Yardstick competition, franchise bidding and firms' incentives to collude

Eshien Chong[a,b,*] Fréddy Huet[b,c,†]

[a] ADIS-GRJM, U. Paris 11, 54 Bd. Desgranges, 92231 Sceaux Cedex, France.

[b] ATOM, U. Paris 1,106–112 Bd. de l'Hôpital, 75013 Paris Cedex, France.

[c] CERESUR, U. la Réunion, 15 Av. René Cassin, 97490 St. Clothilde, France.

Abstract

Collusion seems to be a pervasive problem when regional monopoly rights are auctioned to private firms. This leads us to study whether firms may collude if the regulator uses yardstick competition to simulate competitive forces, and how this is affected when both schemes are used. Using an infinitely repeated game framework, we find that collusion is sustainable when firms are sufficiently patient under yardstick competition. An additional franchise bidding mechanism can even help firms sustain collusion when they are impatient. When temporary monopoly rights are attributed for sufficiently long periods of time, collusion may not be sustainable even when firms are patient.

JEL Code: D42, D44, L50, L51.

Key words: Yardstick competition, Franchise bidding, Collusion, Local public services.

1 Introduction

The private sector is increasingly being called upon to provide services that are traditionally provided by the public sector such as water distribution, highway construction, garbage collection, or even healthcare services, etc.

*Corresponding author. Email: chong.eshien@online.fr

†Email: huetfreddy@yahoo.fr

Where this is the case, a contract is usually concluded between the public authority and the private firm chosen to provide the service in question. However, in order to address the problems associated with the monopolistic dimension that such industries often exhibit, auctions seemed to be the favorite way for the public authority to choose its private partner. Indeed, as Demsetz (1968) has shown, *ex ante* competitive forces can then be a substitute for normal market competition.

However, collusion among the possible private operators seems to be a pervasive problem when public authorities auction off monopoly rights for these services. For instance, Porter and Zona (1993) noted that more than one half of the criminal cases filed by the Antitrust Division of the US Department of Justice between 1982 and 1988 concerned bid rigging. As well, it is common knowledge today that collusion also plagued the spectrum auctions organized by the US Federal Communications Commission in 1996-1997 (Cramton and Schwartz (2000)). Klemperer (2002) documented a similar case in the German spectrum auctions in 1999. More recently, in Europe, the Swedish Competition Authority exposed a cartel in procurement contracts of road-surfacing (Swedish Competition Authority (2003), Swedish Competition Authority (2005)). Likewise, the French Competition Authority recently convicted three firms in the public urban transportation sector for market sharing between 1996 and 1998 (Conseil de la Concurrence (2005a)) and five firms for collusion in public road construction markets between 1991 and 1998 (Conseil de la Concurrence (2005b)).

When collusion occurs, public authorities are unable to pass on the efficiency gains expected from the privatization of these services to consumers and/or taxpayers. Since collusion seems to be a pervasive problem in auctions, one might legitimately ask: couldn't the public authority use some other mechanism to benefit from competitive pressures when managing the contracts concluded with the private sector? One such mechanism is yardstick competition, under which the financial outcome of a firm providing a public service would depend on its relative performance with respect to other comparable firms providing similar services. Competitive forces are thus simulated by a regulator (Shleifer (1985)). Given that some of the public services in question only exhibit a monopolistic character on a regional or local level, a national regulator could have several operators under its jurisdiction. Therefore, a basis would be created on which to compare relative performances of various firms undertaking the same public service in different places. Yardstick competition is already being used in the UK water sector (Cowan (1997)), the Japanese passenger railway sector (Mizutani (1997) and Okabe (2004)), and the Norwegian bus services (Dalen and Gómez-Lobo (2003)).

The same question was also raised recently by a French consumer association. This association published a study in its magazine revealing that the high water prices in large cities in France that could be due to the high level of concentration in the industry (Union Fédérale des Consommateurs (2006)). It called for the creation of a public entity to oversee the fixing of water prices and establish comparisons between different water services in different municipalities. In other words, in this particular sector in France, regulation through yardstick competition is being considered as a substitute or a complement to auctions.

Obviously, as in any competitive environment, firms regulated under yardstick competition may also be tempted to behave collusively. However, this issue has been given little attention in the economic literature. To the best of our knowledge, this subject has only been studied by Laffont and Martimort

(2000) and Tangerås (2002). The authors derived the optimal collusion-proof yardstick competition, and showed that the regulator should trade off costly rents and productive efficiency. In their settings, collusion between firms was coordinated and enforced by a benevolent third party. In a static context, this could be seen as a short cut to capturing the self-enforceability of collusion that could emerge from repeated relationships.

In this paper, we seek to complement the previous literature by considering firms' incentives to collude under yardstick competition using a repeated game setting. Hence, collusion in our setting is *explicitly* self-enforcing. Moreover, we will consider the possibility that a franchise bidding mechanism may be used in addition to yardstick competition to attribute rights to operate in different geographical markets, and we study how this would alter firms' incentives to collude. For this purpose, we cast our model in a world where self-enforceable collusion should be the easiest. This is motivated by our belief that should firms be unable to collude under propitious conditions, collusion would therefore be unlikely when the operating of the firms is more hostile with respect to their capability to sustain collusion. As a result, the firms in our model are perfectly symmetric with respect to their production costs: arguably, it is more difficult for collusion among heterogeneous firms to be self-sustaining (Cabral (2000), Jacquemin and Slade (1989), and Rothschild (1999))[1]. We will also use grim trigger strategies *à la* Friedman (1971) to study collusion sustainability

We find that even under conditions propitious to sustaining collusion, firms may have an incentive to back out of a collusion agreement. If the regulator uses only yardstick competition, this will be true if the regulator

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

can compensate the more efficient firms instead of penalizing the less efficient firms. In this case, collusion would be sustainable only when firms are sufficiently patient. If both franchise bidding and yardstick competition are used, collusion would be harder to sustain when the monopoly rights to operate in a market are granted for a sufficiently long period of time and firms are "moderately" patient. Quite surprising, a supplementary franchise bidding mechanism may actually *help firms to sustain collusion*. Indeed, we find that when both mechanisms are used, firms are able to sustain collusion even when they are very impatient! This is explained by the fact that a defection in our model implies that the defecting firm would give up current rents for future ones.

The remainder of this paper is organized as follows: in section 2 we set up the simple model. Section 3 considers franchise bidding and yardstick competition in a static asymmetric information context. We then study firms' incentives to collude when the static game is infinitely repeated under the various configurations. We will also discuss some policy recommendations. Concluding remarks follow with proof to support our findings in the in the appendix.

2 The model

2.1 Firms and markets

We consider two geographically separate monopolistic markets, each with a unitary inelastic demand. Gross consumer surplus in each market is assumed to be $S/2$ and such that production is always desirable. These markets can be thought of as belonging to the water industry or urban public transport sector.

