Yardstick competition vs. individual incentive regulation: What the theoretical literature has to say?

Eshien CHONG *

ADIS, ATOM

Abstract

In some industries such as water distribution or garbage collecting, a national regulator, when he exists, is faced with several local monopolies. When confronted with asymmetric information situations, the regulator could devise contracts basing the payments to a given firm as a function of performances of its peers. The regulator could then reduce information cost, and acheive greater efficiency. Such a scheme is known as yardstick competition. This paper seeks to compare individual incentive contracts to yardstick competition through a survey on the theoretical literature.

*ADIS, Faculté Jean Monnet, 54 Boulevard Desgranges, 92331 Sceaux Cedex, and ATOM, 106-112 Boulevard de l'Hôpital, 75647 Paris Cedex 13, France. email: chong.eshien@online.fr. The author expresses his gratitude to Emmanuel Reynaud, Stéphane Saussier, Steven Tadelis and participants of the ATOM seminal for their helpful comments and critiques. The usual disclaimer applies.

Abstract

Dans certaines industries telles que la distribution de l'eau ou le ramassage des ordures, un régulateur national, s'il existe, est face à plusieurs monopoles locaux. Quand il est confronté à une situation d'asymétrie d'information, le régulateur peut proposer des contrats qui spécifie le paiement à un agent en fonction de la performance des autres agents comparables. Le régulateur peut donc diminuer le coût informationnel, et atteindre une meilleure efficacité. C'est ce qu'on appelle la concurrence par comparaison. Ce papier cherche à comparer une régulation individuelle optimale à une régulation basé sur la concurrence par comparaison à travers d' une revue de la littérature théorique.

1 Introduction

Asymmetric information plagues the relation between a regulator and monopoly (or monopolies) which he seeks to regulate. Notably, on the cost side, the regulator often has limited information on how efficient a firm is, or on how efficient a firm can be, even if most of the time he could observed realized costs. As regulatory policies can depend crucially on such knowledge, one has to account for this problem when studying regulatory policies.

Economic theory shows that the regulator can sollicit these information. More precisely, the regulator can induce firms to reveal their private information and regulate in consequence. This gives rise to analysis initiated by Baron and Myerson[1982], and Laffont and Tirole[1986], where the regulator sollicits directly firms' private information. The resulting regulatory scheme is individualistic in nature.

Another way for the regulator to have access to such information is suggested by Schleifer[1985], when the regulator uses observations of different firms to deduce their private information, and regulate them consequently. This is termed as yardstick competition, and compensations to a firm will depend on performances of other similar firms[1].

In reality, a regulator is almost never in a situation in which the only source of information stems from the firm he regulates. He has either several local monopolies under its jurisdiction (as in water distribution, electricity production, public transport service, etc.), or if he is confronted with a national monopoly, international benchmark can be sought.

[1]By similar firms, we mean firms that are comparable among themselves. While firms need to be identical, the regulator using yardstick competition should be able to account for heterogeneous factors affecting the firms, be such factors arising from the firms' production technologies or environments in which they operate.

A question that arises would be: when is one scheme preferred over the other? This is the question we seek to reply through a survey into the theoretical literature and comparing results between a yardstick competition (or more general a relative performance mechanism) scheme and an individual one. Here, we will define yardstick competition (or relative performance evaluation) as a scheme that makes a firm's payoff dependent on some observed variables of its counterparts, and individual incentive regulation as a scheme that makes an agent's payoff dependent only on its own observable performance.

This paper is organized as follows: we start by considering presenting a static multiple agent setting to study yardstick competition and individual schemes. We briefly discuss some works on agency theory in a multiple agent setting first before discussing yardstick competition and individual regulation. We show that yardstick competition can do better than an individual one when performances are correlated. Then, we examine some limits that could result from relative evaluation mechanisms, and we analyze if an individual incentive regulation could do better in these cases. This discussion is followed by studying the impact of some other industrial variables that the regulator would like to take into account in his schemes. Yardstick competition and individual schemes are compared with respect to their impact on such variables to see when one would outperform the other. Concluding remarks come after.

