Yardstick competition, franchise bidding and tacit collusion*

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Résumé

Yardstick competition has been advocated by some economists as a means to introduce some virtual competition in regional monopolies (Schleifer[1985]). As with any competitive environment, collusion among firms is an important issue that could undermine the efficiency of the yardstick scheme. In this paper, we week to study incentives to collude tacitly among firms regulated under yardstick competition through a simple, symmetric 2 firms model with an infinitely repeated game. We find that collusion is harder to sustain when the regulator rewards the truth-telling firm. As high rewards may not be credible, we argue that franchise bidding coupled with yardstick competition could be used to disrupt collusive incentive. This is true in our model whenever local monopolies are awarded for sufficiently long periods.

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Introduction

Yardstick competition can be seen as a means to introduce some virtual competition into industries where market competition is not viable. Indeed, if the regulator has several comparable firms operating under his jurisdiction in markets characterized by a natural monopolistic structure, he could devised schemes that specifies the revenues of each firms as a function of the firm's relative performance with respect to its peers. The regulator who uses such a regulatory scheme is able to reduce his asymmetric information position when formulating the regulatory policy (Auriol and Laffont[1992], Auriol[2000]), and at the same time, create incentives for firms to be efficient (Schleifer[1985]).

However, as with any competitive environment, yardstick competition could create incentives for the firms to collude. This would undermine the efficiency of such a scheme. This has led to several authors to study how the scheme should be modified in order to deter collusive behaviour (Laffont and Martimort[2000], Tangerås[2002]). In these studies, however, collusion is modeled as an enforceable side-contract which specifies transfers between firms in order to sustain the collusion among them. While it has been argued that this is just a short cut to a dynamic model for collusion, it is not clear if collusion is really possible when transfers between firms are impossible. Indeed, in the reality, collusions are more likely to be implemented by an implicit contract rather than an explicit one. It is therefore our purpose in this paper to study the possibility of tacit collusion when the regulator uses a yardstick scheme.

In order to test the idea that tacit collusion is sustainable, we have chosen to adopt assumptions that are deemed favourable to tacit collusion. One of such is perfectly correlated firms. On top of this, we will study trigger strategy games (Friedman[1971]), where we suppose that regulated firms will play the collusive strategy until a deviating behaviour reverts the firms back to playing a non cooperative strategy. However, we will assume that firm cannot rely on explicit contract to enforce collusion.

We find that even in an infinitely repeated game, perfectly correlated firms will have some incentives to deviate from the collusive strategy under certain circumstances. This will be true if the regulator can promise high amounts of rewards to the deviating firm, in which case yardstick competition will

deliver the full-information outcome. However, a reward too high may not be realistic, which prompts us to study the introduction of franchise bidding as a tool to destabilize collusive incentives among the firms. We find that this will be the case if the period of time between two franchise bidding is long enough.

Note that it is not in the aim of this paper to study optimal regulatory scheme, nor to study how yardstick competition should be modified in order to deter collusion. We refer the interested reader on this subject to the articles cited above.

The paper will be organized as follows : the first section will set up the static model, which we will study in the second section. In this section, we will focus our attention to yardstick competition and shows how a report-based yardstick scheme allows the regulation to extract firms' private information. We will then be able to discuss on the possibilities that arise when the static model is infinitely repeated. This allows us to study the collusive incentives and deviation incentives that result from yardstick competition. In the fourth section, we study the impact on collusive incentives and deviation incentives introduced by franchise bidding. In this section, we discuss on a static version of the game, before going on to introduce some dynamics of the franchise bidding-yardstick competition game in the following section. We finish by some concluding remarks.

1 The static model

1.1 Technology and preferences

We assume that there are two regional monopolies under the supervision of a regulator. In each region, market is inelastic and, for simplicity's sake, we will suppose that there is a unit demand which generates a gross consumer surplus $S/2$ in each of the market. Furthermore, we suppose that the gross consumer surplus in each market is such that production will always be desired. This is a rather mild assumption, especially when one is dealing with industries that produces essential infrastructure goods such as water, electricity etc.

Each region is being served by a local firm i, $i = 1, 2$ whose technology is characterized by the following cost function :

$$C_i = \beta_i - e_i$$

Costs depend on an exogeneous productivity parameter β_i and on an effort term. Through putting in an amount of effort, the firms could bring down their costs. We shall suppose that $e_i \geq 0$. However, as the saying goes, "the best of all monopoly profits is a quiet life"(Hicks[1935]), it is therefore natural to think that efforts are costly in terms of disutility to the firms, which are operating in monopolistic markets. We note this disutility of efforts by :

$$\phi(e_i), \text{ with } \phi \geq 0, \phi' > 0, \phi'' > 0$$

Thus disutility of efforts is always non negative, it is increasing in effort at an increasing rate.

Since these regional markets are monopolistic in nature, we assume that there is a national regulator already in place to supervise the local firms. The regulator, however, is confronted with an asymmetric information position : he does not exactly know the firms' productivity level β_i nor is he able to monitor efforts e_i of the firms in bring down costs. He can only observe the aggregated cost of each firms C_i. He is, however, able to disagregate the costs into their components through a adequately designed incentive contract.

While it seems more realistic to assume that the firms' costs would depend on some industry-wide factors and local conditions, for simplicity's sake, we will rather assume that only industry-specific conditions impact on each firm's production costs, that is :

$$\beta_i = \beta, \qquad \forall i = 1, 2$$

This assumption implies that the two firms in the model are prefectly correlated. We have deliberately choosen such an assumption, as our aim in this paper is to study collusive incentives induced by yardstick competition. It seems therefore reasonable to assume the most propitious conditions possible for collusive incentives, and study whether if collusion is sustainable under such favourable conditions.