Two firms, denoted $i, i = 1, 2$, are capable of producing the good in question. To produce the good in one market, firm i needs to incur costs C_i which, following Laffont and Tirole (1993), are assumed to be written as

$$C_i = \beta_i - e_i$$

β_i is firm i's productivity parameter. We suppose that firms are perfectly symmetric or correlated in the sense that they have the same productivity parameter, i.e. $\beta_1 = \beta_2 = \beta$. We can think of β as the industry's productivity parameter. We further suppose that β can take on two values: $\underline{\beta}$ with probability v and $\overline{\beta}$ with probability $(1 - v)$, with $\overline{\beta} > \underline{\beta}$, and let $\Delta\beta \equiv \overline{\beta} - \underline{\beta}$. In the repeated version of the game, β is assumed to be identically and independently drawn (with respect to time) at the beginning of each period. Firms can also bring down costs by undertaking certain efforts, captured through the term e_i. Cost-reducing efforts are costly in terms of disutility to the firms. This is denoted by $\varphi(e_i)$,and we assume that $\varphi > 0$ for $e > 0$, $\varphi' > 0, \varphi'' > 0$. Thus disutility of efforts is always non-negative. It is increasing in effort at an increasing rate. We further suppose that cost-reducing efforts in a market have no impact on the disutility of cost-reducing efforts on another market.

2.2 Regulator

Since these regional markets are monopolistic in nature, we assume that there is a national regulator in place to supervise the provision of the service in question for both markets. The regulator is confronted with an asymmetric information problem: he does not know the firms' exact productivity level β_i nor is he able to monitor the firms' efforts e_i. In order to overcome his informational problems, we suppose that the regulator could choose between two types of mechanisms: either attribute the monopoly rights of each market through franchise bidding, or regulate firms by using yardstick competition.

The regulator could also choose to use both mechanisms.

Whatever mechanism is chosen, the regulator totally reimburses the firms for their production costs C_i observed *ex post*. In addition, he will make a supplementary net transfer, noted t_i, to firm i. Firm i's rents in terms of utility are therefore

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

The regulator is assumed to be utilitarian: he seeks to maximize social welfare which is simply the sum of social surpluses in each market:

$$\mathscr{W} = S - (1+\lambda)\sum_i(\beta_i - e_i + \varphi(e_i)) - \lambda\sum_i U_i$$

where λ is the shadow costs of public funds, i.e. the regulator's costs of raising his funds.

2.3 Collusion

Whether firms regulated under the various competition-oriented schemes can collude will depend on their incentives to stick to the collusive strategy. In other words, in order to collude, regulated firms under the various schemes must be able to sustain a collusive agreement: collusive contracts are illegal and therefore, will not be enforced by a country's formal institutions. Consequently, collusion between the firms is plausible if firms are able to sustain the collusive agreement. In other words, a collusion has to be *self-enforceable*. We use an infinitely repeated game framework with grim trigger strategies (Friedman (1971)) to study this question. In reality, regulated firms will interact repeatedly with each other (through and with the regulator); a repeated relationship is thus a means for the firms to sustain their collusive agreement.

Under grim trigger strategies, a firm will choose to stick to a collusive strategy if there has been no defection in the previous period. In the opposite case, firms will revert to playing their non cooperative strategy. Collusion is sustainable whenever the discounted expected utility stemming from collusion is greater than the discounted expected utility stemming from a defection and from the consequent non cooperative behavior. We assume that both firms have the same discount factor, denoted δ.

2.4 Timing of the game

Before the game starts, the regulator will choose to use franchise bidding, yardstick competition, or both. In each period, nature chooses β and reveals it to the firms. The regulator then offers the corresponding contract to the firms and commits to it. This contract will be based on the firms' reports on their productivity parameter, and a net transfer based on these reports[2]. Firms can either accept or decline the offer. If a firm declines the offer, it has utility U_R, which is the utility guaranteed by the firm's outside option. We normalize this to $U_R = 0$. If the firms accept the offer, they will submit a report on the productivity parameter. Production and transfers are then carried out according to the terms of the contract proposed by the regulator. A new period starts with a new realization of β. The game is infinitely repeated.

Clearly, if the regulator is not confronted with asymmetric information, he will offer the full information contract which specifies a first-best level of effort, denoted e^{FI}. e^{FI} is such that $\varphi'(e^{FI}) = 1$. The net transfer under the full information contract is set at $t^{FI} = \varphi(e^{FI})$ to exactly compensate the firms for their disutility of efforts. Firms will receive no rents.

[2]The revelation principle ensures that there is no loss of generality by focusing only on direct revelation mechanisms.

3 Competition, natural monopolies and asymmetric information

When the regulator is confronted with an asymmetric information problem, he cannot use the full information contract: a firm will have an incentive to declare itself as being inefficient when in reality it is efficient if the regulator uses the optimal full information contract. Baron and Myerson (1982) and Laffont and Tirole (1993) have characterized the optimal individual incentive contract to regulate the firms in this case. Throughout this paper, we will rather look at mechanisms that allow the regulator to "artificially simulate" competition among the firms in order to overcome its asymmetric information problem. Two mechanisms of this type are considered here: franchise bidding and yardstick competition.

3.1 Yardstick competition in a static setting

When the regulator uses yardstick competition, he *compares* relative performances of both firms and links the firms' financial outcome based on their relative performance. Under a revelation game, we could consider that a regulator who uses yardstick competition compares the firms' reports and sets transfers to the firms based on the comparison. We therefore suppose if a regulator uses yardstick competition, each firm is already granted a market. A contract under yardstick competition can be seen as a cost and net transfer pair based on both reports given by both firms: $\{t(\tilde{\beta}_i, \tilde{\beta}_j), C(\tilde{\beta}_i, \tilde{\beta}_j)\}$ where $\tilde{\beta}_i$ is firm i's own report on the industry-wide productivity parameter and $\tilde{\beta}_j$ that of firm j's, $j \neq i$.

Since firms have an incentive to report $\overline{\beta}$ only when $\underline{\beta}$ is realized (in which case firms will receive positive informational rents measured in terms of economies on disutility of cost-reducing efforts) and they are perfectly correlated, any incompatible reports in the sense that $\tilde{\beta}_i \neq \tilde{\beta}_j$ would allow the regulator to deduce that the industry-wide productivity parameter is $\underline{\beta}$ and that the firm reporting $\overline{\beta}$ is lying. Let us consider the following mechanism adapted from Auriol (1993, 2000) and Auriol and Laffont (1992)[3]:

i. if $\tilde{\beta}_i = \tilde{\beta}_j$, then $C_c(\tilde{\beta}_i, \tilde{\beta}_j) = \tilde{\beta}_i - e_c$ and $t(\tilde{\beta}_i, \tilde{\beta}_j) = t_c$: when reports are compatible then the contract will totally reimburses firms' costs according to the reported industry-wide productivity parameter, and set transfers to t_c

ii. if $\tilde{\beta}_i \neq \tilde{\beta}_j$, then $C_c(\tilde{\beta}_i, \tilde{\beta}_j) = \underline{\beta} - e_c$ and $t(\overline{\beta}, \underline{\beta}) = t_c - P$ and/or $t(\underline{\beta}, \overline{\beta}) = t_c + A$: when reports are incompatible, the regulator will only reimburse the level of costs intended for a $\underline{\beta}$ type firm. Moreover, he will set transfers to include a compensation A for the firm reporting $\underline{\beta}$, and/or a fine P for a firm reporting $\overline{\beta}$.

t_c, C_c and e_c are the transfers, costs that will be reimbursed and the resulting level of cost reducing effort specified in the contract by the regulator. Tables 1 and 2 give the firms' utility according to the realized productivity and their respective reports while proposition 1 summarizes the result of the equilibrium of the static game.