2 Relative performance evaluation in a multiple agents setting

Before starting to compare the two different regulatory schemes, we start by having a look into incentive contracts when the principal is confronted with either one agent, or multiple agents. We begin by looking into a pure moral

hazard problem before adding adverse selection to the discussion.

2.1 Multiple agents and the moral hazard problem

A principal is faced with a moral hazard problem when he cannot observe or monitor an agent's actions or efforts that could have an impact on the agent's output[2]. As efforts could be costly in term of disutilities for an agent, the agent will not assign appropriate level of effort or take adequate actions from the principal's point of view. The principal will have to provide incentives to the agent so that the latter would take actions that the principal desires.

As it is now well-known in the literature, the optimal contract when the principal is only concern with a single agent depends crucially on the agent's attitude towards risks. It can be shown[3] that when the agent is risk-averse, and assuming that the principal is risk-neutral, then the principal will have to trade off risk-sharing and providing incentives. Indeed, the incapability of the principal to observe the agent's actions result in the fact that the principal will want to make the agent's pay dependent on his own output, which is the only variable that the principal observes (and which is informative on the agent's action). As the agent's output is random in nature, such a payment scheme will introduce some risks for the agent. The full-information solution cannot be attained in this case, as the principal cannot fully insured the agent (by offering a fixed payment regardless of the agent's output, as would be the full information case) in order to provide incentives so that the agent will take the desired actions.

However when the agent is risk-neutral, the full information first-best can be

[2]More concretely, an agent's action will have an impact on the likelihood of its outcome. For instance, an agent could increase the probability of having a higher output if it puts in more efforts.

[3]See for instance, Laffont and Martimort[2002] for an in-depth discussion.

acheived. Incentives are then provided by making the agent's pay dependent on his output, without the need for the principal to insured it against the risk. There is no trade-off between insurance and incentives.

Let us now suppose that besides an agent's output x, the principal can oberve a verifiable supplementary signal z. From Holström[1979], we know that if x is a sufficient statistic for $\{x, z\}$ with respect to the agent's actions, then the optimal contract will not depend on z . In other words, if a signal is completely uninformative (with respect to the agent's action), using it in the agent's contract will only add noise to his payment scheme, and adding noise to an agent's pay is almost never beneficial (Holström[1979]). Another direct implication of this result is that when z is informative, the principal should make the agent's pay dependent on the signal as well, regardless of how much noise this would introduce into the agent's pay. Let us note that this result applies whether the agent is risk-averse or risk-neutral.

One could easily extend this to the multiple agents case, where the principal's problem is to determine the vector of each agent's actions and their respective payoffs, taking into account that each agent will participate (participation constraints or individual rationality constraints), and the fact that given a pay scheme, an agent's action will depend on other agents' actions. This leads to Holmström[1982]'s result that relative performance evaluation is generally better off than an independent one when agents' output is not independently distributed. Indeed, when $T(x)$ is a vector of sufficient statistic based on x, the vector of all agents' outputs, for each agent i's action, then the optimal payment scheme of each agent i should be based on $T_i(x)$. The reason to this is that, $T_i(x)$, as a sufficient statistics, contains all relevant information about an agent's i action that is contained in the output vector x of all the agents. In other words, relative performance evaluation would generally do better than an individual one when agents' outputs are not independent. This is the case because other agents' outputs become informative signals for the principal on a particular agent's hidden action.

	agents' outputs correlated	agents' output independent
risk-averse	relative evaluation	individual
risk neutral	relative evaluation	individual

Table 1: Relative evaluation and individual scheme: moral hazard

One direct implication of this result is that it is valueless to reward agents according to their relative performance if there is no common underlying uncertainty. Another implication is that rank-order tournaments (Lazear and Rosen[1981], and Green and Stockey[1983]), which awards prizes on the basis of ordinal rankings, is suboptimal, as rank statistics, not being sufficient statistics, contain rarely all relevant information. As such it is informationally wasteful to use such schemes. However, one should note that, as Green and Stockey[1983] show, as the number of agents is sufficiently large, rank statistics can be an accurate estimator of agents' actions.

