# Yardstick competition, franchise bidding and collusive incentives*

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**Abstract**

Yardstick competition has been advocated by some economists as a means to introduce virtually some competition into regional monopolies (Schleifer[1985]). As with any competitive environment, collusion among firms is an important issue that could undermine the efficiency of yardstick competition. In this paper, we study incentives to collude among firms regulated under such a scheme through an infinitely repeated game with two perfectly symmetric firms. We find that collusion is harder to sustain when the regulator rewards the truth-telling firm. Franchise bidding mechanisms may be a way for the regulator to influence firms' discount factor, and is therefore a tool through which the regulator could use to make collusion harder to sustain. We study how collusive incentives could be changed when the regulator uses franchise bidding to attribute markets before regulation. We show that if the period of time between two franchise bidding stage is long enough, firms will find it harder to sustain a self-enforcing collusive bids to share the markets.

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## Introduction

Yardstick competition (Schleifer[1985]) is a means by which competition may be introduced into naturally monopolistic segments of network industries such water distribution, public transportations etc. As Klein and Gray[1997] noted, reforms seeking to privatize network industries may not be able to bring about long lasting public benefits if governments do not address the policy to account for problems that is linked to the monopoly segment of the privatized industry. Under yardstick competition, competition is created because each regulated firm's payments under the scheme would depend on its performance relatively to that of its peers.

Yardstick competition has been used in various sectors by various countries to introduce competition where market competition is not viable. For instance, the US Medicare Program is essentially a form of yardstick competition (Schleifer[1985], Dranove[1987]). Yardstick competition is also applied in the Japanese railway sector (Mizutani[1997], Okabe[2004]) , the Norwegian bus industry (Dalen and Gomez-Lobo[2003]), and the UK water sector (Cowan[1997]) among others.

As with any competitive environment, yardstick competition could lead to collusive behaviour among firms. Collusion would then undermine the efficiency that such a scheme that seek in the first place to introduce competition into a monopoly industry. Notably, the public benefits of introducing competition into such industries could be offset by collusion among the firms.

In this paper, it is our aim to study how collusive incentives are created or altered when a regulator uses yardstick competition in locally monopolistic markets. We will also check into the case to see how collusive incentives are altered when franchise bidding is used simultaneously with yardstick competition to regulate locally monopolistic industries. Examples of such industries include local transportation and water distribution. In order to study regulated firms' collusive incentives, we will mobilize an infinitely repeated game framework. Indeed, throughout this article, we will restrict ourselves to collusion of a tacit nature. We define tacit collusion in a broad sense, meaning that whatever collusive contract that firms may established among themselves has to be self-enforcing. In other words, we allow for the fact that tacit collusion may be supported by a contract, so long that the contract is self-enforcing, and we only collusion that are based on a explicit contract that is enforceable by a third party, for instance, a court[1]. Collusion is all the more likely under yardstick competition if the collusive pact is all the more self-sustainable under a repeated game framework. We will also adopt some assumptions that are deemed favorable to sustain collusion. One of such is that the regulated firms are perfectly correlated. Indeed, one may argue that collusion among asymmetric firms is more difficult to sustain in absence any side payments. According to Cabral[2000], Jacquemin and Slade[1989] and Rothschild[1999], increasing heterogeneity in terms of costs among firms makes coming to a collusive agreement harder[2]. On top of this, we will consider grim trigger strategy games (Friedman[1978]), where we suppose that regulated firms will play the collusive strategy until a deviating behaviour reverts all firms back to playing a non cooperative strategy.

We find that even in an infinitely repeated game, perfectly correlated firms may have some incentives to deviate from the collusive strategy under some circumstances. This is true if the regulator may promise high compensation to encourage deviating strategies from firms, in which case yardstick competition can induce 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.

[1]We restrict attention to this class of collusion for several reasons: first of all, regulated firms operate in market geographical areas. This would possibly render explicit collusion harder. Besides, it seems unlikely that judiciairy instances would enforce explicit collusive contracts. Moreover, where collusion is supported byb an explicit contracts, the regulator, or other competition authorities, may disposed of other instruments such a leniency programs or whistle-blowing to deter collusion.

[2]For instance, Cabral[2000], in p. 138, states that "*Collusion is normally easier to maintain among few and similar firms*".

Note that it is not in our intention to study the optimal yardstick competition scheme or franchise bidding schemes, nor it is our aim to study the optimal trade off between various schemes.

The paper will be organized as follows: we will begin with a review of some related literature on the issue, before setting up a simple static model. Benchmark cases on the full information case are derived and we show how yardstick competition allows the regulator to extract information rents and promote efficiency. This allows us to study collusive incentives when yardstick competition is used repeatedly to regulate firms. This is the object of the third section. In the fourth section and fifth section, we study again the impact of collusive incentives under a static and an infinitely repeated game framework when the yardstick competition is used simultaneously with franchise bidding. Concluding remarks come after.

## 1 Some related literature

To our knowledge, there are only two theoretical studies that has been carried out in studying collusive incentives introduced by yardstick competition: Tangerås[2002], and Laffont and Martimort[2000]. The objective of the two papers is to characterize the optimal collusion proof yardstick competition. To this end, the authors use a mechanism design framework, where collusion is sustained through a enforceable side contract with side transfers among firms through a benevolent third party. This modelization, noted the authors, can be seen as a short cut to modelizing a collusion that is sustained through a repeated game framework. They are then able to derive the trade off between incentives and allocative efficiency, given that the regulator has to account for collusion proofness in using a yardstick scheme. They show that in such a setting, the yardstick regulatory scheme optimally trades off efficiency and rents that that have to be given up in order for firms to behave honestly. The major difference between the two articles resides in that firms may or may not be in possession of private information when writing the collusive side agreement, and consequently, the regulator may exploit internal incentive problem of the collusive side agreement in Laffont and Martimort[2000]'s setting, where the collusive side agreement concerns privately informed firms.

Our approach differs from the setting above, in that we will consider an infinitely repeated game approach to understanding collusive incentives under yardstick competition. Firms must therefore rely on a self-enforcing collusive contract. We add furthermore to the literature in evaluating collusive incentives when franchise bidding is used in conjonction with yardstick competition, or some kind of incentive regulation. The reason for considering this configuration will become clear in later parts of the discussion.

# 2 The static model

## 2.1 Technology and preferences

We assume that there are two regional monopolies under the supervision of a regulator. In each region, market demand 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 $\beta_i$ 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 $\beta_i$ nor is he able to monitor efforts $e_i$ of the firms in bring down costs. He can only observe the realized 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 $\beta$ can take two values: $\overline{\beta}$ with probability $1 - v$ and $\underline{\beta}$ with probability $v$, 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 usually 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 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 $\lambda$ 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.

### 2.2 Timing of the static game

In the static game, we suppose that the firms will first observe the realized $\beta$ and it is their private information. The regulator then announces the scheme that he will use, either to attribute the market through franchise bidding, or to use yardstick competition, and in the latter case, commits to some sort of regulatory contract. Refusing to participate in the market(s) leaves 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 participate in the market(s), the regulator will ask for reports of their costs. According to their reports, gross transfers are paid out to the firms as specified in the regulatory contract and each firm meets its designated target.

# 3 Regulation with yardstick competition

## 3.1 The full information case

We will now derive the full information case as a benchmark before studying yardstick competition under asymmetric information. When the regulator can fully observe the firms' private information, the choice of the firm is irrelevant given that both firms are symmetric. The contract which the regulator will propose is stated by the following proposition:

**Proposition 1.** *In the full information case, the regulator will set the price such as a firm i will be totally reimburse of its costs and costs reducing efforts:* $t_i^{FI} = \phi(e^{FI})$, $C^{FI} = \beta_i - e^{FI}, \beta_i \in \{\underline{\beta}, \overline{\beta}\}$. *On top of that, cost reduction that is required on the firm* $i$, $i = 1, 2$, *will be such that the marginal cost of cost reduction is equal to the marginal benefit of cost reduction. Formally, the first best level of efforts* $e^{FI}$ *is such that* $\phi'(e_i^{FI}) = 1$.