Proposition 1 *In equilibrium, the regulator can propose the full information contract and both firms will report truthfully. When the regulator uses only fines, i.e.* $P > 0$ *and* $A = 0$*, then truthful reports form a Bayesian-Nash equilibrium. On the contrary, when the regulator uses compensation in yardstick competition, truthful reports form an equilibrium in dominant strategy*

[3] These authors consider using only very high fines to dissuade information dissimulation. Here, we also consider the role of compensations.

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

	Reports $\underline{\beta}$	Reports $\overline{\beta}$
Reports $\underline{\beta}$	$t_c - \varphi(e_c), t_c - \varphi(e_c)$	$t_c - \varphi(e_c) + A, t_c - \varphi(e_c) - P$
Reports $\overline{\beta}$	$t_c - \varphi(e_c) - P, t_c - \varphi(e_c) + A$	$t_c - \varphi(e_c - \Delta\beta), t_c - \varphi(e_c - \Delta\beta)$

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

	Reports $\underline{\beta}$	Reports $\overline{\beta}$
Reports $\underline{\beta}$	$t_c - \varphi(e_c + \Delta\beta), t_c - \varphi(e_c + \Delta\beta)$	$t_c - \varphi(e_c + \Delta\beta) + A,$ $t_c - \varphi(e_c + \Delta\beta) - P$
Reports $\overline{\beta}$	$t_c - \varphi(e_c + \Delta\beta) - P,$ $t_c - \varphi(e_c + \Delta\beta) + A$	$t_c - \varphi(e_c), t_c - \varphi(e_c)$

if $\varphi(e_c) - \varphi(e_c - \Delta\beta) \leq A \leq \varphi(e_c + \Delta\beta) - \varphi(e_c)$.

We denote $\overline{U} \equiv \varphi(e^{FI}) - \varphi(e^{FI} + \Delta\beta)$ (resp. $\underline{U} \equiv \varphi(e^{FI}) - \varphi(e^{FI} - \Delta\beta)$) as the informational rents under the full information contract of the $\overline{\beta}$-type (resp. $\underline{\beta}$-type) firm when it reports as being a $\underline{\beta}$ (resp. $\overline{\beta}$) type. Notice that $\overline{U} < 0$ and $\underline{U} > 0$.

Note that truthful reports do not comprise a unique Bayesian-Nash equilibrium in the game[4]. The other Bayesian-Nash equilibrium of the game, when $\underline{\beta}$ is realized and when only fines are used in yardstick competition, results in both firms reporting $\overline{\beta}$ when $\underline{\beta}$ is realized[5]. Therefore, regulated firms

[4]This has been shown in previous literature. See for instance Demski and Sappington (1984) or Mookherjee (1984).

[5]Nevertheless, Auriol (2000) has shown that an implementation of yardstick competition based on fines through a menu of linear contracts will still deliver a unique first best equilibrium, contrary to this game of simultaneous revelation: firms will find it in

are incited to collude even under the static revelation game with yardstick competition based only on fines. Consequently, to be certain that truthful reports will be the unique equilibrium in a revelation game, the regulator should prefer using a dominant strategy implementation in which he compensates for truthful revelations in the event of incompatible reports. In this latter case, the structure of the game has the esssence of a prisoner's dilemma and the amount of compensations that the regulator can use is in fact upwardly bounded if he does not want to induce an inefficient-type firm to report itself as being efficient. The lower bound, on the other hand, guarantees that firms will prefer to report honestly when they are efficient. In the remaining discussion, we will suppose that the regulator fixes A within this interval.

This static game shows that the value of yardstick competition lies in the fact that a regulator could exploit the correlation between firms' private information. This provides the regulator with a supplementary instrument to solicit firms' private information, and allows him to save costly informational rents. As Crémer and McLean (1985, 1988) showed, any correlation, however mild, in agents' private information will enable the principal to extract all their informational rents.

3.2 Franchise bidding in a static setting

When a franchise bidding scheme is used, normal market competition (which is non viable) can be substituted with *ex ante* competition (Demsetz (1968)). In this setting, the regulator will define the market rights for each local monopoly and grant the rights to operate in a market to the firm with the

their best interest to choose the first-best level of cost reducing efforts under a yardstick competition based on fines implemented through a menu of linear contracts.

lowest costs. To study this setting, we continue to restrict ourselves to direct revelation mechanisms: instead of bidding directly on their cost levels, firms bid by submitting reports on the industry-wide productivity parameter. The regulator therefore attributes the rights to operate a market through a contract specifying the reimbursed cost level $C(e_c)$[6] and net transfer t_c to the firm reporting the lowest β. We will further consider the following tie-breaking rule: each firm will be attributed rights to operate in one market when their reports coincide. The rationale behind this rule is that the results obtained can be compared when we consider other configurations in later parts of the discussion. Notably, when we study the setting where franchise bidding is used together with yardstick competition, the regulator will want to have different firms on both markets, so that he could credibly compare their performances.

The major difference of this game with yardstick competition lies in that the regulator no longer has access to fines or compensations when reports differ: simply, he encourages truthful revelations through his choice to attribute the rights to operate in the markets to one firm or the other when reports differ. Tables 3 and 4 present the firms' payoff according to their reports and the realized β for a given transfer t_c. Proposition 2 provides a summary of the outcome of the game.

Proposition 2 *When franchise bidding is used, the regulator will auction off the full information contracts. Firms report truthfully in a Bayesian-Nash equilibrium. A full information outcome can be achieved.*

Note however that according to the proposition above, truthful reports are not the only Bayesian-Nash equilibrium. More specifically, when $\underline{\beta}$ is

[6] This can be seen as a cost target to which the regulator credibly commits.

Table 3: Payoff matrix when the realized productivity parameter is $\underline{\beta}$

	Reports $\underline{\beta}$	Reports $\overline{\beta}$
Reports $\underline{\beta}$	$t_c - \varphi(e_c), t_c - \varphi(e_c)$	$2[t_c - \varphi(e_c)], 0$
Reports $\overline{\beta}$	$0, 2[t_c - \varphi(e_c)]$	$t - \varphi(e_c - \Delta\beta), t - \varphi(e_c - \Delta\beta)$

Table 4: Payoff matrix when the realized productivity parameter is $\overline{\beta}$

	Reports $\underline{\beta}$	Reports $\overline{\beta}$
Reports $\underline{\beta}$	$t_c - \varphi(e_c + \Delta\beta), t_c - \varphi(e_c + \Delta\beta)$	$2[t_c - \varphi(e_c + \Delta\beta)], 0$
Reports $\overline{\beta}$	$0, 2[t_c - \varphi(e_c + \Delta\beta)]$	$t_c - \varphi(e_c), t_c - \varphi(e_c)$

realized, firms may be better off by both reporting $\overline{\beta}$: it would then be possible for them to earn positive informational rents. Similar to when yardstick competition with fines is used, collusion is possible even in this static game.

4 Self enforceable collusion

The regulator's use of artificial competition could induce the firms to behave cooperatively instead of competitively. Even under a static framework, as we have seen above, collusion may be an equilibrium under some circumstances when competition is being simulated. Should this be the case, these instruments that allow the regulator to simulate competitive pressure might have adverse consequences on social welfare. As such, it is important to assess the plausibility of collusive behavior when regulatory tools simulating competition are used. This is the goal of this section. Collusion sustainability is discussed under three possible configurations: firstly, when only yardstick competition is used; secondly, when only a franchise bidding mechanism is used; and thirdly, when the regulator uses franchise bidding to attribute market rights and then regulates the firm(s) using yardstick competition. A discussion in terms of policy follows.