In fact, relative performance evaluation is not only useful to the principal when there is common underlying uncertainties. Mookherjee[1984] show that when there is no common underlying uncertainty, but production externality, relative performance evaluation can still be optimal. By production externality, he means that the output of an agent will have an impact on another agent's output, when there is no common uncertainties linking the two outputs. In other words, when output of agents are correlated in any manner, relative performance evaluation would generally be preferred over an individual payment scheme based solely on the particular agent's output.

Nalebuff and Stiglitz[1983] find another advantage to using relative performance evaluation mechanisms when the principal is confronted to serveral agents: they argue that such a mechanism is more flexible than an individual scheme in providing incentives, as individual incentive schemes tend to be tailor to specific situations. For the authors, when an environment is fast changing, the principal should prefer a contract based on relative performance evaluation because of its greater flexibility.

From this subsection, two conclusions can be derived: firstly, similitudes in the firms' operating environment renders their perfomances comparable; and secondly, using relative performance evaluation mechanisms allow the principal to do better than an individual scheme whenever agents' observed outputs are correlated in any way as a result of common uncertainties that affect the agents' outputs. An insight from this analysis is that, should a regulator seeks to implement yardstick competition, he should ask the following question: can performance of one regulated firm bring about information on actions of the other regulated firms? An implementation of yardstick competition may not be desirable when the response to this question is negative.

2.2 Adding adverse selection to the problem

A more general problem to providing incentives is when not only the principal cannot observe efforts or actions of agents, but when agents detain also some private information. Such a form of asymmetry information is known as an adverse selection problem.

Demski and Sappington[1984] look into this problem in a single agent setting and in a multiple agents setting. In their study, they assumed 2 agents, each characterized by an adverse selection parameter which can take two different values with a certain probability. Output of an agent is a function of their respective adverse selection parameter and each agent's action or efforts. The two adverse selection parameters are postively correlated, which means that if one agent has a certain value (for instance, a high productivity), it is more likely that the other agent will have a similar value (that is high productivity) rather than another one (that is low productivity).

Under their assumptions, an individual scheme (for risk neutral agents) will lead to the second best: in this case the regulator will have to distort the

agent's efforts and give up some rents. The reason is simple: since the agent has some private information that he could use to his advantage that the principal cannot foresee, the latter will have to make the agent reveal this information by giving him rents. Since rents can be costly, the principal will have interest to distort efforts in order to make a contract less interesting for a more advantaged agent to pretend to be a less advantaged agent. The resulting optimal contract thus trades off rents and efforts, that is allocative efficiency and productive efficiency.

However, making agents reveal their private information is easier when the principal is faced with two agents. The principal can then devise payment scheme of an agent on his own observed output and on the other agent's observed output. By doing so, they show that there exist payoffs that could lead to the full information first best outcome. In fact, the principal will in this case specify 4 payoffs, depending on an agent's output is high or low, and depending on his counterparts output being high or low. They show that such a payment scheme satisfies both the agents' participation constraints at their reservation utility (allocative efficiency), and incentive contraints. There will be neither be any productive inefficiencies that arise from such as scheme, allowing them to conclude that when output of the agents are correlated, and when the agents are risk-neutral, the principal can achieve the full information outcome[4,5].

[4]In fact, they suggest treating the agents asymmetrically to achieve a better result: the principal would prefered an incentive scheme that constrained an agent to report truthfully as a dominant strategy and the other agent is constrained to report truthfully as an equilibrium reponse. The reason behind this is that we would have a subgame undominated strategy equilibrium here, while in the other scheme, we have not explicitly consider what other strategy the agents might adopt.

[5]Crémer and MacLean[1985] show as well that full extraction of rent is possible under a Vickrey auction if the matrix of the probability of all agents' private information conditional to one agent i's private information is full rank, with $i = 1, \ldots, i, \ldots,$. In their study, they focus on auction design when private information is correlated among participants of an auction.

2.3 Implications on regulation

Schleifer[1985] was among the first to apply relative performance evaluation mechanism to regulate local monopolies. He shows that by breaking up the dependency of a firm's payoff on its own performance (which is basically cost of service regulation), and making it depend instead of other firms' performances, the regulator could actually create artificially some competition among locally monopolistic firms. Concretely, he suggest constructing benchmarks through statistical or econometrical methods, and setting the price policy and transfers (if desired) based on such benchmarks. This would make a firm's payoff dependent on actions of its counterparts, thereby instigating competition among them. He term this regulatory policy *yardstick competition*. Such a scheme would, he shows, bring about the first-best outcome.