*Proof.* see appendix. □

Note that under full information, the regulator will leave the firms with no rents because rents are costly. Allocation efficiency and production efficiency can be achieved, since the regulator shares the same information as the firms.

## 3.2 The asymmetric information case

Let us now turn to the case where the regulator observes the firms' realized costs, but does not know the true value of $\beta_i$ and does not monitor the level of effort . The regulator, however, knows the distribution of the $\beta_i$. Appealing to the revelation principle, we could restrict our attention to direct revelation mechanisms, where the regulator commits to some transfer and the cost target according to firms' direct reports on their $\beta_i$. In a nutshell, we could characterize the direct revelation mechanism in our case as the pair $\{t(\tilde{\beta}_i), C(\tilde{\beta}_i)\}_{\tilde{\beta}_i \in \{\underline{\beta}, \overline{\beta}\}}$, where $\tilde{\beta}_i$ is firm $i$'s report on the industry-wide productivity parameter, $C(\tilde{\beta}_i)$ is the cost target for report $\tilde{\beta}_i$ and $t(\tilde{\beta}_i)$ is the transfers associated with report $\tilde{\beta}_i$.

### 3.2.1 Firms' behaviour

The firm's utility, given a contract, can be written as:

$$U_i(\tilde{\beta}_i, e_i) = t_i(\tilde{\beta}_i) + C(\tilde{\beta}_i) - C(\beta_i) - \phi(e)$$

In the event that the regulator ignores his asymmetric information and proposes the full information contract, and that $\overline{\beta}$ is realized, a regulated firm reporting $\underline{\beta}$ will have to meet the cost target $C(\underline{\beta}) = \underline{\beta} - e^{FI}$, and it receives $t(\underline{\beta}) = \phi(e^{FI})$. In order to attain the cost target, the firm will have to make an effort $\Delta\beta + e^{FI}$, where $\Delta\beta$ is defined as $\overline{\beta} - \underline{\beta}$. The firm's utility is therefore:

$$\begin{aligned} U_i(\tilde{\beta}_i = \underline{\beta}, \overline{\beta}) &= \phi(e^{FI}) + (\underline{\beta} - e^{FI}) - (\overline{\beta} - e^{FI} - \Delta\beta) - \phi(e^{FI} + \Delta\beta) \\ &= \phi(e^{FI}) - \phi(e^{FI} + \Delta\beta) \end{aligned}$$

Given our assumptions, $\phi(e^{FI} + \Delta\beta) > \phi(e^{FI})$, we thus have $U_i(\tilde{\beta}_i = \underline{\beta}, \overline{\beta}) < 0$, whereas $U_i(\tilde{\beta}_i = \overline{\beta}, \overline{\beta}) = 0$. Thus, when $\overline{\beta}$ is realized, firms will never have any incentives to report $\underline{\beta}$. Thus firm $i$ will want to truthfully report the realized productivity parameter. There is no point in cheating in its report.

However, if $\underline{\beta}$ that is realized, a firm reporting $\tilde{\beta}_i = \overline{\beta}$ would have utility:

$$\begin{aligned} U_i(\tilde{\beta}_i = \overline{\beta}, \underline{\beta}) &= \phi(e^{FI}) + (\overline{\beta} - e^{FI}) - (\underline{\beta} - e^{FI} + \Delta\beta) - \phi(e^{FI} - \Delta\beta) \\ &= \phi(e^{FI}) - \phi(e^{FI} - \Delta\beta) \end{aligned}$$

Since $\phi'(\cdot) > 0$ and $\phi''(\cdot) > 0$, we will have $\phi(e^{FI}) > \phi(e^{FI} - \Delta\beta)$, that is $U_i(\tilde{\beta}_i = \overline{\beta}, \underline{\beta}) > 0$. On the other hand, if the firm had reported truthfully, it would secure a level of utility that is equal to 0. Therefore, firm $i$ has incentives to cheat on the regulator with untruthful report. In doing so, it would gain in rents amounting to $\phi(e^{FI}) - \phi(e^{FI} - \Delta\beta)$. Notice here that the informational rents that accrues to the efficient type firm is measured in terms of economy of disutility of efforts given its superior technology[3]. In order to ensure truthful revelation of $\beta_i$, the regulator will have to design a mechanism that allows him to solicit the firms' private information. One of such mechanisms is yardstick competition.

### 3.2.2 Yardstick competition

Since the regulated firms' are perfectly correlated, the regulator could build a mechanism around this correlation so as to incite the firms to truthfully reveal their private information. Yardstick competition is one such mechanism. Under yardstick competition, the firms' payoff will be conditionned on their own report and report of the other firm. Let us note $(t_i(\tilde{\beta}_i, \tilde{\beta}_j), C_i(\tilde{\beta}_i, \tilde{\beta}_j))$ the transfer/cost contract for firm $i$ when it reports $\tilde{\beta}_i$ while its counterpart reports $\tilde{\beta}_j$. Given that the productivity parameter is perfectly correlated, and that firms do not have any incentive to report $\underline{\beta}$ when the realized productivity parameter is $\overline{\beta}$, any incompatible reports will allow the regulator to know that

1. the true realized productivity parameter is $\underline{\beta}$, and
2. the firm reporting $\tilde{\beta}_i = \overline{\beta}$ is lying.

Suppose that the regulator proposes the following mechanism:

[3]Indeed, $\phi(e^{FI})$ is the level of utility associated with first best level of efforts. Since the cost target in the regulatory contract for a $\overline{\beta}$ type firm is $\overline{\beta} - e^{FI}$, a $\underline{\beta}$ type firm will only need to put in a level of effort $e^{FI} - \Delta\beta$ in order to realize cost $\overline{\beta} - e^{FI}$. As such, the disutility of effort in this case for the $\underline{\beta}$ type firm will be $\phi(e^{FI} - \Delta\beta)$, and the difference $\phi(e^{FI}) - \phi(e^{FI} - \Delta\beta)$ is the economy in terms of disutility of efforts gained by a $\underline{\beta}$ type firm when he reports $\tilde{\beta}_i = \overline{\beta}$ and is offered the full information contract.

1. if the reports of both firms are compatible, i.e. $\tilde{\beta}_i = \tilde{\beta}_j$, $i = 1, 2$, the regulator would think that $\tilde{\beta}_i$ is realized. He could therefore fix the transfer at $t_i(\tilde{\beta}_i, \tilde{\beta}_i) = \phi(\tilde{\beta}_i - C_i(\tilde{\beta}_i, \tilde{\beta}_i))$ , and reimburses $C_i(\tilde{\beta}_i, \tilde{\beta}_i) = \tilde{\beta}_i - e_i$, with $\tilde{\beta}_i = \{\underline{\beta}, \overline{\beta}\}$. Seeking to maximize welfare, and given that the firms' private information is "screened", the level of costs that he reimburses will be such that $C_i(\tilde{\beta}_i, \tilde{\beta}_i) = \tilde{\beta}_i - e^{FI}, i = 1, 2$ and transfers would therefore be $t_i(\tilde{\beta}_i, \tilde{\beta}_i) = \phi(e^{FI})$.

2. if reports of both firms are incompatible, i.e. $\tilde{\beta}_i \neq \tilde{\beta}_j$, $i = 1, 2$, then the regulator will assume that the true realization of the productivity parameter is $\underline{\beta}$. Therefore, he reimburses $\underline{\beta} - e^{FI}$ in order to maximize social welfare. The rationale behind the regulator's choice is given above. The regulator may decide to punish the cheating firm and/or compensate the true-telling firm, and therefore transfers are set $t_i(\overline{\beta}, \underline{\beta}) = \phi(\underline{\beta} - C_i(\underline{\beta})) - P$, and $t_i(\underline{\beta}, \overline{\beta}) = \phi(\underline{\beta} - C_i(\underline{\beta})) + A$, with $i \neq j, i = 1, 2$, and $A, P \geq 0$ being respectively the amount of compensation (resp. fine) that the regulator imposes on the truth-telling (resp. lying) firm.