4.1 Collusion under yardstick competition

From tables 1 and 2, we can see that it is mutually beneficial for both firms if they report themselves as being a $\overline{\beta}$-type when the industrial-wide productivity parameter is $\underline{\beta}$: they would each gain $\underline{U} > 0$. When the industry-wide productivity parameter is $\overline{\beta}$, firms can do no better than report truthfully. As such, the collusion agreement between the firms can be seen as firms agreeing to report $\overline{\beta}$ whatever the realized industry-wide productivity parameter. Moreover, firms will be tempted to defect by reporting truthfully only when $\underline{\beta}$ is realized. As a result, to sustain collusion, firms must not defect when $\underline{\beta}$ is realized. This yields the following proposition:

Proposition 3 *When the regulator uses yardstick competition based only on fines, then firms can always sustain collusion. When the regulator uses yardstick competition based on compensations, then collusion is sustainable if and only if compensations are sufficiently low and/or firms are sufficiently patient. In terms of a critical threshold $\delta^*_{YC,c}$, collusion is sustainable when yardstick competition with compensation is used if and only if*

$$\delta \geq \delta^*_{YC,c} = \frac{A - \underline{U}}{A - (1-v)\underline{U}} \tag{1}$$

Proposition 3 is quite expected: a firm has no interest in defecting from collusion when yardstick competition based on fines is used. This is because defection provides no benefit to the defecting firm: only the other firm, behaving collusively, is fined. On the other hand, when yardstick competition with compensations is used, firms may be tempted by the perspective of compensations and, therefore, may choose to defect. Firms would be more tempted to defect if the compensations are high, and/or they discount future periods at a lower rate.

The following corollary provides insights into the impact of some variables on the critical threshold:

Corollary 1 *For any $\underline{U} < A \leq -\overline{U}$ fixed by the regulator, the critical threshold factor decreases in $\Delta\beta$ and in v.*

Corollary 1 suggests that firms will find it easier to sustain collusion under compensation-based yardstick competition when difference in the industry-wide productivity level is large and the probability that the industry-wide productivity parameter $\underline{\beta}$ is high. In both cases, higher future informational rents from collusion can be expected, thus firms can afford to be less patient in order to sustain collusion.

4.2 Collusion in franchise bidding

As in the above proposition, one can see from table 3 and 4 that when a franchise bidding mechanism is used to auction off the first best contract, firms may have an incentive to collude by reporting the $\overline{\beta}$ industry-wide productivity parameter regardless of its truel realization. This way, they will share the markets, and at the same time, benefit from informational rents. In this dynamic setting, we suppose that the contract that is being auctioned will grant the winning firm(s) one period of monopoly rights. In other words, the regulator will auction off the monopoly rights for each market during each period. This can be justified by the fact that the firms' private information changes for each period.

In order to sustain collusion to share markets by always reporting $\overline{\beta}$, firms must resist the temptation to defect when the truel realization of this parameter is $\underline{\beta}$. As in the previous discussion, a $\overline{\beta}$ firm stands to lose in this case by reporting being a $\underline{\beta}$-type. It is clear that firms will have no incentive to defect when such a mechanism is used, hence proposition 4.

Proposition 4 *When a franchise bidding mechanism is used to attribute monopoly rights for the various markets, collusion is always sustainable.*

This result can be easily explained: winning both markets does not provide any benefits to the defecting firms because the contracts that are auctioned here are full-information contracts. Therefore, firms will always prefer to behave collusively and share the markets when franchise bidding is used, and collusion is stable.

4.3 Collusion when both schemes are used

The regulator may consider using both schemes together to introduce competitive forces in order to regulate these regional monopolies. In this case, the regulator first uses a franchise bidding mechanism to grant market rights for $n+1$ periods, and then regulates the winning firm(s) using yardstick competition during the subsequent n periods. In the repeated game, at the end of the $(n+1)$ period, the rights will be available for bids again for another $n+1$ periods, *ad infinitum.*

Since the goal of collusion is to maximize joint profits, we define the firms' collusive strategy here as reporting $\overline{\beta}$ regardless of the realized industry-wide productivity parameter for all periods of the game. Under such a collusion, firms share markets and benefit from informational rents when the markets are franchised, and they coordinate their reports under yardstick competition in order to benefit from informational rents. However, note that if a firm wins both markets, it is able to coordinate its own reports in the consequent n periods when yardstick competition is used. As such, it could benefit from informational rents stemming from *both* markets during the regulation period. A firm may therefore want to defect by reporting truthfully when $\underline{\beta}$ is realized, and by reporting $\underline{\beta}$ even when $\overline{\beta}$ is realized. In the first case, a defecting firm's utility is

$$U^{\mathscr{D}}_{\underline{\beta}}(\underline{\beta}) = 2v\frac{\delta(1-\delta^n)}{1-\delta}\underline{U}$$

where $U^{\mathscr{D}}_{\beta}(\tilde{\beta})$ is the defecting firm's utility when the industry-wide productivity parameter is β and it reports $\tilde{\beta}$.

When $\overline{\beta}$ is realized, a defecting firm may want to report itself as being $\underline{\beta}$ in order to secure the monopoly rights for both markets for the subsequent $(n+1)$ periods at stake. In this case, the defecting firm's utility is

$$U^{\mathscr{D}}_{\overline{\beta}}(\underline{\beta}) = 2\overline{U} + 2v\frac{\delta(1-\delta^n)}{(1-\delta)}\underline{U}$$

As such, collusion is sustainable if and only if

$$\underline{U} + \frac{v\delta}{(1-\delta)}\underline{U} \geq 2v\frac{\delta(1-\delta^n)}{(1-\delta)}\underline{U} \tag{2}$$

when $\underline{\beta}$ is realized, and

$$\frac{v\delta}{(1-\delta)}\underline{U} \geq 2\overline{U} + 2v\frac{\delta(1-\delta^n)}{(1-\delta)}\underline{U} \tag{3}$$

when $\overline{\beta}$ is realized.

One can easily see that if equation (2) is satisfied, then equation (3) will automatically be satisfied. Indeed, as $|\overline{U}| > |\underline{U}|$ and $\overline{U} < 0$, equation (2) implies that $\frac{v\delta}{(1-\delta)}\underline{U} \geq 2v\frac{\delta(1-\delta^n)}{(1-\delta)}\underline{U} - \underline{U}$. This latter term should be greater than $2\overline{U}+2v\frac{\delta(1-\delta^n)}{(1-\delta)}\underline{U}$. As such, collusion is sustainable if equation (2) holds.

Equation (2) can be rewritten as

$$2v\delta^{n+1}-(1+v)\delta+1\geq 0 \tag{4}$$

We define $f(v,\delta,n)\equiv 2v\delta^{n+1}-(1+v)\delta+1$. We plot the graphs of this equation according to δ and for $v=0.2, 0.5$ and $v=0.8$. For each given v, the figures trace graphs for $n=1,4,9,24$ and 34, which correspond to a length of $2,5,10,25$ and 35 periods of monopoly rights. Collusion is sustainable in the interval of δ where $f(\cdot)$ is negative.

