity, and the expected pay-off would be $t_c - \varphi(e_c)$. Thus, the present value of leaving the collusive arrangement would be $t_c - \varphi(e_c - \Delta\beta) + \sum_{t=1}^{\infty} \delta^t \big(t_c - \varphi(e_c)\big)$. This condition can be expressed as $\underline{U} + \frac{\delta}{1-\delta} U$.

From this, the condition for sustaining the collusion can be derived as $\underline{U} + \frac{\delta}{1-\delta}\{v\underline{U} + (1-v)U\} > \underline{U} + \frac{\delta}{1-\delta}U$. This condition can be transformed as $\underline{U} > U$. It is clear that $\underline{U} > U$ is always satisfied. Thus, the collusion would always be sustained if Shleifer-style yardstick competition were applied to the static model of hidden information.

Table 5. Pay-off of the model of hidden action (Japanese yardstick competition)

	$\underline{\beta}$(=make an effort)	$\overline{\beta}$(=not make an effort)
$\underline{\beta}$	$t_c - \varphi(e_c)$、$t_c - \varphi(e_c)$	$\frac{\Delta\beta}{2} + t_c - \varphi(e_c)$、$t_c - \frac{\Delta\beta}{2}$
$\overline{\beta}$	$t_c - \frac{\Delta\beta}{2}$、$\frac{\Delta\beta}{2} + t_c - \varphi(e_c)$	t_c、t_c

Table 5 is the pay-off table for the case of Japanese yardstick competition applied to the static model of hidden action. We calculate the condition to sustain the collusion from this table.

Now, collusion is defined as each firm never making any effort, and then, allowing low productivity to be realized. The present value of the pay-off to sustain the collusion is $t_c + \sum_{t=1}^{\infty} \delta^t\, t_c = \frac{1}{1-\delta} t_c$.

If a firm were to leave the collusive arrangement and make an effort, the pay-off in this period would be $\frac{\Delta\beta}{2} + t_c - (e_c)$. After the next period, the other firm would make an effort, and the expected pay-off would be $t_c - \varphi(e_c)$. Thus, the present value of leaving the collusive arrangement would be $\frac{\Delta\beta}{2} + t_c - \varphi(e_c) + \sum_{t=1}^{\infty} \delta^t \{t_c - \varphi(e_c)\} = \frac{\Delta\beta}{2} + \frac{1}{1-\delta} t_c - \frac{1}{1-\delta}\varphi(e_c)$.

From this, the condition for sustaining the collusion can be derived as $\frac{\Delta\beta}{2} + \frac{1}{1-\delta} t_c - \frac{1}{1-\delta}\varphi(e_c) < \frac{1}{1-\delta} t_c$. This condition can be transformed as $\geqq 1 - \frac{\varphi(e_c)}{\frac{\Delta\beta}{2}}$. From this condition, it is clear that a larger $\varphi(e_c)$ or smaller $\Delta\beta$ would allow the collusion to be sustained more easily.

Table 6. Pay-off of the model of hidden action (Shleifer-style yardstick competition)

	$\underline{\beta}$(=make an effort)	$\overline{\beta}$(=not make an effort)
$\underline{\beta}$	$t_c - \varphi(e_c)$、$t_c - \varphi(e_c)$	$\Delta\beta + t_c - \varphi(e_c)$、$t_c - \Delta\beta$
$\overline{\beta}$	$t_c - \Delta\beta$、$\Delta\beta + t_c - \varphi(e_c)$	t_c、t_c

Table 6 is the pay-off table for the case of Shleifer-style yardstick competition applied to the static model of hidden action. We calculate the condition to sustain the collusion from this table. The present value of the pay-off to sustain the collusion would be $t_c + \sum_{t=1}^{\infty} \delta^t t_c = \frac{1}{1-\delta} t_c$.

If a firm were to leave the collusive arrangement and make an effort, the pay-off in this period would be $\Delta\beta + t_c - (e_c)$. After the next period, the other firm would make an effort and the expected pay-off would be $t_c - \varphi(e_c)$. Thus, the present value of leaving the collusive arrangement would be $\Delta\beta + t_c - \varphi(e_c) + \sum_{t=1}^{\infty} \delta^t \{t_c - \varphi(e_c)\} = \Delta\beta + \frac{1}{1-\delta} t_c - \frac{1}{1-\delta} \varphi(e_c)$.

From this, the condition for sustaining the collusion can be derived as $\Delta\beta + \frac{1}{1-\delta} t_c - \frac{1}{1-\delta} \varphi(e_c) < \frac{1}{1-\delta} t_c$. This condition can be transformed as $\geqq 1 - \frac{\varphi(e_c)}{\Delta\beta}$. From this condition, it is clear that it would be more difficult for collusion to be sustained under Shleifer-style yardstick competition than Japanese yardstick competition.

Table 7. Pay-off when $\boldsymbol{\underline{\beta}}$ 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 8. Pay-off when $\overline{\boldsymbol{\beta}}$ 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、$2(t_c-\varphi(e_c+\Delta\beta))$	$t_c-\varphi(e_c)$、$t_c-\varphi(e_c)$

Tables 7 and 8 are the pay-off tables for the case of franchise bidding applied to the static model of hidden information. We calculate the condition to sustain the collusion from these tables.