Under the mechanism above, a firm $i$'s level of utility can be rewritten as a fonction of its own report, the report of the other firm $j$, and the cost and transfer specified in the contract according to the reports:

$$U_i(\tilde{\beta}_i, \tilde{\beta}_j, \beta_i) = t_i(\tilde{\beta}_i, \tilde{\beta}_j) + C_i(\tilde{\beta}_i, \tilde{\beta}_j) - C(\beta_i) - \phi(e_i), \quad i \neq j, i, j = 1, 2$$

In order for truth telling to be a (Bayesian-)Nash equilibrium of the game, we must have for firm $i$:

$$U_i(\overline{\beta}, \overline{\beta}, \overline{\beta}) \geq U_i(\underline{\beta}, \overline{\beta}, \overline{\beta}), \qquad i = 1, 2 \tag{1}$$

$$U_i(\underline{\beta}, \underline{\beta}, \underline{\beta}) \geq U_i(\overline{\beta}, \underline{\beta}, \underline{\beta}), \qquad i = 1, 2 \tag{2}$$

where $U_i(\tilde{\beta}_i, \tilde{\beta}_j, \beta)$ is the utility of firm $i$ when it submits a report $\tilde{\beta}_i$ and firm $j$ submits a report $\tilde{\beta}_j$ in the event that $\beta$ is realized, $\tilde{\beta}_i, \tilde{\beta}_j, \beta \in \{\underline{\beta}, \overline{\beta}\}$. The above constraints state that firm $i$ will not have any incentive to deviate from reporting the truth productivity parameter, given that firm $j$ reports truthfully.

Under the proposed mechanism, these contraints can be rewritten as:

$$\begin{aligned} 0 &\geq \phi(e^{FI}) + A - \phi(e^{FI} + \Delta\beta), \qquad i = 1,2 \\ 0 &\geq -P \end{aligned}$$

Thus, truth-telling is a Nash equilibrium when $P \geq 0$ and $A \leq \phi(e^{FI} + \Delta\beta) - \phi(e^{FI})$. In particular, the first set of inequality is verified when $A = 0$, as $\phi(e^{FI}) - \phi(e^{FI} + \Delta\beta) < 0$. As such, in order to have truth-telling as a (Bayesian-)Nash equilibrium, it suffices to punish firms whenever reports are incompatible. The equilibrium outcome will have both firms reporting truthfully, and the regulator need not apply any punishment, and the full information outcome is acheived.

Note that truth telling is not the unique (Bayesian-)Nash equilibrium[4]. Table 1 (resp. table 2) gives the firms' level of utility according to different strategy profiles when the realized productivity parameter is $\overline{\beta}$, i.e. the firms are of the inefficient (resp. efficient) type.

| Firm 1 / Firm 2 | Reports $\underline{\beta}$ | Reports $\overline{\beta}$ |
|---|---|---|
| Reports $\underline{\beta}$ | $\phi(e^{FI}) - \phi(e^{FI} + \Delta\beta)$, $\phi(e^{FI}) - \phi(e^{FI} + \Delta\beta)$ | $\phi(e^{FI}) - P - \phi(e^{FI} + \Delta\beta)$, $\phi(e^{FI}) + A - \phi(e^{FI} + \Delta\beta)$ |
| Reports $\overline{\beta}$ | $\phi(e^{FI}) + A - \phi(e^{FI} + \Delta\beta)$, $\phi(e^{FI}) - P - \phi(e^{FI} + \Delta\beta)$ | 0, 0 |

Table 1: Payoff matrix when the realized productivity parameter is $\overline{\beta}$

We note, however, that it is possible for the regulator to implement truth-telling as a dominant strategy equilibrium. To this end, $P$ and $A$ would have

[4]This has been shown in previous study of asymmetric information. See for instance Demski and Sappington[1984]. Previous studies on yardstick competition have limited to show that truth-telling as a Bayesian Nash equilibrium, when the other agent(s) are telling the truth. Auriol[2000] has nevertheless show that implementing yardstick competition through a menu of linear contracts ensure truthful revelation as a dominant strategy equilibrium under a more general setting, contrary to a game of simultaneous revelation.

| Firm 1 / Firm 2 | Reports $\underline{\beta}$ | Reports $\overline{\beta}$ |
|---|---|---|
| Reports $\underline{\beta}$ | $0,$<br>$0$ | $-P,$<br>$A$ |
| Reports $\overline{\beta}$ | $A,$<br>$-P$ | $\phi(e^{FI})-\phi(e^{FI}-\Delta\beta),$<br>$\phi(e^{FI})-\phi(e^{FI}-\Delta\beta)$ |

Table 2: Payoff matrix when the realized productivity parameter is $\underline{\beta}$

to satisfy the following contraints:

$$\begin{array}{rcll} U_i(\overline{\beta},\overline{\beta},\overline{\beta}) & \geq & U_i(\underline{\beta},\overline{\beta},\overline{\beta}), & i=1,2 \\ U_i(\overline{\beta},\underline{\beta},\overline{\beta}) & \geq & U_i(\underline{\beta},\underline{\beta},\overline{\beta}), & i=1,2 \\ U_i(\underline{\beta},\underline{\beta},\underline{\beta}) & \geq & U_i(\overline{\beta},\underline{\beta},\underline{\beta}), & i=1,2 \\ U_i(\underline{\beta},\overline{\beta},\underline{\beta}) & \geq & U_i(\overline{\beta},\overline{\beta},\underline{\beta}), & i=1,2 \end{array}$$

These contraints give rise to the following inequalities:

$$\begin{array}{rcl} A & \leq & \phi(e^{FI}+\Delta\beta)-\phi(e^{FI}) \\ P & \leq & 0 \\ P & \geq & 0 \\ A & \geq & \phi(e^{FI})-\phi(e^{FI}-\Delta\beta) \end{array}$$

Therefore, if the regulator wants to implement truth-telling as a dominant strategy equilibrium, he will need to set $P=0$, and compensates any firms that report $\underline{\beta}$ whenever reports are incompatible. The compensation should be such that $[\phi(e^{FI})-\phi(e-\Delta\beta)] \leq A \leq [\phi(e^{FI}+\Delta\beta)-\phi(e^{FI})]$[5]. Under a dominant strategy implementation, firms' utility under yardstick competition has a prisoner dilemma's structure.

**Proposition 2.** *Under yardstick competition, it is possible for the regulator, on conditioning the transfer to a firm on the reports of the other firm, to acheive the full information outcome.*

We see that the value of yardstick competition lies in the fact that the correlation between the firms' private information provides the regulator with

[5]There will exist such a range for $A$, as $\phi(e^{FI}+\Delta\beta) > \phi(e^{FI}) > \phi(e^{FI}-\Delta\beta)$. Given that $\phi''(\cdot) > 0$, $\phi(e^{FI}+\Delta\beta)-\phi(e^{FI}) > \phi(e^{FI})-\phi(e^{FI}-\Delta\beta)$.

an additional instrument to solicit their private information. When firms' private information are perfectly correlated, the regulator is able to obtain this information without giving up any informational rents, and acheive the full information equilibrium[6].

# 4 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. In order to account for this aspect of the contractual relationship between the regulator and the firms, 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 $(1-v)$ and $v$ respectively. Here we have assumed that industry-wide productivity realizations are independent over time[7]. We will further assume that the regulator proposes the same static contract period over period.