Furthermore, let us assumed that β can take two values : $\overline{\beta}$ with probability v and $\underline{\beta}$ with probability $1 - v$, with $\overline{\beta} > \underline{\beta}$ so that productivity in the industry is high when $\underline{\beta}$ is realized.

We suppose that the regulator will totally compensate the firms for their production costs C_i, while at the same time makes a net transfer t_i to each firms for serving the market. This is an accounting convention classically adopted in the regulatory economics literature. Hence, we can write each firm's rent as

$$U_i = t_i - \phi(e_i)$$

Assuming that the regulator seeks to maximize total social welfare. Since markets are geographically separated, total social welfare in the economy is actually the sum of social market in each market :

$$\begin{aligned} \mathscr{W} &= \underbrace{S - (1+\lambda)\sum_i (t_i + C_i)}_{\text{Net consumer surplus}} + \underbrace{\sum_i U_i}_{\text{Producer surplus}} \\ &= S - (1+\lambda)\sum_i (\beta_i - e_i + \phi(e_i)) - \lambda \sum_i U_i \end{aligned}$$

where λ is the shadow costs of public funds (Laffont and Tirole[1993]). This notion captures the idea that in order to use 1 monetary unit, public autorities need to raise $(1+\lambda)$ monetary units.

1.2 Timing of the static game

In the static game, we suppose that firms observe in the first stage the realized β and it is the private information of the firms. The regulator then commits to a contract, which firms can accept or refuse. Refusing the contract leave the firms with a level of utility U_i^o, which captures the firms' outside options. Without loss of generality, we normalized this utility of reservation to 0. As assumed above, consumer surplus generated by the good is such that its production is always desired. As such, the contracts that the regulator offers must at least satisfy the firms reservation utility. Should the firms choose to produce, the regulator will ask for reports of their private productivity parameter. According to their reports, transfers are paid out to the firms as specified in the regulatory contract and each firm meets its designated target.

2 The static regulatory game

2.1 The full information case

We will now derive the full information case as a benchmark before studying regulation under asymmetric information and yardstick competition. The regulator's problem is given by the programme :

$$\left[\begin{array}{ll} \max_{e,U} & S-(1+\lambda)\sum_i(\beta_i-e_i+\phi(e_i))-\lambda\sum_i U_i \\ s.t. & U_i\geq 0, \qquad\qquad i=1,2 \end{array}\right.$$

The solution to this problem is given by the following conditions for $i = 1, 2$:

$$\begin{array}{lll} \phi'(e_i)=1 & \text{or} & e_i\equiv e^{FI} \\ U_i=0 & \text{or} & t_i=\phi(e^{FI}) \end{array}$$

Interpretation of these conditions are fairly straightforward : the level of effort that the regulator will command will be such that the marginal disutility of effort on the firms is equal to the marginal cost reduction. As rents are costly, the firms will reserve just their reservation utility and no extra rents. This is done by the regulator setting the level of net transfert to compensate the firms for their disutility of effort. We resume this result in the following :

Result 1. *In the full information case, the first best level of effort is such that the firms' marginal disutility is equal to 1, and net transfers for each firm correspond to the level of disutility of efforts required of the firms by the regulator.*

2.2 Yardstick competition

Let us now assume that the regulator is not able to observe disagregate the firms' production costs. Therefore, he has to sollicit for information from the firms with adequately design regulatory contracts. As the regulator has 2 regional monopolies under his jurisdiction, he could use yardstick competition

to filter out the firms' private information on their productivity parameter, thereby finding himself in the symmetric information case. To this end, he asks the firms to report on their private productivity parameters, knowing that the parameters either take on $\underline{\beta}$ or $\overline{\beta}$.

We note a firm i's report $\tilde{\beta}_i$. Under asymmetric information, and without proper incentives, firm i will choose its report so as to maximize its utility, which could be written as :

$$\begin{aligned} U_i(\tilde{\beta}_i, e_i) &= t_i + (\tilde{\beta}_i - e_i) - (\beta - e_i) - \phi(e_i) \\ &= (\tilde{\beta}_i - \beta) + t_i - \phi(e_i) \end{aligned}$$

In the event that $\overline{\beta}$ is realized, reporting $\underline{\beta}$, i.e. $\tilde{\beta}_i = \underline{\beta}$ would bring about a negative utility for the firm, all else being equal :

$$U_i(\tilde{\beta}_i = \overline{\beta}, \overline{\beta}) - U_i(\tilde{\beta}_i = \underline{\beta}, \overline{\beta}) = \underline{\beta} - \overline{\beta} < 0$$

Thus firm i will want to truthfully report the realized productivity parameter. There is no point in cheating in its reports.

However, should it be $\underline{\beta}$ that is realized, reporting $\tilde{\beta}_i = \overline{\beta}$ would result in the firm having more rents :

$$U_i(\tilde{\beta}_i = \overline{\beta}, \underline{\beta}) - U_i(\tilde{\beta}_i = \underline{\beta}, \underline{\beta}) = \overline{\beta} - \underline{\beta} > 0$$

Firm i thus has incentives to cheat on the regulator with untruthful report on the actual productivity parameter. In doing so, it would gain in rents amounting to $\Delta\beta$.

One way for the regulator to induce truthful reports when the realized industry-wide parameter is favorable is to use yardstick competition to filter out the information. In this case, firms are tempted to report the unfavorable productivity parameter. Based on this, any uncompatible reports (that is whenever firm i's report differs from firm j's report, $j \neq i$) will allow the regulator to be informed on the true realization of the state of nature. To incite firms to truthfully reveal the favorable realization of the productivity parameter, Auriol and Laffont[1992], Auriol[1993] and Tangerås[2002] suggest punishing the firm reporting $\overline{\beta}$ whenever incompatible reports arise. This, they show, will induce firms to truthfully reveal their productivity parameter as a nash

equilibrium. In this way, unknown common information can be thought of as being filtered out, bringing the regulator, at least under our assumptions here, into the symmetric information position.