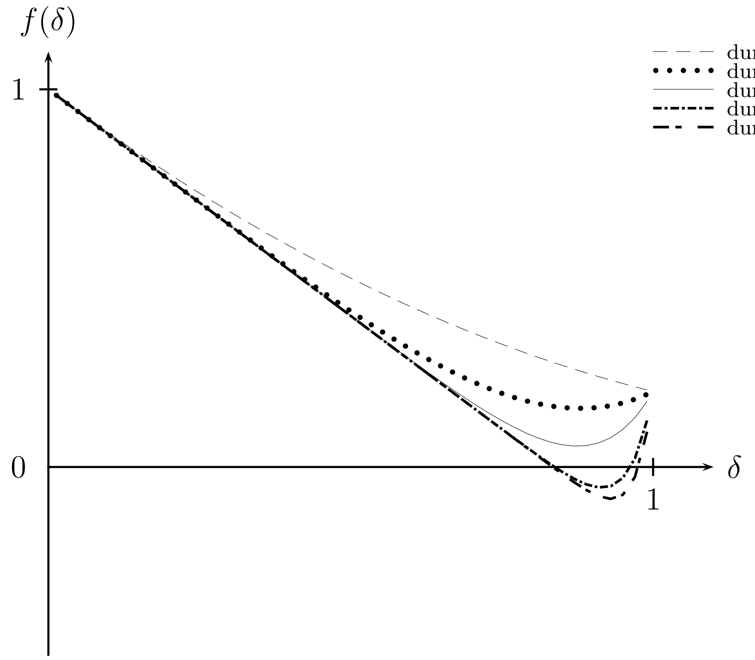

Figure 1: Graphs of $f(\delta,n)$ when $v=0.2$

Several observations may be made from figures 1–3: all things equal, firms will find collusion relatively harder to sustain when v is high, and when the monopoly rights are granted for a relatively long period of time. Intuitively,

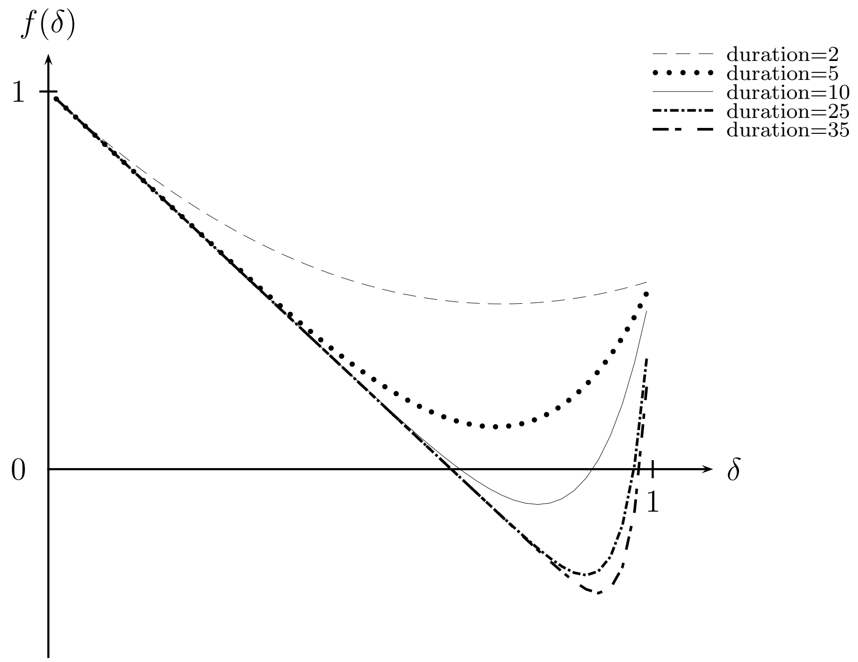

Figure 2: Graphs of $f(\delta, n)$ when $v = 0.5$

a higher v implies a higher possibility for firms to benefit from future informational rents, since $\underline{\beta}$ is more likely to be realized. This means that the stakes from collusion and defection become more important. A longer number of periods for which monopoly rights are granted will also change the stakes of defection for firms: the longer they detain these rights, the higher the perspective of future rents from defection.

Surprisingly, the figures also show that there may be two critical threshold discount factors in this game: firms may sustain collusion if they are patient enough, and if they are sufficiently impatient! These critical threshold factors correspond to the value of δ when $f(v, \delta, n) = 0$ in the figures. This finding contrasts with the usual result found in the literature on self-enforcing collusion in a repeated game. This means that, in our case, the use of both competitive schemes may actually help firms sustain collusion! If we denote

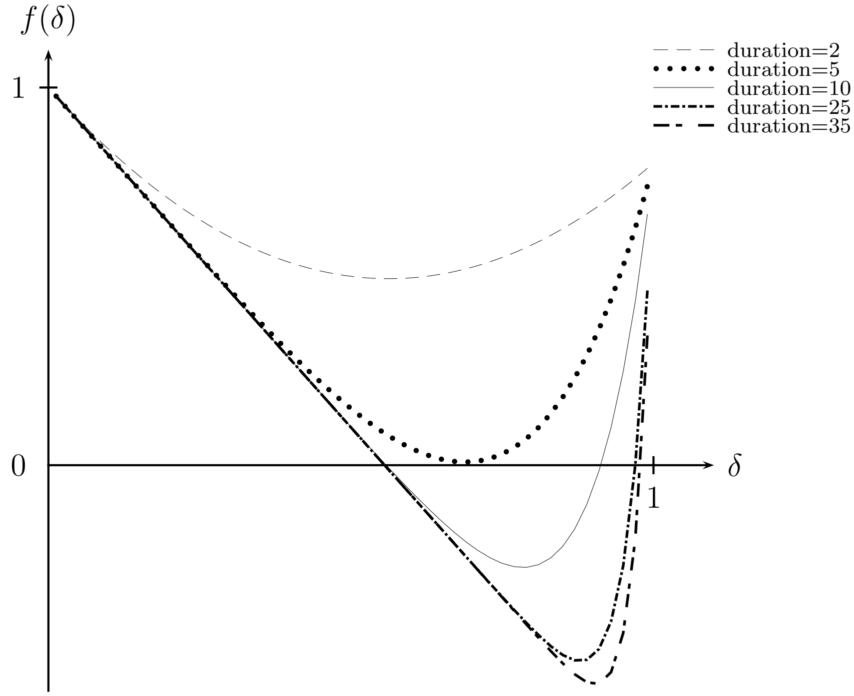

Figure 3: Graphs of $f(\delta, n)$ when $v = 0.8$

$\underline{\delta}^*_{\text{FB,YC}}$ the first critical threshold factor and $\overline{\delta}^*_{\text{FB,YC}}$ the second critical threshold factor, with $\overline{\delta}^*_{\text{FB,YC}} > \underline{\delta}^*_{\text{FB,YC}}$, then collusion is sustainable if $\delta \leq \underline{\delta}^*_{\text{FB,YC}}$ or $\delta \geq \overline{\delta}^*_{\text{FB,YC}}$. We summarize these observations in the following proposition:

Proposition 5 *When the regulator attributes the markets using a franchise bidding mechanism before regulating the firms under yardstick competition, collusion is always sustainable if v and the length of monopoly rights are sufficiently low. When v and the length of the monopoly rights are high enough, firms may sustain collusion only if they are patient enough, or if they are impatient enough.*

The intuition behind these results is as follows: notice that when a firm defects, it must to forego the informational rents in the first period when franchise bidding is used in order to win the monopoly rights for *both* markets. This allows the defecting firm to benefit from *expected* informational rents stemming from both markets during the subsequent periods granted by the monopoly rights. As such, if these rents are unlikely (v low), or these expected rents are low (because monopoly rights expire too soon), then firms will not be incited to forego the present gains by defecting. More importantly, even when these expected rents are high, firms may not be interested in defecting when they are impatient: they would prefer to benefit from the current informational rents by sticking to the collusion agreement when monopoly rights are being franchised. Hence $\delta \leq \underline{\delta}^*_{\text{FB,YC}}$.