## 4.1 Collusive strategies and firms' utility

From table 1 and table 2 it is easy to see that firms can gain from colluding and coordinating in their reports to the regulator: firms have an incentive to report truthfully when $\overline{\beta}$ is realized, but both firms have an interest to report $\overline{\beta}$ when $\underline{\beta}$ is realized. The question, however, is if the firms can

[6]In fact, Crémer and McLean[1985,1988], among others, have shown that any correlation, however mild, in agents' private information would allow for the principal to extract all rents.

[7]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.

stick to such a strategy. Indeed, collusive contracts are illegal and are not enforceable by formal institutions. As such, collusion is all the more plausible if the collusion is *self-enforcing*, when firms repetively interact with each other (through the regulator). In other words, in order to evaluate the plausibility of collusion, one needs to study the incentives of firms to deviate from the collusion strategy. Consequently, collusion will be all the more likely the easier the firms can sustain the collusive agreement. We abstract ourselves from the coordination problem by adopting a grim trigger strategy framework (Friedman[1979]) to study the issue. This should facilitate any collusive initiative. Under such a configuration, firms start by playing the collusion strategy until there is a deviation. When a firm deviates from the collusive strategy, all firms will revert back to playing their truth-telling strategy. We define deviation by a firm $i$ as firm $i$ reporting truthfully.

The timing of the static game with collusion is illustrated by figure 1. We have allowed for a stage where firms can decide to collude or not to collude in the game. However, as we have mention earlier, since firms cannot rely on an explicit contract to enforced a coordinated collusive strategy, the collusive "agreement" at this stage must be self enforceable, in the sense that firms must rely on the fact that neither firm has any incentives to deviate from this collusive agreement. On top of that, firms are perfectly symmetric in our model. As such, it is not essential that firms do meet to coordinate during this stage: both firms can easily identify the collusive strategy to play should they want to collude. Since no agreement reached at this stage can be enforced by a third party, our model can apply to the case where collusion is tacit, and to the case that collusion is coordinated explicitly, but they are unable to use an explicit contract[8] to support the agreement. What matters here is that the collusive strategy must be self-enforceable.

Note as well that the time when this stage occurs (relatively to the realization of $\beta$) is without consequence in our analysis as firms are perfectly correlated[9].

[8]That is, a contract that can be enforced by a third party, for instance, some judiciairy institutions.

[9]The major difference between the fact that the firms coordinate before $\beta$ is realized and after $\beta$ is realized, is that in the former case, renegotiations may be necessary after $\beta$ is realized when firms are not perfectly correlated, i.e. the collusive "agreement" is optimal

This modelling allows us to focus only on firms' discounted expected utility.

We suppose that firms have a discount factor equals to $\delta$. Under a trigger strategy framework, firm $i$ discounted expected utility when both firms continously play their collusive strategy is therefore:

$$U_i^c = \sum_{t=0}^{\infty} \delta^t v[\phi(e^{FI}) - \phi(e^{FI} - \Delta\beta)] = \frac{v}{(1-\delta)}[\phi(e^{FI}) - \phi(e^{FI} - \Delta\beta)]$$

and discounted expected utility for firm $i$ after a deviation from the collusion would yield:

$$U_i^d = vA + \sum_{t=1}^{\infty} \delta^t \times 0$$

if the regulator proposes some compensation when reports are incompatible. We have supposed that when $A$ is such that when $\overline{\beta}$ is realized, firms have no interest to report $\underline{\beta}$ to receive the compensation, that is $A \leq [\phi(e^{FI} + \Delta\beta) - \phi(e^{FI})]$. In the event that the regulator prefers to only punish firms whenever reports are incompatible, then we will have $U_i^d = 0$. We can now evalute collusive incentives of the firms under the various yardstick competition scheme.

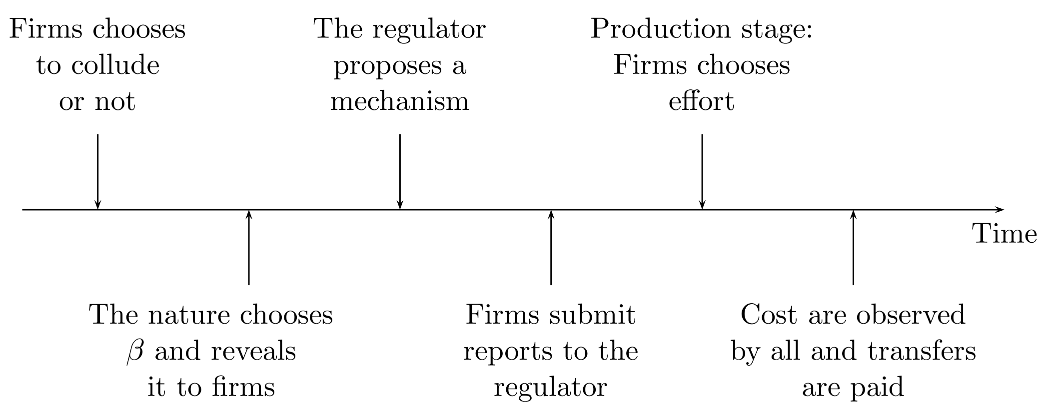


Figure 1: Timing of the game with collusion

*ex ante* to the realization of the productivity parameter, but not optimal *ex post*. In the latter case, the collusive "agreement" must take into account asymmetry information between the firms when firms are not perfectly correlated.

### 4.2 Yardstick competition and collusive incentives

Collusion is sustainable through a trigger strategy game if and only if the expected discounted utility from continuing to collude is larger than the expected discounted utility for a firm should it deviates :

$$U_i^c \geq U_i^d$$

We could easily see that if the regulator relies only on punishing firms in the event of incompatible reports to acheive truth-telling, firms will never have any incentive to deviate from the collusive strategy. Indeed, collusive under such a scheme is sustainable if and only if:

$$\frac{1}{(1-\delta)} v[\phi(e^{FI}) - \phi(e^{FI} - \Delta\beta)] \geq 0$$

which is always verified given our assumptions. Collusion is therefore always sustainable, and the regulated firms will have an interest to always collude.

More generally, if the regulator decides to compensate the firm reporting $\underline{\beta}$ when reports are not compatible, collusion under s trigger strategy game is sustainable if and only if the discounted expected utility when both firms play a collusive strategy is greater than the discounted expected utility for a deviating firm:

$$\frac{1}{(1-\delta)} v[\phi(e^{FI}) - \phi(e^{FI} - \Delta\beta)] \geq vA$$

Or, in terms of a critical threshold discount factor, whci we will denote $\delta^*$, collusion among the firms is sustainable whenever firms' discount factor is such that:

$$\delta \geq \delta^* = \frac{A - [\phi(e^{FI}) - \phi(e^{FI} - \Delta\beta)]}{A}$$

As expected, one could easily see that the higher the compensation that the regulator sets, the higher the critical threshold discount factor should be in order for firms to sustain collusion. Indeed, one could easily check that the threshold discount factor is increasing in the amount of compenstion, albeit at a decreasing rate[10]. Firms will then have to be more patient in order to sustain the collusion. Impatient firms may find it more interesting to deviate from collusion. Implementation of yardstick competition as a dominant strategy equilibrium (with respect to an implementation in terms of (Bayesian-)Nash equilibrium) would thus seem to allow the regulator to reduce the likelihood of an eventual collusion between the regulated firms.

At this point, one should keep in mind that the compensation has to satisfy $A \leq [\phi(e^{FI} + \Delta\beta) - \phi(e^{FI})]$, so that when $\overline{\beta}$ is realized, firms will not have any incentives to report $\underline{\beta}$ for the sake of the compensation. This suggests that there is an upper bound on the amount of compensation that a regulator could use. Suppose now that the regulator fixes $A = [\phi(e^{FI} + \Delta\beta) - \phi(e^{FI})]$, then the threshold discount factor could be rewritten as:

$$\delta^* = 1 - \frac{\phi(e^{FI}) - \phi(e^{FI} - \Delta\beta)}{\phi(e^{FI} + \Delta\beta) - \phi(e^{FI})}$$

We see that the threshold discount factor is increasing in $\Delta\beta$[11].