Once the common asymmetric information is filtered out, the regulator will be able to disagregate total production costs, and control for cost-reducing efforts. t_i will be set to $\phi(e^{FI})$.

Result 2. *Under yardstick competition, the regulatory contract is characterized by :*

1. $e_i = e^{FI}, i = 1, 2$
2. $t_i = \phi(e^{FI}), i = 1, 2$ *and*
3. *if* $\tilde{\beta}_i \neq \tilde{\beta}_j, j \neq i$ *then punish firm* i *such that* $\tilde{\beta}_i = \overline{\beta}, i = 1, 2$

The resulting equilibrium is that of the full information.

Therefore, under yardstick competition and when firms are symmetric, there will be no information rent and no effort distortion.

3 Repeated interactions and collusive incentives

In most cases, the production of a regional monopoly good is hardly static. Demand for the good will persist over time, and industrial conditions may change as well from period to period. In a way, the firms will almost always be "in business" and repeatedly interact with the regulator. To study the effects of this, we will assume that the above static game is infinitely repeated. We assume furthermore that, changes from period to period ars captured by the industry-wide productivity parameter. In other words, during each regulatory review, the nature will choose between $\overline{\beta}$ and $\underline{\beta}$ before revealing it to the firms, with probability v and $(1 - v)$ respectively. Here we have assumed implicitly that industry-wide productivity realizations are independent over time[1].

We will assume furthermore that the regulator proposes the same static contract under each regulatory review to the firms. We have seen that to in-

[1]This assumption allows us to abstract ourselves from side issues due to the fact that if the productivity parameter should be time dependent, there will only be asymmetric information during the first period of the game.

duce truthful reports, the regulator could punish the cheating firm. Another possible mechanism in inciting firms to truthful revelation is to compensate the truth-telling firm when incompatible report arises, and only when incompatible report arises. This mechanism will work only if the regulator promise a high enough rewards[2]. Firms, tempted by the prospective of rewards, will be incited to truthfully reveal their productivity parameter in equilibrium, and rewards will never have to be paid. The two ways in inducing revelation is equivalent in the one period game, under the condition that rewards are high enough.

3.1 Infinitely repeated punishment yardstick reporting scheme

Let us now see if punishing firms and rewarding firms for untruthful revelation or truthful revelation respectively would be equivalent when the games are dynamic. To do this, we will suppose that the static game is repeated infinitely. To study this problem, we make use of the trigger-strategy equilibrium (Friedman[1971]). In this configuration, we suppose that firms start by cooperating to report on their reporting strategies. Henceforth, during each review the two firms have the following possible strategies :

1. continue cooperation
2. deviate

The regulator proposes passively during each review the same static contract.

We suppose that firms have a discount factor δ, and that they maximize the same utility function. A cooperation strategy would be to report $\overline{\beta}$ in all states of the nature, while we characterize the deviation strategy as to truthfully reveal the industry-wide productivity parameter. Should there be a deviation strategy by either one of the firms, boths firms will revert back to the non cooperative strategy, i.e. truthful revelation of industry-wide productivity parameter.

Note that in our framework, the only strategic variable that the firms could put to use to their advantage is their reports $\tilde{\beta}_i, i = 1, 2$. In our two type

[2]Otherwise the truth-telling strategy is strictly dominated by the strategy which consists in reporting $\tilde{\beta}_i = \overline{\beta}$. In this case, there will be no truthful reporting on the true realization of the industry-wide productivity parameter.

case, the amount of rents that accrues to the firm i, $i = 1, 2$, is $(\tilde{\beta}_i - \underline{\beta})$, $\tilde{\beta}_i = \{\overline{\beta}, \underline{\beta}\}$.

Under the punishment scheme, the regulator impose a fine P on whichever firm that reports $\tilde{\beta} = \overline{\beta}$ whenever the reports are not compatible. We will write the expected intertemporal payment of a firm i under the various strategies, and we index the rents of firm i under the punishment scheme par $\mathscr{P}$:

1. continuing the cooperation would yield
$$\begin{aligned} U_{i,\mathscr{P}}^{\text{collude}} &= (1-v)\Delta\beta + \delta(1-v)\Delta\beta + \dots \\ &= \frac{1}{1-\delta}(1-v)\Delta\beta \end{aligned}$$
2. and the utility of a non cooperating firm give rise to
$$U_{i,\mathscr{P}}^{\text{compete}} = 0$$
3. deviating once would yield for the deviating firm
$$\begin{aligned} U_{i,\mathscr{P}}^{\text{deviate}} &= 0 + \sum_{t}^{+\infty} \delta^t U_{i,\mathscr{P}}^{\text{compete}} \\ &= 0 \end{aligned}$$

The collusive strategy is therefore sustainable when the game is repeating over time if and only if the discounted payoff from the cooperating strategy is larger than the deviating payoff for each firm :
$$\begin{aligned} U_{i,\mathscr{P}}^{\text{collude}} &> U_{i,\mathscr{P}}^{\text{deviate}} \\ \frac{1}{1-\delta}(1-v)\Delta\beta &> 0 \end{aligned}$$

One can see that, by our assumptions, this inequality is always verified. Thus, under the punishment yardstick reporting scheme, collusion is always sustainable. Deviating from the collusive behaviour does not bring any benefit to the deviating firm when we consider a trigger strategy game.