The intuition behind the second part of the results is more classic: after a defection, under grim trigger strategies, firms revert to behaving non cooperatively. In our case, this implies that once the monopoly rights expired and are franchised again in the future, a firm will also be required to forego future rents after defection. Hence, firms will have to be sufficiently patient to sustain collusion. In other words, the firms' discount factor has to satisfy $\delta \geq \overline{\delta}^*_{\text{FB,YC}}$ in order to sustain collusion.

Notice that when $n = 0$, this corresponds to the case where only franchise bidding is used. Collusion is then always sustainable as concluded previously. The following corollary studies the case when monopoly rights are granted once and for all:

Corollary 2 *As $n \to +\infty$, $f(v, \delta, n) \to 1 - (1 + v)\delta$. Collusion is sustainable if $\delta \leq \frac{1}{1+v}$. More particularly, if $v \to 1$ then collusion is sustainable if $\delta \leq \frac{1}{2}$. On the contrary, if $v \to 0$, then collusion is always sustainable.*

From corollary 2, it would seem that the lower critical threshold factor is downwardly bounded by $\frac{1}{2}$, i.e. $\underline{\delta}^*_{\text{FB,YC}} \geq \frac{1}{2}$. Thus, for very impatient firms, a supplementary franchise bidding mechanism may contribute to helping them sustain collusion. Furthermore, notice that the upper critical threshold disappears when monopoly rights are granted infinitely. This suggests that collusion will not be sustainable even for very patient firms in this case when v is high enough. Intuitively, this is because when $n \to +\infty$, a defection will never be "punished". Hence, there is no need for a defecting firm to forego future informational rents following a defection.

In a nutshell, the main insight is that the use of a supplementary franchise bidding mechanism could in fact help firms to sustain collusion, contrary to what may be expected.

4.4 Some policy considerations

Collusion can be a concern when the regulator tries to introduce competitive forces into regional monopolies. Nevertheless, the firms' ability to sustain a collusive agreement changes according to the type of mechanism used by the regulator. As seen from the analysis above, yardstick competition based on fines should be avoided: in this case, firms are always able to sustain collusion. When a yardstick competition scheme is used repeatedly, collusion is not sustainable unless firms are sufficiently patient. Moreover, the higher the amount of compensations, the more difficult it is for firms to sustain collusion. This suggests that when the regulator is faced with very patient firms, in order to discourage any collusive initiative, he will have to commit to providing very high amounts of compensation.

However, high compensations may introduce adverse incentives into the scheme. Furthermore, compensations that are too high may not be credible, and consequently, may not be sufficient to deter firms' collusive incentives. This is where a supplementary franchise bidding mechanism to attribute market rights can help the regulator. Indeed, when monopoly rights are being attributed for a *sufficiently long period of time*, collusion may be sustainable when firms are patient only to a certain extent. By using both schemes together, the regulator can destabilize collusion for such firms.

One should also note that using both mechanisms together may in fact help firm sustain collusion. According to our analysis, this could happen when firms are impatient. Therefore, one could suggest using only yardstick competition based on compensations when firms are impatient, and using both schemes when both firms are patient. In the former case, another advantage is that compensations can be less important. Notice that if firms are extremely patient, then collusion should be sustainable. In this case, the regulator might want to consider some other types of incentive regulation and not introduce competitive forces into such markets.

One may notice that the choice of type of regulation is influenced by the likelihood of the more efficient productivity parameter $\underline{\beta}$. When yardstick competition is repeatedly used, the critical threshold factor decreases as v increases: firms can afford to be less patient to sustain collusion. On the other hand, when temporary monopoly rights are first attributed through auctions before yardstick competition is used, firms have to be less patient than the lower critical threshold factor to sustain the collusive agreement. One can see that this critical threshold factor decreases to a certain extent as v increases. This implies that firms must be more impatient, to a certain extent, in order to sustain collusion as v increases. The choice between using both schemes, or only yardstick competition, could therefore depend on this parameter, especially when firms are neither too patient nor too impatient.

In summary, when collusion could be a problem, using both franchise bidding to attribute market rights and yardstick competition *ex post* to regulate may not be the solution to discouraging firms from behaving collusively. Franchise bidding may in fact help firms to sustain their collusive agreement! The length for which the monopoly rights for the markets are granted can also play a role in helping the regulator prevent collusion.

5 Conclusion

In this paper, we have adopted an infinitely repeated game framework to study firms' collusive incentives when the regulator tries to introduce competitive forces into regional monopolies. It was found that firms are able to sustain collusion when the yardstick competition that is used is based on fines. However, when the yardstick competition scheme includes compensations in the event of incompatible reports, collusion is sustainable only when firms are sufficiently patient.

Using a supplementary franchise bidding mechanism with yardstick competition may not always help the regulator destabilize the firms' capability to collude. This latter objective can be achieved only if firms are "moderately" patient, and on the condition that the temporary monopoly rights are attributed for sufficiently long periods of time. The use of both schemes therefore seems appropriate when firms are moderately patient. Otherwise, when firms are impatient, a supplementary franchise bidding mechanism may help to sustain collusion!

We believe that our proposition 3 could also be used to shed some light on the ongoing debate between the use of leniency programs and whistle-blowing programs in the antitrust arena against cartels. In the former, competition authorities impose fines on all cartel members except the defecting one, while in the latter, competition authorities offer compensation to the defecting cartel member. While our model has not been specifically constructed to study this issue, this propostion nevertheless seems to argue in favor of the use of whistle-blowing programs. However, the danger of a whistle-blowing program could lie in the amount of compensation that should be fixed.

A related question concerns whether a regulation authority or a competition authority should be placed in charge of deterrence of collusive behavior when an industry is submitted to regulations. Our results seem to tilt favorably towards the regulation authority. Indeed, a competition authority works on collusion problems *ex post*, even if the policy introduces an *ex ante* impact on a firm's incentive to collude, while a regulation authority can directly act *ex ante* and prevent collusion through adequately designed regulatory instruments. However, one still has to compare costs and benefits of delegating this task to a regulation authority, and it is likely that they may complement each other in this endeavor.

Nevertheless, we must admit that there are limits to our analysis. The most important is perhaps the fact that we may have oversimplified the stakes that firms could have in winning temporary market rights. One may think that a firm that wins the rights to operate on a market will develop advantages over firms that "stayed out of the business" (Williamson (1976)), enhancing its chances of winning future markets. This may erode some of the collusive incentives that firms may have.