This sugests that when $\Delta\beta$ is large, it will be easier for the regulator to discourage any collusive incentives. Indeed, the larger is the difference in the productivity parameter, the regulator higher a compensation that the regulator is able to use to tempt firms to deviate. As such, in order to sustain the collusive outcome, both firms will have to be more patient. This suggests as well that when the difference in the productivity parameter is small, the threshold discount factor will be lower as $\frac{\phi(e^{FI}) - \phi(e^{FI} - \Delta\beta)}{\phi(e^{FI} + \Delta\beta) - \phi(e^{FI})}$ will be closer to unity. The regulator will have a lesser margin to tempt the firms away from behaving collusively. Firms can afford to be less patient to sustain the collusive pact. We resume these observations in the following proposition:

**Proposition 3.** *Collusion is less likely the higher is the compensation and/or the lower firms' discount factor. High compensations are possible when the difference between the two level of productivity is large.*

[10] $\frac{\partial \delta^*}{\partial A} = [\phi(e^{FI}) - \phi(e^{FI} - \Delta\beta)]A^{-2} > 0$ and $\frac{\partial^2 \delta^*}{\partial A^2} = -2[\phi(e^{FI}) - \phi(e^{FI} - \Delta\beta)]A^{-3} < 0$.

[11] See appendix A.2 for proof.

### 4.3 Detering collusion under repeated yardstick competition

As one can see, in a repeated game framework, collusion may be enforced through repeated interactions between the firms in absence of any collusive contract. In order for the regulator to deter collusion, yardstick competition based on compensation when reports differ should be preferred. Indeed, collusion is sustainable whatever the firms' discount factor when the regulator decides to punish in the event of incompatible reports. Even when the regulator uses a compensation based scheme, collusion may be sustainable, depending on firms' discount factor and on $\Delta\beta$. When $\Delta\beta$ is low, it would be harder for the regulator to deter collusive behaviour, while if $\Delta\beta$ is higher enough, the regulator could propose a high compensation, making the collusive agreement harder to sustain.

Even so, there may be limits to the capacity of the regulator to discourage collusive behaviour. Indeed, even when there is no upper bound on the amount of compensation (to prevent firms from reporting $\underline{\beta}$ when $\overline{\beta}$ is realized), the regulator still has to fix an amount of compensation $A$ that is at least as high as the discounted rents that firms can expect from future ongoing collusion. This amount could be quite high, if firms are patient enough, and it may be not credible, or even possible, for the regulator to commit itself to such high amounts of compensation for various reasons, political or economic.

One will however notice that the likelihood of collusion depends as well on firms' discount factor. This suggest another means for the regulator to prevent collusion, should $\Delta\beta$ be too low and/or should he be limited in his capacities to commit to too high a compensation: he could try to influence this parameter instead. Indeed, the discount factor could be reinterpreted as the probability that the contractual relationship will continue into the following period. Indeed, the regulator is probably able to decide whether to renew a firm's contract for the following period. One means to this end may be the regulator stochastically decides during each period if each firms contracts will be renewed. Such a mechanism seems implausible for obvious reasons.

Another way to this end, much more plausible, is for the regulator to use a franchise bidding mechanism to attribute the markets (Demsetz[1969]). Such a mechanism may introduce some uncertainty into whether the contractual relationship will be renewed in the following period, thereby destabilizing collusive incentives. While the idea of using franchise bidding in complement with yardstick competition to deter collusion has been already suggested in the literature (Bouf and Péguy[2001], Lévêque[2004]), we believe that our interpretation as it being a tool to influence on firms' discount factor is new to the literature. However, it should be noted that when franchise bidding mechanisms are used, the regulator will not have unilateral control over the renewal of a firm's contract. This would rather result from the bids submitted by the firms and institutional rules organizing the franchise bidding mechanism. Firms may act strategically in their bids, and collusion may not become harder to sustain. We propose to study in further detail such the impact of having this supplementary mechanism on firms' collusive incentives in the two coming sections.

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

As mentioned, using franchise bidding in complement to yardstick competition might be a way for the regulator to influence the firms' discount factor. However, when franchise bidding is used, the regulator can no longer unilaterally terminate a contract with a firm. Whether the contractually relationship will end depends the franchise bidding mechanism and behaviour of participating firms. As such, it is not straightforward to think that collusive incentives may be destabilized when such a mechanism is in place. We will now turn to study the impact of such a franchise bidding with regulation configuration on collusive incentives, first under a static setting and then in a repeated game framework in the following section. We describe first the timing of the static game, before characterizing equilibrium of the game.

### 5.1 Timing of the static game

Since the regulator now uses a franchise bidding mechanism to attribute the market, and then applies some sort of regulation, we will model the static game as a two stage game. Figure 2 shows the timing of the game.

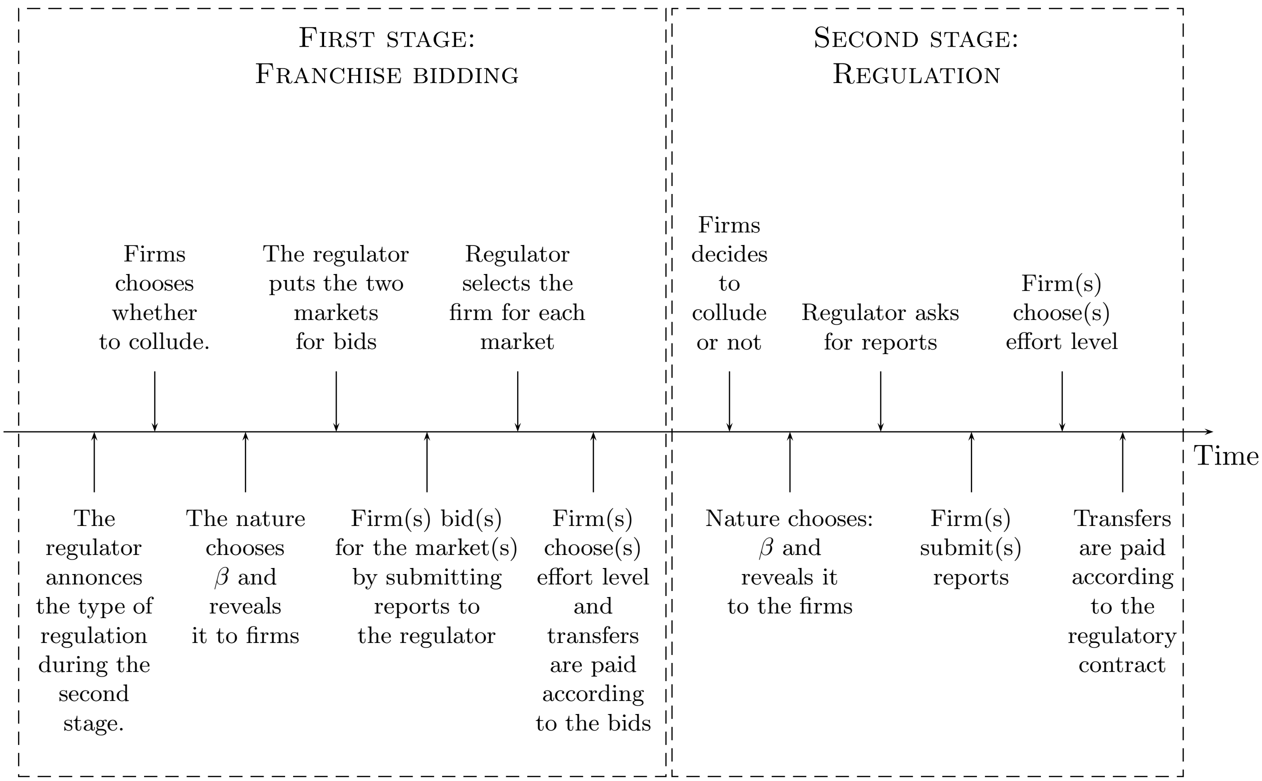


Figure 2: Timing of the two stage game with franchise bidding

In the first stage of the game, franchise bidding is used to attribute the markets simulteneously and independently. Each market is attributed to the firm with the lowest costs, or equivalently, annonces the lowest productivity parameter. When an ex æcquo arises, the regulator attributes one market to each firm.