Result 3. *Under the assumptions of our model, and considering a trigger strategy game, collusion is stable over time when the regulator uses a punishment yardstick scheme. In other words, firms will never deviate.*

3.2 Infinitely repeated reward based yardstick reporting scheme

Let us now turn to the case when the regulator, instead of punishing the firms, rewarding the truth-telling one an amount equals to A whenever there are incompatible reports. We will denote the by the subscript $\mathscr{A}$ the payoff of the firms when playing out different options when the regulator uses a reward yardstick reporting scheme. In this case, while the colluding and competing strategies would yield the same level of utilities as above for the firms, the deviating strategy, should it be played by the firm, would yield

$$U_{i,\mathscr{A}}^{\text{deviate}} = (1-v)A$$

One could easily see that, under the rewarding yardstick reporting scheme, firms could be tempted to play the deviation strategy. The reason is obvious : deviating in a given period allow the deviating firm to reap some rewards from the regulator, should its peer choose to play the collusion strategy. Collusion is therefore stable whenever

$$\frac{1}{1-\delta}(1-v)\Delta\beta > (1-v)A$$

Or in terms of a threhold discount factor, the collusion among the firms are sustainable whenever firms' discount factor is such that

$$\delta > \delta^* = \frac{A - \Delta\beta}{A}$$

We see that when the reward is sufficiently high, and/or the discount factor is sufficiently low (i.e. firms prefer more the present to the future, or that firms are more impatient), then collusion is not sustainable. In other words, under a rewarding yardstick reporting scheme, firms may have incentives to deviate, ensuring thereby that the industry-wide productivity parameter is truthfully revealed to the regulator.

Result 4. *Collusion is not sustainable under the reward-based yardstick reporting scheme if firms discount factor is sufficiently low and/or rewards are sufficiently high.*

3.3 The respective role of punishment and rewards

As one can see, when a game is static, the punishment-based yardstick scheme allows the regulator to achieve the same optimum as a reward-based yardstick competition. However, when we consider an infinitely repeated game with trigger strategies, we can easily see that punishing the lying firm and rewarding the truthful firm in the event of incompatible reports is not equivalent in terms of the sustainability of a possible collusion between the regulated firms.

Indeed, in the first case, the nature of the punishment game itself sustains any possible collusion among firms. Firms are not tempted to deviate from their collusive strategies, because deviating does not bring them any benefits. On the contrary, continuous expected rents are assured when they do not deviate, despite how impatient they can be or the amount of fines. The condition to sustain collusion infinitely is satisfied naturally by our initial assumptions.

However, under the reward-based yardstick scheme, tacit collusion is no longer that stable. Indeed, the ability to collude by the two firms depends on two parameters : the discount factor and the amount of the reward that the regulator would give to deviating firms. When firms are sufficiently impatient, and/or rewards sufficiently high, then the collusion is not sustainable, even when the game is repeated infinitely.

This result suggests that under an infinitely repeated game, the two ways to incite truth-telling are not equivalent. One could argue that a reward-based yardstick scheme should be prefered over a punishment-based yardstick scheme, as it makes collusion harder to sustain for the regulated firms. One could also see that, in equilibrium, the rewards may never have to be paid out by the regulator, because if collusion is not sustainable, then incompatible reports may not arise and there is no need to pay a "truthful" firm to compensate it for its "cooperation" with the regulator.

In this case, should collusion be an issue to the regulator, detering collusion is a simple matter for the regulator : it suffices to promise a reward high enough. Even if public funds are costly, this is not a problem here, as there will be no incompatible report.

However, it could not be credible for the regulator to commit to such high rewards[3]. If firms anticipate that the regulator could never, even in the event of incompatible reports, give out such high rewards, the collusion becomes once again stable. Another way for the regulator to destabilize the tacit collusion formation is to influence on the discount factor. Indeed, as the discount factor could be interpretated as the probability that the ongoing relation will continue in the coming period, the regulator can influence firms' discount factor through diminishing for instance the probability that the firm is going to continue to stay and operate in its market when the next regulatory review arrives. In other words, we could reinterprete the firms' discount factor as the probability that its contract is going to be renewed in the coming regulatory reviews, and dimishing this would diminish the firms' discount factor, thus making the collusion less stable. One way to do this is to introduce franchise bidding (Demsetz[1968]). Our interpretation of franchise bidding as a tool for the regulatory to influence upon firms' discount factor to deter collusion lends itself naturally to support assertions from some economists that yardstick competition couples with franchise bidding can be a solution to disrupt possible collusion (Bouf and Péguy[2001], Lévêque[2004]). We will study this proposition in our next section.

4 Franchise Bidding, yardstick competition and collusive incentives : a static analysis

As we have said above, one means to destabilize the collusion incentive in the reward-based yardstick scheme is to make the probability of ongoing relation with the firms smaller. This, coupled with some rewards, may be able for the regulator to induce truth-telling in an infinitely repeated game with the firms. Franchise bidding is one way for the regulator to influence on the discount factor. As such, it could be argue that franchise bidding can reduce the collusive incentives among firms regulated under yardstick competition. Indeed, with franchise bidding, one can introduce some incertainties on the probability that the firm will operate in the market in the future. This makes deviating from the collusion strategy more tempting, as the expected future gains in this situation reduces.

[3]To be sure that collusion will never arise, the regulator has to promise as much as the expected discounted informational rents.

However, to study the issue further, one cannot merely rely on the discount factor argument. Firms will react strategically during the bidding stage and thereby, influence on the probability that the contractual relationship with the regulator will continue. As there are two firms in our model, and production is always desirable. Taking into account strategic behaviour of the actors is therefore important in order to shed some light on the issue. This is the direction that we will take in this section.