Another possible limit could be that we have not accounted for the fact that regulatory procedures and franchise bidding mechanisms are costly to implement. For instance, Yvrande-Billon (2005) mentions that costs for preparing a bid in the French urban transport sector range from 30,000€ for a small network to 500,000€ for a large one. A regulator may want to trade off the costs of benefits of discouraging collusion through the length of monopoly rights or effort distorsion.

Nonetheless, we believe that our results help recognize that when a regulator tries to simulate competitive forces, firms may collude. Whether they could in fact do this will partly depend on the regulatory scheme being used. A regulator intending to use schemes that simulate market forces should keep this in mind, and evaluate the extent to which such behavior is possible. A mixture of several instruments may either sustain or destabilize collusion. Great care should therefore be exercised before implementing various possible regulatory tools.

Acknowledgements

We are grateful to Masahiko Aoki, Claudine Desrieux, David Encaoua, Pierre Garrouste, Sébastien Lécou,Thierry Pénard, Yannick Perez, Jérôme Pouyet, Jean-François Sattin, Marcelo Saguan, Brian Silverman, Howard Shelanski, Carine Staropoli, Ed Steinmueller, Anne Yvrande-Billon and participants of the ATOM seminar, of the GRJM seminar, of the Atéliers de la MSE, of ESNIE 2005, of EARIE 2005, of the LVI Congès Annuel de l'AFSE, of the 4th Conference on Applied Infrastructure Research, and of the Conference on Public Services and Management for their helpful comments and criticisms. We especially thank Stéphane Saussier for his advice and guidance. The usual caveats apply.

Appendix

A Proofs

A.1 Proof for proposition 1

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

$$U_i(\overline{\beta},\overline{\beta},\overline{\beta}) \geq U_i(\underline{\beta},\overline{\beta},\overline{\beta}), \qquad i=1,2 \tag{5}$$

$$U_i(\underline{\beta},\underline{\beta},\underline{\beta}) \geq U_i(\overline{\beta},\underline{\beta},\underline{\beta}), \qquad i=1,2 \tag{6}$$

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 β is realized, $\tilde{\beta}_i,\tilde{\beta}_j,\beta \in \{\underline{\beta},\overline{\beta}\}$. Under the proposed mechanism, these constraints, can be rewritten as:

$$t_c - \varphi(e_c) \geq t_c - \varphi(e_c + \Delta\beta) + A$$

$$t_c - \varphi(e_c) \geq t_c - \varphi(e_c) - P$$

Thus, truthful reporting is a Bayesian Nash equilibrium when $P \geq 0$ and $A \leq \phi(e_c + \Delta\beta) - \phi(e_c)$. In particular, this is true for $A = 0$ and for the contract that specifies $e_c = e^{FI}$, $t_c = \varphi(e^{FI})$. Thus, the regulator can impose the full information contract and it is sufficient to achieve truthful reporting and punish firms when reports are incompatible.

Truthful reporting is an equilibrium in dominant strategy if and only if, in addition to the two inequalities above, the following conditions are satisfied:

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

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

They will be satisfied if $P = 0$ and $\varphi(e_c) - \varphi(e_c - \Delta\beta) \leq A \leq \varphi(e_c + \Delta\beta) - \varphi(e_c)$. In particular, this is true if the regulator specifies C_c such that $e_c = e^{FI}$ and $t_c = \varphi(e^{FI})$. Indeed, given that $\varphi''(\cdot) > 0$, $\varphi(e^{FI}+\Delta\beta) - \varphi(e^{FI}) >$

$\varphi(e^{FI}) - \varphi(e^{FI} - \Delta\beta)$. Consequently, such a range exists for A. The regulator can thus offer the full information contract under yardstick competition based only on compensation.

A.2 Proof for proposition 2

Under the franchise bidding game, truthful reports are a Bayesian-Nash equilibrium if and only if the set of equations 5–6 are satisfied. From tables 3 and 4 and for a contract specified by the regulator, these conditions are:

$$\begin{aligned} t_c - \varphi(e_c) &\geq 2[t_c - \varphi(e_c + \Delta\beta)] \\ t_c - \varphi(e_c) &\geq 0 \end{aligned}$$

Therefore, for any t_c and e_c specified (through the reimbursed costs level) in the contract satisfying these constraints, firms will report truthfully in (a Bayesian-Nash) equilibrium. In particular, these incentive compatibility constraints are satisfied by $e_c = e^{FI}$ and $t_c = \varphi(e^{FI})$, the first-best level of efforts and the first-best level of net transfers. Under this contract, the second constraint is automatically satisfied:

$$\varphi(e^{FI}) - \varphi(e^{FI}) = 0$$

This first constraint can be rewritten as

$$\begin{aligned} & 0 &\geq& \ 2[\varphi(e^{FI}) - \varphi(e^{FI} + \Delta\beta)] \\ \rightleftharpoons \quad & \varphi(e^{FI} + \Delta\beta) &\geq& \ \varphi(e^{FI}) \end{aligned}$$

Given that $\varphi' > 0$, we have $\varphi(e^{FI} + \Delta\beta) > \varphi(e^{FI})$. Therefore, this constraint is satisfied as well. Moreover, firms are willing to accept this contract as it guarantees them their reservation utility.

A.3 Proof for proposition 3

To sustain collusion, firms must not be tempted to defect when $\underline{\beta}$ is realized and after it has been revealed to the firm. In this case, a firm's discounted expected rent is $\underline{U} + v\frac{\delta}{(1-\delta)}\underline{U}$. If the regulator uses yardstick competition based on fines, a defecting firm's expected utility is 0 and firms revert back to behaving non cooperatively. Under grim trigger strategies, collusion is sustainable if and only if

$$\begin{aligned}\underline{U} + \sum_{t=1}^{\infty} \delta^t v \underline{U} &\geq 0 \\ \delta \leq \delta^*_{\text{YC},f} &= \frac{1}{1-v}\end{aligned}$$

where $\delta^*_{\text{YC},f}$ is the critical threshold. Since $(1-v) < 1$, $\delta^*_{\text{YC},f} > 1$. Thus, firms will always be able to sustain collusion.

When the regulator uses yardstick competition based on compensation, defection brings A to the firm but firms subsequently revert to behaving non-cooperatively. As such, under this type of yardstick competition, collusion is sustainable if and only if

$$\begin{aligned}\underline{U} + v\frac{\delta}{(1-\delta)}\underline{U} &\geq A \\ \delta \geq \delta^*_{\text{YC},c} &= \frac{A-\underline{U}}{A-\underline{U}(1-v)}\end{aligned}$$

where $\delta^*_{\text{YC},c}$ is the critical threshold factor. Since $0 < (1-v) < 1$ by assumption, we have $(1-v)\underline{U} < \underline{U}$ and so $[A-(1-v)\underline{U}] > [A-\underline{U}]$. As such $\delta^*_{\text{YC},c} < 1$: $\delta^*_{\text{YC},c}$ is bounded by 1. Furthermore, if $A > \underline{U}$. Hence $\delta^*_{\text{YC},c} > 0$. Given that $\delta \in]0,1[$, firms are therefore able to sustain collusion under this type of yardstick competition if they are patient enough (so that $\delta \geq \delta_{\text{YC},c}$).

We will now show that the higher the amount of compensation, the more patient firms will have to be to sustain collusion:

$$\frac{\partial \delta^*_{\text{YC},c}}{\partial A} = \frac{v\underline{U}}{[A - \underline{U}(1-v)]^2} > 0$$

since $v, \underline{U} > 0$. Therefore, the critical threshold increases with the amount of compensations.