In the second stage of the game, since the productivity parameter changes, the regulator will implement an incentive regulation on the firm(s) annonced during the first stage. As there is a possibility that a single firm will operate on both markets, we will consider a individual incentive regulation and yardstick competition as two possible regulation that the regulator might use. We suppose that the regulator is able to commit to his choice of regulatory scheme during the first period. Since there is a possibility that a firm will run both markets during the second stage on the game, the regulator may wish to use an individual scheme instead of yardstick competition to regulate the firm. In this case, individual incentive regulation is characterized by a menu of contracts as derived by Laffont and Tirole[1986,1993]. In our case, noting the individual incentive contract by a superscript $I$ and defining $\Phi(e) \equiv \phi(e) - \phi(e - \Delta\beta)$ and $e = \beta - C(\beta)$, the individual incentive contract is characterized by:

- No rents and undereffort for a low productivity firm ($\overline{\beta}$-type). Formally, $t^I(\overline{\beta})$ is such that $U_i(\overline{\beta} - C^I(\overline{\beta})) = 0$ and a level of effort such as:
$$\phi'(\overline{\beta} - C^I(\overline{\beta})) = 1 - \frac{\lambda}{1+\lambda}\frac{v}{1-v}\Phi'(\overline{\beta} - C^I(\overline{\beta}))$$
- A positive rents and an efficient level of effort for a high productivity firm ($\underline{\beta}$-type). Formally, $t^I(\underline{\beta})$ will be such that $U_i(\underline{\beta}) = \Phi(\overline{\beta} - C^I(\overline{\beta}))$ and a level of effort such that
$$\phi'(\underline{\beta} - C^I(\underline{\beta})) = 1$$

In the regulation stage, firm(s) is(are) required once more to submit reports on their productivity parameters, and the regulator applies the incentive regulation consequently. Notice that we have allow for the firms to behave collusively at the beginning of each stage, should there be any need or interest for the firms to coordinate their reports (either on bids or on costs reports).

### 5.2 Equilibrium of the static game

Before characterizing the equilibrium of the two stage by backward induction, one has to first compute the firms' utility under various strategy profils. We derive payoffs at each stage of the game under different strategies profil in the appendix.

In the second stage of the game, when both firms operate each in a market, truth-telling is an equilibrium, given that the regulator would commit to a compensation $A$ to the firm reporting $\underline{\beta}$ such that $\phi(e^{FI} + \Delta\beta) > \phi(e^{FI}) > \phi(e^{FI} - \Delta\beta)$ in case of incompatible reports. Expected utility during the second stage of the game is therefore 0. During this stage of the game, collusion is therefore not sustainable. On the other hand, if there is only one firm operating in each market, the second stage expected utility will be positive, whatever the regulatory scheme that the regulator might be using. We will note $U^R_{2nd}$, $R = \{I, YC\}$, the expected equilibrium utility during the second stage of the game when only one firm operates in both markets under either an individual incentive scheme or yardstick competition.

During the first stage bidding game, firms will never have any incentives to report $\underline{\beta}$ when the realized parameter is $\overline{\beta}$ to be able to operate as a monopoly during the second stage of the game, as a firm doing so would receive a negative level of utility. Indeed, during the first stage of the game, expected utility under such a strategy is $2[\phi(e^{FI}) - \phi(e^{FI} + \Delta\beta)]$ while expected utility during the second stage of the game, as a monopoly in both markets yields $\delta U^R_{2nd}$. Let us suppose that during the second period game yardstick competition is used. As $U^{YC}_{2nd} = 2\delta v[\phi(e^{FI}) - \phi(e^{FI} - \Delta\beta)] < 2|[\phi(e^{FI}) - \phi(e^{FI} + \Delta\beta)]|$, and given that $U^{YC}_{2nd} \geq U^I_{2nd}$, expected utility from playing such a strategy is negative whatever the regulation used in the second stage game. As such, when $\overline{\beta}$ is realized, firms will bid $\overline{\beta}$. This implies that when $\overline{\beta}$ is realized, firms competing for the markets will bid truthfully in the first stage.

Table 3 gives the utility given the second stage equilibrium solved by backward induction according to whether firms will decide to share the markets during the first stage game, or when they would compete for the markets. Market sharing here will be taken to mean bidding $\overline{\beta}$ whatever the realized productivity parameter during the first stage game. If firms compete for the markets, then they will bid their true productivity parameter.

| Firm 1 / Firm 2 | Share markets | Compete |
|---|---|---|
| Share markets | $[\phi(e^{FI}) - \phi(e^{FI} - \Delta\beta)]$, $[\phi(e^{FI}) - \phi(e^{FI} - \Delta\beta)]$ | $\delta U^R_{2nd}$, 0 |
| Compete | 0, $\delta U^R_{2nd}$ | 0, 0 |

Table 3: Firms' utility according to their bids when $\underline{\beta}$ is realized

The (Bayesian-)Nash equilibrium (when both firms expect each other to bid truthfully) during the first stage game when $\underline{\beta}$ is realized will both firms competing for the markets. Indeed the following constraints are satisfied when $\underline{\beta}$ is realized:

$$U_i(\underline{\beta}, \underline{\beta}, \underline{\beta}) \geq U_i(\overline{\beta}, \underline{\beta}, \underline{\beta}), \qquad i = 1, 2$$

Ih the regulator wants this equilibrium to be unique when $\underline{\beta}$ is realized, a supplementary set of contraints needs to be satisfied:

$$U_i(\underline{\beta}, \overline{\beta}, \underline{\beta}) \geq U_i(\overline{\beta}, \overline{\beta}, \underline{\beta}), \qquad i = 1, 2$$

This will be the case when yardstick competition is used during the second stage of the game if the firms' discount factor is less than $\frac{1}{2}$, $\delta \leq \frac{1}{2v}$. Indeed, when yardstick competition is used during the second stage of the game, a firm that competes when the other decides to share the market has expected utility $U^{YC}_{2nd} = 2\delta v[\phi(e^{FI}) - \phi(e^{FI} - \Delta\beta)]$ while market sharing would only yield $[\phi(e^{FI}) - \phi(e^{FI} - \Delta\beta)]$. Market sharing strategy cannot be an equilibrium if the condition is satisfied. In this case, there will be an efficient level of cost-reducing efforts and the regulator gives no rents to the firms.However, if the firms are patient enough, that market sharing is an equilibrium, even if during the second stage of the game, there will be no collusion. Having said this, the regulator will choose to use yardstick competition during the second stage of the game, as under such a scheme he need not give up any rents, while if he uses an individual scheme, he will have to given up some costly rents to acheive truthful reports during the second period. We resume this in the following proposition.

**Proposition 4.** *The regulator will choose to implement yardstick competition during the second stage. In the franchise bidding-yardstick competition game, the (Bayesian-)Nash equilibrium of the game will have both firms bidding to compete for the markets, and then reporting truthfully under yardstick competition whenever firms are sufficiently patient. Thus, they will receive no positive rents and provide the efficient level of cost-reducing efforts. When firms discount factor* $\delta \leq \frac{1}{2v}$*, the regulator can be certain that firms will compete for the markets in the first stage game.*

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.