4.1 Timing of the two stage static game

We will now suppose that the two markets are subject to a franchise bidding process before being regulated by yardstick competition. The timing of the static game is now modeled as a 2 stage game :

1. During the first stage,
   (a) the industry-wide productivity parameter is revealed to the firms
   (b) the regulator annonce the type of regulation in the second stage game and put the two markets up for franchise bidding
   (c) the regulator chooses the firms to operate in each market
   (d) in the first period, the bids of the firms are apply
   (e) goods are produced during the first period and payments made according to the winning firms' bid
2. During the second stage,
   (a) the nature chooses the second period industry-wide productivity parameter and reveal it to the firms
   (b) the regulator proposes the relevant regulatory contract(s)
   (c) the firm(s) report(s)/choose(s) the relevant parameter/contract
   (d) productions occured and payments are made according to the second period regulatory contract

In order to simplify the analysis, we will suppose that the discount factor is the same for the firms throughout the static two stage game. This "static" two stage game is then infinitely repeated to examine the effects of introducing franchise bidding.

4.2 Incentive regulatory contracts in the second stage of the game

During the second period in this game, two possibilities can arise :

1. a different firms operate in each market
2. one of the firms operating in the two markets

4.2.1 Two operating firms in each market

In the first case, we will suppose that the regulator will apply yardstick competition, either the reward-based scheme or the punishment based scheme. Note that it may not be optimal for the regulator to do this, i.e. the regulator would do better with an individual contract and regulate each firms seperately. If the firms follow a cooperation strategy, it is easy to see that the expected rent that will accrue to each firm will amount to $(1-v)\Delta\beta$. On the contrary, a non cooperative strategy will leave each firm with no rents if each of them behaves non cooperatively. However, should one firm decides to cooperate, and the other one not, a reward-based scheme will allow this firm to gain $(1-v)A$, whereas a punishment-based yardstick scheme will leave her with nothing, but implies an negative utility for the other firm.

4.2.2 One operating firm in the two markets

In the second case, things get a little more complicated. The regulator can now have two choices of regulatory contracts : either he continues using yardstick competition, or he could instead regulate the firm with using individual incentive scheme. The rationale behind the regulator using such a scheme is simple to understand : the regulator is aware that he is faced with a "global" monopoly when the same firm is operating in the two distinct markets, and he is aware as well that he is in an asymmetry information position with respect to the operating firm. The operating firm can thus benefit from this situation, giving rise to some inefficiencies from the social welfare point of

view. Hence, a better alternative for him can be to apply an individual incentive contract. However, it is possible that yardstick competition be used. We will study each possibility consequently.

Let us first check the case where the regulator would continue to use yardstick competition even if he is faced with the same firm operating in the two markets. We see that the second period for the operating firm would amount in expectation to $2(1-v)\Delta\beta$.

The distribution of the industry-wide parameter is common knowledge. This allow us to specify the incentive contract that the regulator will propose to the firm in place under an individual scheme. Laffont and Tirole[1986,1993] derive the characteristics of such a contract. It can be shown that, given our model, the menu of contracts would have the following form :

1. for the realization of a low industry-wide productivity parameter, $\beta = \overline{\beta}$, the optimal individual incentive contract will leave no rents to the firm and specifies a contract that requires undereffort (with respect to the full-information optimum) from the firm.
2. for the realization of a high industry-wide productivity parameter, $\beta = \underline{\beta}$, the optimal individual incentive contract will leave some rents to the firm in place and specifies a contract that requires an efficient level of effort (with respect to the full-information optimum) from the firm.

These results are obtained under the condition that there is some shadow costs to public funds. When this is the case, rents left by the regulator to the firm is costly, and thereby, the regulator will have to trade-off productive efficiency and costly rents. In order to discourage the firm with a high industry-wide productivity to claim to have a low productivity parameter, the regulator gives up rents so that the firm will have no interest to lie about the truth realization of the industry-wide parameter. Since rents are costly, the regulator will leave no rents to the firm when the low industry-wide productivity parameter is realized, and he will at the same time distort the efforts required from the firm in such a situation. This allows the regulator to limit the amount of rents needed to induce truth-telling when $\underline{\beta}$ is realized. Indeed, the level of effort required from the $\overline{\beta}$ prevents the $\underline{\beta}$ to exploit all the advantage that it could reap by putting in the efficient level of effort. As such, if we note the rent of the operating under this circumstance in a market

$U^{\text{ind}}_{2nd}(\underline{\beta})$, we have $U^{\text{ind}}_{2nd}(\underline{\beta}) < \Delta\beta$.

For our discussion here, what is important is that : whether the regulator continues to replicate a yardstick competition, or if he uses an individual incentive compatible regulatory contract, when the same firm operates in the two markets, it can expect to touch a positive level of rent. We will note this level of rents that accrues to the firm in place $2(1-v)U'_{2\text{nd}}(\underline{\beta})$, where $U'_{2\text{nd}}(\underline{\beta})$ is the amount of rent that the firm touches in the second stage when $\underline{\beta}$ is realized in the market during this stage, and conditionnally to the regulation that is applied in this stage.

4.2.3 Payoffs and strategies in the second stage of the game

We summarized this in the following :

- When the two firms operate in each market separately, there will be zero rent for each firm if firms play non cooperative strategy. On the other hand, if firms play a cooperative strategy, then rents accrue to each firm amounts to $(1-v)\Delta\beta$.
- When there is only one firm in the operating market, the expected rent that accrues to the operating firms will be positive, and amounts to $2(1-v)U'_{2\text{nd}}(\underline{\beta})$.