A.4 Proof for corollary 1

Recall that $\underline{U} \equiv \varphi(e^{FI}) - \varphi(e^{FI} - \Delta\beta) > 0$ and $\overline{U} \equiv \varphi(e^{FI}) - \varphi(e^{FI} + \Delta\beta) < 0$. We thus have

$$\begin{aligned} \underline{U}'_{\Delta\beta} \equiv \frac{\partial \underline{U}}{\partial \Delta\beta} &= \varphi'(e^{FI} - \Delta\beta) > 0 \\ \overline{U}'_{\Delta\beta} \equiv \frac{\partial \overline{U}}{\partial \Delta\beta} &= -\varphi'(e^{FI} + \Delta\beta) < 0 \end{aligned}$$

Therefore, for any given A, we have

$$\begin{aligned} \frac{\partial \delta^*_{\text{YC},c}}{\partial \Delta\beta} &= \frac{-\underline{U}'_{\Delta\beta}[A - (1-v)\underline{U}] + (1-v)\underline{U}'_{\Delta\beta}[A - \underline{U}]}{[A - (1-v)\underline{U}]^2} \\ &= \frac{-vA\varphi'(e^{FI} - \Delta\beta)}{[A - (1-v)\underline{U}]^2} < 0 \end{aligned}$$

as $\varphi'(\cdot), v, A > 0$. Hence the critical threshold discount factor decreases in $\Delta\beta$ for $\underline{U} < A < -\overline{U}$.

Similarly, we have

$$\frac{\partial \delta^*_{\text{YC},c}}{\partial (1-v)} = \frac{\underline{U}(A - \underline{U})}{[A - (1-v)\underline{U}]^2} > 0$$

$\delta^*_{\text{YC},c}$ thus increases in $(1-v)$. Therefore, $\delta^*_{\text{YC},c}$ is decreasing in v.

A.5 Proof for proposition 4

When $\underline{\beta}$ is realized, the expected rents from collusion are $\underline{U} + \frac{v\delta}{(1-\delta)}\underline{U}$. Defection allows the defecting firm to obtain monopoly rights for both markets but the contract auctioned yields utility that is equal to the winning firm's outside option, i.e. 0. Moreover, firms will revert back to playing non cooperatively, therefore expected utility from defection is 0. Collusion is therefore sustainable if and only if

$$\begin{aligned} \underline{U} + \frac{v\delta}{(1-\delta)}\underline{U} &\geq 0 \\ \delta \leq \delta^*_{\text{FB}} &= \frac{1}{1-v} \end{aligned}$$

where δ^*_{FB} is the critical threshold. Given that $\delta^*_{\text{FB}} > 1$ as $v < 1$, this condition is always verified. Therefore, collusion is always sustainable.

References

Emmanuelle Auriol. Monopole ou doupole: L'effet de comparaison. *Annales d'Economie et de Statistique*, 31:1–31, 1993.

Emmanuelle Auriol. Concurrence par comparaison: Un point de vue normatif. *Revue Economique*, 51:621–634, 2000.

Emmanuelle Auriol and Jean-Jacques Laffont. Regulation by duopoly. *Journal of Economics and Management Strategy*, 1(3):507–533, 1992.

David P. Baron and Roger B. Myerson. Regulating a monopolist with unknown costs. *Econometrica*, 50(4):911–930, 1982.

Luis M. B. Cabral. *Introduction to Industrial Organization*. MIT Press, Cambridge, MA, 2000.

Conseil de la Concurrence. Communiqués de 2005: Transport public de voyageurs. Press Release, 7 July 2005a.

Conseil de la Concurrence. Communiqués de 2005: Secteur des travaux routiers en Seine-Maritime. Press Release, 15 December 2005b.

Simon Cowan. Competition in the water industry. *Oxford Review of Economic Policy*, 13:83–92, 1997.

Peter Cramton and Jesse A. Schwartz. Collusive bidding: Lessons from the

FCC spectrum auctions. *Journal of Regulatory Economics*, 17:229–252, 2000.

Jacques Crémer and Richard P. McLean. Optimal selling strategies under uncertainty for a discriminating monopolist when demands are interdependent. *Econometrica*, 53(2):345–362, 1985.

Jacques Crémer and Richard P. McLean. Full extraction of the surplus in bayesian and dominant strategy auctions. *Econometrica*, 56(6):1247–1257, 1988.

Dag Morten Dalen and Andres Gómez-Lobo. Yardsticks on the road: Regulatory contracts and cost efficiency in the Norwegian bus industry. *Transportation*, 30:371–386, 2003.

Harold Demsetz. Why regulate utilities? *Journal of Law and Economics*, 11:55–66, 1968.

Joel S. Demski and David E.M. Sappington. Optimal incentive contracts with multiple agents. *Journal of Economic Theory*, 33:152–171, 1984.

James W. Friedman. A non-cooperative equilibrium for supergames. *Review of Economic Studies*, 38:1–12, 1971.

Alexis Jacquemin and Margaret E. Slade. Cartels, collusion, and horizontal merger. In Richard Schmalensee and Robert D. Willig, editors, *Handbook of Industrial Organization*, volume 1, chapter 7, pages 415–473. North Holland, Amsterdam, 1989.

Paul Klemperer. What really matters in auction design. *Journal of Economic Perspectives*, 16(1):169–189, 2002.

Jean-Jacques Laffont and David Martimort. Mechanism design with collusion and correlation. *Econometrica*, 68(2):309–342, 2000.

Jean-Jacques Laffont and Jean Tirole. *A Theory of Incentives in Procurement and Regulation*. MIT Press, 1993.

Fumitoshi Mizutani. Empirical analysis of yardstick competition in the Japanese railway industry. *International Journal of Transport Economics*, 24:367–392, 1997.

Dilip Mookherjee. Optimal incentive scheme ith many agents. *Review of Economic Studies*, 51:433–446, 1984.

Masaru Okabe. New passenger railway fares. *Japan Railway and Transport Review*, (37):4–15, 2004.

Robert H. Porter and J. Douglas Zona. Detection of bid rigging in procurement auctions. *Journal of Political Economy*, 101(3):518–538, 1993.

Robert Rothschild. Cartel stability when costs are heterogeneous. *International Journal of Industrial Organization*, 17:717–734, 1999.

Andrei Shleifer. A theory of yardstick competition. *RAND Journal of Economics*, 16(3):319–327, 1985.

Swedish Competition Authority. The Swedish Competition Authority welcomes the judgement on the role of the Swedish National Road Administration in the asphalt cartel. Press Release, 12 December 2003.

Swedish Competition Authority. Cartels are operating in the Swedish construction industry, say managers. Press Release, 22 July 2005.

Thomas P. Tangerås. Collusion-proof yardstick competition. *Journal of Public Economics*, 83(2):231–254, 2002.

Union Fédérale des Consommateurs. Eau: Scandale sur facture. *Que Choisir*, (434), February 2006.

Oliver Williamson. Franchise bidding for natural monopolies: In general and with respect to CATV. *Bell Journal of Economics*, 7(1):73–104, 1976.

Anne Yvrande-Billon. The attribution process of delegation contracts in the French urban transport sector: Why is competitive bidding a myth? *Annals of Public and Cooperative Economics (forthcoming)*, 2005.