# 6 Collusion incentives under repeated franchise bidding-yardstick competition

We will now study collusive incentives when the static two-stage game is infinitely repeated. In order to do this, we will have to first identify the collusive behaviour upon which firms might agree, as well as possible deviating behaviour that may arise. Throughout this section, we will assume that the regulator uses yardstick competition as the regulatory device.

### 6.1 Collusive behaviour and incentives

In the static game we have allow for firms to get together at the beginning of the franchise bidding stage and at the beginning of the yardstick competition stage. At the franchise bidding stage, firms could agree with each other to share the markets and coordinate their reports. At the regulation stage, suppose that the two firms has been chosen to operate in each market, a collusive pact would be to coordinate their reports to the regulator under yardstick competition.

At the bidding stage, firms can agree to share markets and then collude again during the regulation stage. At this stage, a firm may deviate and tries to capture both markets by reporting truthfully. In this case, the deviating firm would operates in both markets, and will be regulated under yardstick competition during the second stage of the game. Expected discounted utility for the firm will thus be $2\delta v[\phi(e^{FI}) - \phi(e^{FI} - \Delta\beta)]$. Restricting ourselves to trigger strategies equilibrium, where after a deviating behaviour, firms will revert back to playing non cooperatively, a market sharing - cooperative reporting type of collusion is sustainable to deviation during the bidding stage if and only if the discounted expect utility under such a type of collusion is greater than the expected utility of non cooperatively bidding to gain both markets, and then behaving non cooperatively infinitely:

$$\frac{1}{(1-\delta)} v[\phi(e^{FI}) - \phi(e^{FI} - \Delta\beta)] \geq 2\delta v[\phi(e^{FI}) - \phi(e^{FI} - \Delta\beta)] + \sum_{t=1}^{+\infty} \delta^t 0$$

$$\Leftrightarrow \qquad \frac{1}{(1-\delta)} \geq 2\delta$$

This inequality is always satisfied, as $0 < \delta < 1$[12]. Therefore, a collusive behaviour involving market-sharing is always sustainable.

We see that yardstick competition is not sufficient to discourage collusion in terms of franchise bidding in this case. In reality, for most local monopolies,

[12]Indeed, the above inequality can be rewritten as $\delta(1-\delta) \leq \frac{1}{2}$. Define $f(\delta) = \delta(1-\delta)$. $f(\delta)$ is thus a quadratic fonction whose maximum is attained at $\delta = 0.5$ and $f(0.5) = 0.25$. For all $\delta \neq 0.5$, $f(\delta) < 0.25 < \frac{1}{2}$.

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.

### 6.2 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 reattributed again. In this case, an infinitely repeated market sharing strategy would yield the same sum as above, i.e. $\frac{1}{(1-\delta)}v[\phi(e^{FI} - \phi(e^{FI} - \Delta\beta)]$. Deviation during the bidding stage would allow the deviating firm to be alone to operate in both markets for $n$ subsequent period during which regulation is applied. Discounted expected utility for the deviating firm under grim trigger strategies would yield:

$$2v[\phi(e^{FI}) - \phi(e^{FI} - \Delta\beta)][\delta + \delta^2 + \ldots + \delta^n] = \frac{\delta(1-\delta^n)}{1-\delta}2v[\phi(e^{FI}) - \phi(e^{FI} - \Delta\beta)]$$

This is simply 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 $n$ sucessive stages of yardstick competition, then the market sharing collusive agreement is sustainable if and only if:

$$\frac{1}{(1-\delta)}v[\phi(e^{FI}) - \phi(e^{FI} - \Delta\beta)] \geq \frac{\delta(1-\delta^n)}{1-\delta}2v[\phi(e^{FI}) - \phi(e^{FI} - \Delta\beta)]$$

which yields

$$\frac{1}{(1-\delta^n)} \geq 2\delta$$

Figure 3 shows the curves of $2\delta$ and $f(\delta, n) = \frac{1}{(1-\delta^n)}$ according to some values of $n$, i.e. $n = 1, 2, 5, 10$, and $n = 35$, for $\delta \in ]0, 1[$. The dashed line represents $2\delta$, while the solid lines represent $f(\delta, n)$. For values of $\delta$ where the dashed line lies above the solid lines, collusion is sustainable, as the inequality above is satisfied. On the contrary, collusion is not sustainable for values of $\delta$ where the solid lines lay below the dashed line. The critical threshold factor that sustain collusion for a given $n$ is given by the first intersection between a curve and the dashed line.

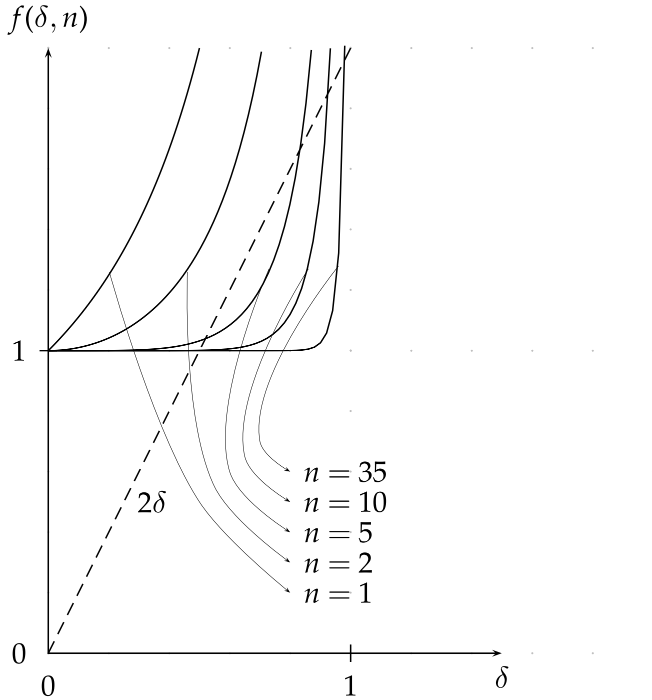


Figure 3: Values of $f(\delta, n)$ according to n

One could draw two principal observations from figure 3: first of all, $n$ is small, collusion is always sustainable. Indeed, one could see that for $n = 1$ and $n = 2$, $2\delta$ will always be greater than $f(\delta, 1)$ and $f(\delta, 2)$ in the relevant range for $\delta$. As $n$ goes up, the value of $\delta$ for which the solid curve will start to lay below the dashed line decrease, meaning that collusion becomes harder to sustain.

The second observation that one can make from figure 3 is that there exists a $n^*$ such that for all $n \geq n^*$, the lower bound for the critical discount threshold factor does not decrease with $n$. In other words, the regulator will not be able to distabilize firms' market sharing incentives by increasing the number of stages during which yardstick competition will be applied beyond a certain extent. The intuition behind this is simple: when $n$ is too low, there are few gains for the firms to deviate from the market sharing agreement, however, as $n$ becomes higher, gains from deviation become substantial. Firms may thereby be more tempted to deviate. When $n$ becomes too large, marginal rents (due to a supplmentary stage of yardstick competition) in some far off future would weight less relatively to near future rents, thereby contributing (marginally) less a temptation for the firms to deviate.

**Proposition 5.** *Under a trigger strategy framework, self-enforcing collusion to share the markets is harder to sustain when yardstick competitive is used relatively more often than franchise bidding.*

Our analysis suggests that to deter market sharing behaviour during the franchise bidding stage, the winning firm should be allow to keep its market for a longer period of time, during which some regulation may be used. This is because the longer a firm is able to keep its market, the more likely to change is the productivity parameter, and the more likely firms can gain in terms of perspective rents. Our analysis suggests as well that in industries where productivity changes often, the regulator could shorten the lapse of time between two bidding stages. Here, yardstick competition could be used instead of no regulation or individual regulation, since it allows the possibility that a firm cheats for rents should it be the only one to operate in both markets, but assures that *ex post*, should it be not the only firm that operates in both markets, the regulator has a means to save up on informational rents. Individual schemes or in absence of regulation, rents will really have to be given up, whether a firm wins-it-all, or if each firm would win a market.