4.3 Bidding for contracts in the first stage

During the first stage of the game, firms will bid for each market. To study the outcome of this game, we will have to specify how the regulator will attribute each markets according to the bids submitted by the firms. To this end, it seems reasonable to suppose that the regulator will attribute the markets to the lowest bid in each market should the bids differ. In the event that the bids are the same in each market for the two firms, then the regulator attributes a market to each firm respectively. We suppose moreover that firms will submit bids on the industry-wide productivity parameter, and that the bids are submitted simultaneously for the two markets. The last two assumptions allows us to simplify our analysis. They allow us to avoid checking other possible strategies that firms could have, and tend to facilitate

eventual collusion between firms.

4.3.1 Cooperative strategy

Once again, a collusive/cooperating strategy at this stage of the game will consist of reporting $\tilde{\beta} = \overline{\beta}$ whatever the realizations of the real β. If the firms decide to collude, they will have to share the markets, i.e. each firms will operate in each market. In the static version of this game, given that under a reward based yardstick competition, if the reward A is sufficiently high, i.e. if $A \geq \Delta\beta$, then the resulting equilibrium leaves each firm with no rents. Otherwise, collusion will be an interesting option. However, under the punishment scheme, the second stage game implies a non cooperative outcome. As such, the utility of the collusive strategy at the bidding stage would depends on the yardstick scheme in place during the second period :

- under the punishment-based yardstick scheme, a market sharing strategy would yield the following utility of each firm :

  $$\mathscr{U}^{s,p} = (1 - v)\Delta\beta$$

  Since the game is static, at the second stage, firms will report truthfully the realized industry-wide productivity parameter for fear of reports. This is exactly the result of the static yardstick game. Thereby, a cooperative market sharing strategy at the first stage would only yield the expected informational rents in the first stage game.
- under the reward-based yardstick competition, if the reward is high enough, then a market sharing strategy would yield

  $$\mathscr{U}^{s,r(h)} = (1 - v)\Delta\beta$$

  The reasoning is the same as above, except for the fact that the firms are tempted in the second stage by the prospects of rewards that could be higher than the resulting collusive informational rents.
- under the reward based yardstick competition, if the reward promised is not high enough, then a market sharing strategy would yield

  $$\mathscr{U}^{s,r(l)} = 2(1 - v)\Delta\beta$$

  Indeed, when the rewards are not high enough, cooperation in the second stage dominates a truth-telling strategy. This would yield the expected informational rents that arise from the second stage cooperative strategy.

The regulator will choose to impose either a punishment-based yardstick competition, or a reward-based one with a high enough reward. Indeed, using a reward-based scheme with a promised reward is low will not deter collusion between the firms, even under the static case. It would seem unreasonable to suppose that a regulator to adopt such a scheme. As such, the resulting payoff for market sharing strategy among firms at the bidding stage would be $\mathscr{U}^s = (1-v)\Delta\beta$.

4.3.2 Non cooperative strategy

At the bidding stage, firms could adopt a non market sharing strategy as well. In this situation, the two firms would compete for the rights to operate in the two markets. Two scenarios are then possible in this configuration :

1. truth-telling on the period's realized industry-wide parameter.
2. report $\tilde{\beta}_i = \underline{\beta}$ whatever the realization of the industry-wide parameter.

For the two possibilities, one will have to study on firm i's utility faced with possible strategy from firm j, where $j \neq i$. In the first scenario, we will have

- if firm j plays the market sharing strategy, and firm i plays the non market sharing strategy, then firm i will be able to have the rights to operate in the two markets. Truth-telling when $\underline{\beta}$ is realized implies that at the first stage, firm i's utility is 0, as no rents will accrue to firm i from its informationnal advantage. On the contrary, he can expects a level of utility that is equals to $2(1-v)U'_{\text{2nd}}(\underline{\beta})$ during the second stage. Total expected utility for firm i is therefore $2(1-v)U'_{\text{2nd}}(\underline{\beta})$, where $U'_{\text{2nd}}(\underline{\beta})$ depends on the regulatory scheme that is in place in the 2nd stage.
- if firm j plays a the nonmarket sharing strategy as well, then each firm would operate in each of the markets during the second stage of the game. This would leave each firm with no rent during the first stage of the game. During the second stage, by assumption, there will be no rents for the two operating firm neither. As such, total expected utility for firm i in this case would be 0. This is because when the regulator would use a punishment-based yardstick scheme, or promised a sufficiently high rewards when incompatible reports arise.

The situation is symmetric for firm j as well.

Another possible strategy that firms could play in order to capture all the markets would be to report $\underline{\beta}$ whatever the realization of the true industry-

wide productivity parameter. It could be rationale for the firms to play this strategy, given that if it secures the two markets, the amount of second stage rents that accrues to it might be worth the first stage loss. As with above, firm i's level of utility is playing such a strategy would depend on firm j's strategy, $j \neq i$. This strategy is non trivial when the true realization of the industry-wide productivity parameter is $\overline{\beta}$. We will look into this as above :

- if firm j reports $\underline{\beta}$ as well when the true parameter is $\overline{\beta}$ then in the first stage game, firm $\overline{i}$ will have a loss of $-\Delta\beta$. The two firms will operate in the each of the markets, and thereby, have a second stage rent that equals 0. Total expected utility is therefore $-\Delta\beta$.
- if firm j reports truthfully $\overline{\beta}$, then firm i will operate in the two markets. As with above, during the first stage, firm i suffers a loss of $2\Delta\beta$ while during the second stage, rents amounting to $2(1-v)U'_{2\text{nd}}(\underline{\beta})$ will acrues to firm i, leaving it with total expected utility $-2\Delta\beta + 2(1-v)U^{\text{ind}}_{2nd}$. Given that $U'_{2\text{nd}}(\underline{\beta}) \leq \Delta\beta$, and that $v < 1$, This total expected utility is negative for firm i.