Now, collusion is defined as each firm always reporting low productivity, even if high productivity is realized. The present value of the pay-off to sustain the collusion is $t_c-\varphi(e_c-\Delta\beta)+\sum_{t=1}^{\infty}\delta^t\left\{v\big(t_c-\varphi(e_c-\Delta\beta)\big)+(1-v)(t_c-\varphi(e_c))\right\}$. If we describe this as $t_c-\varphi(e_c-\Delta\beta)=\underline{U}$ and $t_c-\varphi(e_c)=U$, then the condition can be expressed as $\underline{U}+\frac{\delta}{1-\delta}\left\{v\underline{U}+(1-v)U\right\}$.

If a firm were to leave the collusive arrangement and report its true productivity, the pay-off in this period would be $2\big(t_c-\varphi(e_c)\big)$. After the next period, the other firm would report its true productivity and the expected pay-off would be $t_c-\varphi(e_c)$. Thus, the present value of leaving the collusive arrangement would be $2\big(t_c-\varphi(e_c)\big)+\sum_{t=1}^{\infty}\delta^t\big(t_c-\varphi(e_c)\big)$. This condition can be expressed as $2U+\frac{\delta}{1-\delta}U=\frac{2-\delta}{1-\delta}U$.

From this, the condition for sustaining the collusion can be derived as $\underline{U}+\frac{\delta}{1-\delta}\left\{v\underline{U}+(1-v)U\right\}>\frac{2-\delta}{1-\delta}U$. This condition can be transformed as $\delta\geqq(2U-\underline{U})/(2U-\underline{U}+v(\underline{U}-U))$. From this condition, it is clear that a larger v or a larger $\underline{U}$ would allow the collusion to be sustained more easily. In other words, the possibility to realize high productivity or profit from sustaining the collusion would allow the collusion to be sustained more easily. On the other hand, a larger U would make it more difficult for the collusion to be sustained. U is the profit of leaving the collusive arrangement.

Table 9. Pay-off of the model of hidden action

	$\underline{\beta}$(=make an effort)	$\overline{\beta}$(=not make an 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

Table 9 is the pay-off table for the case of franchise bidding applied to the static model of hidden action. We calculate the condition to sustain the collusion from these tables.

Now, collusion is defined as each firm never making any effort, and then, allowing low productivity to be realized. The present value of the pay-off to sustain the collusion is $t_c + \sum_{t=1}^{\infty} \delta^t t_c = \frac{1}{1-\delta} t_c$.

If a firm were to leave the collusion and make an effort, the pay-off in this period would be $2\{t_c - \varphi(e_c)\}$. After the next period, the other firm would make an effort and the expected pay-off would be $t_c - \varphi(e_c)$. Thus, the present value of leaving the collusive arrangement would be $2\{t_c - \varphi(e_c)\} + \sum_{t=1}^{\infty} \delta^t \{t_c - \varphi(e_c)\} = 2\{t_c - \varphi(e_c)\} + \frac{\delta}{1-\delta}\{t_c - \varphi(e_c)\} = \frac{(2-\delta)\{t_c - \varphi(e_c)\}}{1-\delta}$.

From this, the condition for sustaining the collusion can be derived as $\frac{1}{1-\delta} t_c > \frac{(2-\delta)\{t_c - \varphi(e_c)\}}{1-\delta}$. This condition can be transformed as $\delta \geqq \frac{t_c - 2\varphi(e_c)}{t_c - \varphi(e_c)}$. From this condition, it is clear that $t_c \to 2\varphi(e_c)$ would allow the collusion to be sustained more easily. Thus, a smaller rent from the effort would allow the collusion to be sustained more easily.

5. Conclusion

Table 10 shows the conditions to sustain the collusion under each model.

First, a firm would always allow the collusion to be sustained under Japanese yardstick competition applied to the model of hidden information. In addition, the same results are obtained for Shleifer-style yardstick competition. Thus, these results suggest that yardstick competition would not work well in a market of hidden information. This result differs from the static model, in which we showed that Shleifer-style yardstick competition would work well. This difference arises from the collusion and is characteristic of the dynamic model. On the other hand, we showed that franchise bidding may work well in either market of hidden information or hidden action.

Table 10. Conditions to sustain collusion

<table>
<tr><td></td><td colspan="2">Hidden information</td><td colspan="2">Hidden action</td></tr>
<tr><td rowspan="2">Yardstick competition</td><td>Japanese-style</td><td>Shleifer-style</td><td>Japanese-style</td><td>Shleifer-style</td></tr>
<tr><td>No incentive to tell the truth</td><td>No incentive to tell the truth</td><td>$\delta \geqq 1-\frac{\varphi(e_c)}{\frac{\Delta\beta}{2}}$</td><td>$\delta \geqq 1-\frac{\varphi(e_c)}{\Delta\beta}$</td></tr>
<tr><td>Franchise bidding</td><td colspan="2">$\delta \geqq (2U-\underline{U})/(2U-\underline{U}+v(\underline{U}-U))$</td><td colspan="2">$\delta \geqq \frac{t_c-2\varphi(e_c)}{t_c-\varphi(e_c)}$</td></tr>
</table>

We interpret these results practically. The difference between yardstick competition and franchise bidding is the right to operate a monopoly market. Under yardstick competition, each firm has the right to operate. Thus, they have no incentive to tell the truth or make an effort. On the other hand, under franchise bidding, neither firm has a right to operate in the market. Thus, each has an incentive to tell the truth or make an effort because either may obtain the right to operate in the two markets as a monopoly by doing so.

These results are from the dynamic model based on the static model of Harada and Yamauchi (2014). However, we should point out that this study has some strict assumptions. For example, we do not consider the case of bankruptcy when a firm may lose the right to operate in the market. Thus, we have to continue research in this field to consider such situations.

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