## 7 Conclusion

Yardstick competition is a regulatory tool through which the regulator can create some virtual competition between firms that operate in similar locally monopolistic markets. One of its merits is that informational rents need not be given up *ex post* when the regulator tries to solicit firms' private information. We have seen that if firms expect each other to report truthfully, then imposing some punishment in the event of incompatible reports suffices to induce truthful revelation. Otherwise, if the regulator wants to be sure of achieving truthful revelation, then compensations are needed.

As with any competitive environment, firms may stand to gain from behaving cooperatively. In order to evaluate the plausibility of such a behaviour, we uses a infinitely repeated game framework with trigger strategies. This is because we believe that any collusion that may arise in our case needs to be self-enforcing. Explicit collusive contracts signed between firms are unlikely to be enforced by a third party. Thus, collusive behaviour is all the more likely when it can be self enforcing. To this end, we constructed a model for perfectly symmetric firms, and we show that when yardstick competition is repeatedly used, bigger the difference between the favorable and unfavorable private productivity of the firms, the easier it is for the regulator to promise compensations high enough to deter collusion. With high compensations, collusion is harder to sustain.

It may not be credible for a regulator to promise high compensations. Without credible commitment on compensations, collusion would be easy to sustain, and therefore likely to occur. We suggest franchise bidding may be used to bring down the compensation needed to deter colluson. This is because franchise bidding can be seen as a way for the regulator to influence firms' discount factor, making it harder for firms to sustain collusion. However, should the regulator introduces a supplementary franchise bidding procedure, firms may behave collusively and share the markets. We show that this will not be the case when the markets are not put up for bids too often. The reason to this is that the longer firms get to keep their markets, the higher the perspective of rents, and thereby, the less interesting it is for firms to share markets. We then argue that an individual incentive regulation, or even without regulation, would allow the regulator to discourage collusion during franchise bidding, but the advantage of using yardstick competition is that *ex post*, the regulator can actually save up costly rents while providing incentives *ex ante* for firms to fight for the markets.

Our analysis does have limits, and the most important of which might be that we have oversimplified 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 important rents in all sucessive bidding stage and regulation stage. This might erode all the more any collusive incentive during the bidding stage. This could be an important factor that we have not consider, all the more as industries that we are considering here like water distribution, railways operations etc. are often characterized by very long term contracts.

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 the 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.

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# A Appendix

## A.1 Proof for proposition 1

The regulator's problem can be written as:

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

Optimizing with respect to $e_i$ and $U_i$ yields the following first order condition:

$$\begin{aligned} \phi'(e_i) &= 1 \qquad \text{or} \qquad e_i \equiv e^{FI} \\ U_i &= 0 \qquad \text{or} \qquad t^{FI} = \phi(e^{FI}) \end{aligned}$$

## A.2 The threshold discount factor and $\Delta\beta$ under an infinitely repeated yardstick competition

Let $d(\Delta\beta) = [\phi(e^{FI}+\Delta\beta)-\phi(e^{FI})]-[\phi(e^{FI})-\phi(e^{FI}-\Delta\beta)]$ be the difference between $\phi(e^{FI}+\Delta\beta)-\phi(e^{FI})$ and $\phi(e^{FI})-\phi(e^{FI}-\Delta\beta)$. We will first show that $d(\Delta\beta)$ is increasing in $\Delta\beta$ at an increasing rate:

$$\frac{\partial d(\Delta\beta)}{\partial\Delta\beta} = \phi'(e^{FI}+\Delta\beta)-\phi'(e^{FI}-\Delta\beta) > 0$$

as $\phi''(\cdot) > 0$. Moreover,

$$\frac{\partial^2 d(\Delta\beta)}{\partial(\Delta\beta)^2} = \phi''(e^{FI}+\Delta\beta)+\phi''(e^{FI}-\Delta\beta) > 0$$

It follows that $[\phi(e^{FI}+\Delta\beta)-\phi(e^{FI})]$ increases faster in $\Delta\beta$ than $[\phi(e^{FI})-\phi(e^{FI}-\Delta\beta)]$. Furthermore, we have $\frac{\phi(e^{FI})-\phi(e^{FI}-\Delta\beta)}{\phi(e^{FI}+\Delta\beta)-\phi(e^{FI})} < 1$ since $[\phi(e^{FI}+\Delta\beta)-\phi(e^{FI})] > [\phi(e^{FI})-\phi(e^{FI}-\Delta\beta)]$. As such $\frac{\phi(e^{FI})-\phi(e^{FI}-\Delta\beta)}{\phi(e^{FI}+\Delta\beta)-\phi(e^{FI})}$ is decreasing in $\Delta\beta$ and therefore $1-\frac{\phi(e^{FI})-\phi(e^{FI}-\Delta\beta)}{\phi(e^{FI}+\Delta\beta)-\phi(e^{FI})}$ is increasing in $\Delta\beta$.

## A.3 Firms utility in the two stage franchise bidding-regulation game

### A.3.1 Second stage payoffs

During the second stage of the game, two possibilities can arise: either there is only one firm that will be operating in both markets, or the two firms operate each in one market. In the former case, the operating firm could be regulated under yardstick competition or an individual scheme, and we will assume that in the latter case, yardstick competition will be used. If yardstick competition is used, we assumed that the regulator compensates the firms reporting $\underline{\beta}$ when reports are incompatible, and $A$ is such that $\phi(e^{FI} + \Delta\beta) > \phi(e^{FI}) > \phi(e^{FI} - \Delta\beta)$. As such, in the latter case, in this static framework, the equilibrium outcome has both firm telling the truth [Proposition 2] , expected utility in this case is equal to 0.

We will turn to the case where only one firm operates in both markets. When yardstick competition is used, the firm reports truthfully when $\overline{\beta}$ is realized, and reports $\overline{\beta}$ when $\underline{\beta}$ is realized[13]. Expected utility is therefore

$$U_{2nd}^{YC} = 2v[\phi(e^{FI}) - \phi(e^{FI} - \Delta\beta)]$$

and under an individual incentive regulation

$$U_{2nd}^{I} = 2v[\Phi(\overline{\beta} - C^{I}(\overline{\beta}))]$$

Notice that $U_{2nd}^{YC} \geq U_{2nd}^{I} > 0$ as the menu of individual incentive contracts suppresses effort in the contract intended for the $\overline{\beta}$ type firm in order to save up informational rents in the contract for $\underline{\beta}$ type firm. At this stage of the game, truth telling is an equilibrium in dominant strategy when both firms operate each in one market, with expected utility equals to 0. When only one firm operates, it will report $\underline{\beta}$ whatever the realized productivity parameter under yardstick competition and it will report truthfully under an individual incentive scheme. Expected utility with such an equilibrium outcome is always positive.

[13]Since it is the only firm operating in both markets, submitting two different reports is not possible.

### A.3.2 Payoffs during the first stage franchise bidding

We will now consider firms' utility given the various strategies profils. We will first look into the case when $\overline{\beta}$ is realized before checking into the case when $\underline{\beta}$ is realized.

When $\overline{\beta}$ is realized, truthful reports will result in both firms operating each in one market and utility for both firms is 0 in this case during the first period. Otherwise, firms may want to report $\underline{\beta}$ in order to operate as a monopoly during the two periods. In this case, first period payoff would be $2[\phi(e^{FI}) - \phi(e^{FI} + \Delta\beta)]$.

When $\underline{\beta}$ is realized, truthful reports will have both firms operating in each market. If both firms reports $\overline{\beta}$, then they would each gain $[\phi(e^{FI}) - \phi(e^{FI} - \Delta\beta)]$, and both will be operating each in one market. In the event that a firm reports truthfully, while the other firm reports $\overline{\beta}$, then utility for both firms will be 0, but the firm reporting truthfully will operate in both markets.