Result 5. *Firms will never play a strategy that implies in reporting $\tilde{\beta}_i = \underline{\beta}$ when the true industry wide productivity parameter is $\overline{\beta}$.*

So, as we have seen, reporting $\underline{\beta}$ whatever the realization of the true β is dominated by the truth-telling non market sharing strategy that both firms can play. Indeed, such a strategy would only leave the firm playing it with a negative level of utility, whereas truth-telling leaves it with a level of utility at 0. Firms will only choose to play to truth-telling strategy in the first stage when they decide not to cooperate.

4.4 The equilibrium of the static game franchise bidding-regulation

To find the qeuilibrium of the static game, it is useful to use the following payment matrix with each firm's corresponding strategies :

	Market sharing	Non market sharing
Market sharing	$(1-v)\Delta\beta, (1-v)\Delta\beta$	$0, 2(1-v)U'_{2\text{nd}}(\underline{\beta})$
Non market sharing	$2(1-v)U'_{2\text{nd}}(\underline{\beta}), 0$	0,0

The outcome of the game will therefore depend on whether, for a given firm, the payment for the market sharing strategy would dominate the non market sharing strategy. Should the regulator apply a yardstick scheme during the second stage scheme when there is only one firm operating in the two markets, we will have $U'_{2\text{nd}}(\underline{\beta}) = \Delta\beta$. This latter term is always greater the the payment that stems from the market sharing strategy. Therefore, the nash equillibrium will have both firms playing the non market sharing strategy, delivering the first best full information outcome without the regulator having to give up any rents.

Should the regulator applies an individual scheme during the second stage game, then $U_{2\text{nd}}(\underline{\beta}) < \Delta\beta$. So long as the amount of rents stemming from the firm's asymmetric information under the invidual contrat $U^{\text{ind}}_{2\text{nd}}$ is greater than $\frac{\Delta\beta}{2}$ then the nash equilibrium will again be the non market sharing pair of strategy. Otherwise, a market sharing strategy will be the resulting nash equilibrium.

Result 6. *In a static game in which franchise bidding is used to attribute markets before a regulation stage is applied on firms, the resulting equilibrium will depend on the type of regulation applied during the regulation stage. When yardstick competition is used during the second stage, then the nash equilibrium is the full information one, whereas in the case of an individual incentive scheme during the second stage, the outcome depends on the amount of informational rents specified by the regulatory contract.*

This result indicates that when franchise bidding is used to attribute several local markets, and should regulation be deemed desirable, then it is better for the regulator to implement yardstick competition. The intuition is that when the regulator commits to using yardstick competition even if the two markets are being operated by the same firm, he is actually committing to giving the winning firm some rents should it not collude. This induces firms to compete for the markets, instead of sharing them.

5 Infinitely repeated franchise bidding with yardstick competition

Let us now turn to the study of the infinitely repeated framework with franchise bidding in the first stage of the game. We will start with a simple case, that is, we suppose that if firms choose to collude, then they do so during the two stages of the game.

5.1 Market sharing vs. Non market sharing

Hence, a market sharing and colluding strategy would yield $2(1-v)\Delta\beta$ for each firm during one period. An ongoing collusive strategy would therefore yield for each firm

$$\frac{1}{1-\delta}2(1-v)\Delta\beta$$

Given our framework, one possible deviating strategy would be to play a non market sharing strategy, where the deviating firm would operate in the two markets during the second stage of the game[4]. At the first stage, since the deviating firm would apply a truth-telling strategy, his level of utility is 0, whereas at the second stage, he could expect a level of utility which amounts to $2(1-v)U_{2nd}^{\text{ind}}$, where U_{2nd}^{ind} is always positive and depends on the regulatory policy that the regulator would wish to apply on the single firm in the two markets.

As with trigger-strategies model, both firms would revert back to the non-collusive strategy. In our study, this is in fact the truth-telling strategy for both firms after a deviation,. As we have seen, with such a strategy firms' rent would amount to 0.

[4]Another possible deviating strategy would have the deviating firm sharing the market with the other firm in the first stage of the game, and play the non cooperative strategy at the second stage. This scenario is only possible when a reward-based yardstick competition is used during the second stage. Indeed, under a infinitely repeated game, punishment-based yardstick competition does not incite firms to deviate in this stage.

We can now derive the utility level for a firm i when it plays the non-market sharing strategy. This is in fact the sum of rents stemming from the non-market sharing strategy and actualised rents stemming from the truth telling strategy. the latter being 0, the non market sharing would therefore yield $2(1-v)U'_{2\text{nd}}(\underline{\beta})$.

Considering trigger strategies, collusion among firms is only sustainable if and only if

$$\begin{aligned} \frac{1}{1-\delta}2(1-v)\Delta\beta &> 2(1-v)U'_{2\text{nd}}(\underline{\beta}) \\ \frac{1}{1-\delta}\Delta\beta &> U'_{2\text{nd}}(\underline{\beta}) \end{aligned}$$

Note that since $U'_{2\text{nd}}(\underline{\beta}) \leq \Delta\beta$, the above inequality holds for all value of δ. Collusion is therefore always sustainable when we consider trigger strategies game.

Result 7. *In an infinitely repeated franchise bidding-regulation scheme, collusion is sustainable in trigger strategy games, whatever the form of yardstick competition scheme or individual scheme applied.*

We see that franchise-bidding is not sufficient to discourage collusion in this case. In reality, for most local monopolies, when franchise bidding is used to attribute markets, contracts attributed by such a mechanism normally has relatively long duration. We thus turn now to study the case where franchise bidding is followed several stages of regulation before the markets are up for grabs once again.

5.2 Relatively heavier use of yardstick competition

Let us assume that after an initial franchise bidding stage, yardstick competition is being applied during n stages before the market is reallocated again. An infinitely market sharing strategy would yield $\frac{1}{(1-\delta)}(n+1)\Delta\beta$ for each firm, whereas a deviating strategy would yield rents amounting to

$$0 + n \times 2(1-v)U'_{2nd}(\underline{\beta}) + \frac{1}{(1-\delta)}0$$

under trigger strategies. This is simple the sum of rents that the deviating firm touches during the franchise bidding stage, the successive regulation stages when it is the only firm operating in the two markets, and rents resulting from the truth-telling strategy after deviation.

If there are n stages of yardstick competition after the franchise bidding stage, then collusion is sustainable if

$$\begin{aligned} \frac{1}{(1-\delta)}(n+1) &> 2n \\ \delta^* &> \frac{n-1}{2n} \end{aligned}$$

We can see that the threshold discount factor is in fact increasing in the number of stages that yardstick competition will be applied :

$$\begin{aligned} \delta_n^{*\prime} &= \frac{1}{2n^2} \\ &> 0 \qquad \text{for all } n > 0 \end{aligned}$$

In order to sustain collusion in this case, firms will have to be more patient when the number of stages before franchise bidding is used increase.

Result 8. *When considering trigger strategies equilibrium, market sharing becomes less and less sustainable as the lapse of time between two franchise bidding increase when the regulator applies yardstick competition after an initial franchise bidding stage.*

When collusion is not sustainable given the firms', the non market sharing strategy will be played by both firms, and the regulator will be able to induce the full-information outcome using yardstick competition in all successive stages following the initial franchise bidding, without actually having to pay for the rents. Our results argues for a long lapse of time before each bidding stage, and suggest the use of yardstick competition to deter collusion during franchise biddings.

6 Conclusion

6.1 Discussions

We have seen that under an infinitely repeated yardstick competition framework, a punishment-based scheme has the perverted effect of rendering any collusion strategy stable, while a reward-based scheme can destabilized collusion incentives. On the contrary, in the static framework, the punishment-based scheme is equivalent to the reward-based scheme as long as the reward promised to the firms is high enough. When interactions are frequent between the regulator and the firms, the regulator should therefore prefer a reward-based yardstick competition, should he want to implement such a scheme. We have shown that, under very favourable assumptions for collusion, yardstick competition could still bring about the full information outcome, and the regulator is able to discourage any collusion.

However, it may be difficult for the regulator to commit himself to paying high amount of rewards. Credibility plays an important role in the efficiency of such a scheme. Should the firms believe that the rewards promised are not credible, then collusion between the firms under the yardstick scheme would persist.

Moreover, the amount of rewards that the regulator should promise should be very high under the yardstick scheme. This would prove to be a difficulty for the regulator. In reality, it seems reasonable to think that the regulator would be more credible if he promises small amounts of reward rather than very high ones. Therefore, collusion incentives between the firms might persist should the regulator relies solely on promised rewards to deter such a behaviour.

One way to circumvent the problem is to influence on the discount factor of the firms. Indeed, the discount could be interpreted as the probability that the relation will continue into the next period. When the discount factor is low enough, then firms will value more present rents to future ones, thereby decreasing the amount of rewards that the regulator should promise in order to deter collusive behaviour.

Franchise bidding can be used as a tool for the regulator to influence on the

firms' discount factor. We show that this is indeed the case if the lapse of time between two franchise bidding is long enough. Tempted by the prospective of rents, perfectly correlated firms will not be able to sustain the tacit collusion between them. This will induce the full-information outcome in the regulated markets. Presumably, the regulator can more easily commit to using yardstick competition is subsequent periods following franchise bidding than to promise high amount of rewards. This would confirm intuitions of some authors who advocate the use of franchise bidding in addition to yardstick competition in order to discourage any collusive equilibrium from arising.

Another interesting insight that from our analysis is that when the regulator cannot commits to very high rewards, he could instead use a punishment-based scheme, but commit himself to using yardstick competition in the subsequent stages that follow the initial franchise bidding. One could expect that it may be more credible for the regulator to commit himself on this dimension of his action, rather than on rewards.

6.2 Limits and extensions

The results that we have derived in this study has several limits.

We would like to draw attention to the fact that as the length number of stage in which firms are administered yardstick competition after the franchise bidding stage increases, collusion is harder to sustain. Intuitively, we feel that there should exist a trade-off between the number of stages. The reason is as follows : if the number of stages increase, collusive incentives will increase by the prospects of future rents. However, should the number of stages becomes too large, the game with the franchise bidding variant will tend towards a infinitely game of repeated yardstick competition, whereby to deter collusion, the regulator will have to revert to promises of high rewards for any deviating firms. In this case, the credibility issue becomes once again important, and the regulator should promised once again high rewards to deter collusion. It would therefore the lapse of time between two bidding stage should be large, but not too large, so that yardstick competition part of the game will not dominate and erase the role of franchise bidding. We will investigate this issue further in the near future.

We have oversimplify the stakes that firms could have in order to grab all the markets. Indeed, a winning firm who operates in a market could benefit in terms of technology and information with compare to a firm that stays "out of business" until the next bidding stage. There should be an asymmetry between a firm that operates and a firm that has not for some time (Williamson[1976]). Therefore, winning both markets would imply for the winning firm more more important rents in all sucessive bidding stage and regulation stage. This might erode all the more any collusive incentive when franchise bidding is introduced in addition to yardstick competition.

All this said, we believe that our results would help to recognized that collusion is no simple matter in real life. Even under very strong and favourable conditions for collusion, we have shown that such a behaviour can still be deterred by teh regulator. When firms are asymmetric, and informational asymmetries arise between them too, a collusion between firms under yardstick competition would be harder. This result shows that collusion might not be a problem in reality, should the regulator uses yardstick competition.

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