It should be noted that Schleifer[1985] considers the case where there is no advserse selection, and that the firm's performance depends deterministically on its efforts or cost reducing investments. As firms are supposed moreover to be risk-neutral and the regulator only cares about global social surplus, it is not clear why the regulator could not use an individual incentive scheme and make each firm residual claimant on its own cost-savings.

When we take adverse selection into account, Laffont and Tirole[1986,1993] show that an individual incentive contract will imply the same trade off as discussed previously. In the optimal contract that ensures truth-telling, the regulator will depress efforts in contracts intended for less productive firms, with distorsion at its maximum in the contract intended for the least productive firms. The reason is that rents can be socially costly. When rents are not costly, Sobel[1998] shows that an individual incentive regulation can deliver the first-best outcome just as yardstick competition can. He concludes that *yardstick competition is thus better when there are shadow costs to social funds.*

Why is this so? The reason is that yardstick competition can help the regulator in compelling firms to reveal their private information: making comparisons across firms allows the regulator to not directly sollicit firms' private information, and thus reduces the informationnal costs. Dalen[1998] and Tangerås[2002] both show clearly how this is done, by adopting the stochastic structure used by Laffont and Auriol[1992] and using the revelation principle.

Laffont and Auriol[1992] study informational externalities brought about by a duopolistic market structure, assuming that a firm's adverse selection parameter comprises of two parts. Let us note β_i the adverse selection parameter of firm i. This parameter can be written as a linear function of a common random variable and an idiosyncratic one:

$$\beta_i = \alpha\eta + (1-\alpha)\varepsilon_i, \quad i = 1, 2.$$

The authors supposed that the common shock, η can take on two values $\{\underline{\eta}, \overline{\eta}\}$, and ϵ_i identically and independently distributed on a continuous support. The correlation between firms can then be measured by α. They assume moreover that α will be such that the distribution of the adverse selection parameter can be "split up" into two distinctive intervals. Specifically, when there are two firms, both will either have their adverse selection parameter in the right side interval or in the left side interval:

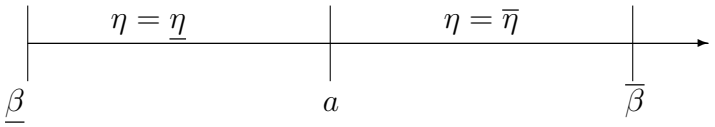

Figure 1: Stochastic structure of β_i in Auriol and Laffont[1992]

The regulator can thus detect and punish incompatible reports made by the firms. Indeed, as firms should both belong to the same interval, whenever reports made by the firms do not fall into the same interval, the regulator

would know which is the untruthful firm. Given this specific stochastic structure, the regulator now dispose of means that can compel firms to reveal their private information[6].

Dalen[1998] and Tangerås[2002] uses the same stochastic assumption to show that yardstick competition reduces the regulator's informational costs. In Tangerås[2002], firms are first asked to summit a report on their common adverse selection parameter. Since the regulator can dissuade any untruthful reports, the regulator will be able to propose the optimal individual incentive contracts in each interval after receiving reports on firms' common adverse selction parameter, having only to induce in this second step the firms to reveal their idiosyncratic adverse selection parameter. As the common uncertainty is filtered out in the first step, adverse selection asymmetry is reduced, enabling the regulator to save up on firms' rents, and thereby distorting less efforts demanded from firms in their contracts. As a whole, yardstick competition delivers a better solution.

We could see that yardstick competition is preferred over an individual one because common uncertainties in the regulator's point of view are filtered out through this scheme. It is as easily seen that when there is perfect correlation between regulated firms, through yardstick competition we can achieved the first best outcome, whereas when firms are not at all correlated, an individual scheme should be preferred. Yardstick competition cannot do better, and would introduce noise into contracts, even though the regulated firms are risk-neutral.

Principally, the analysis from this section allows us to shed some light on three questions: firstly, when can yardstick competition be used? Secondly, how

[6]The author suggest punishing lying firms to this end.

can we define "comparable" firms? And thirdly, when is yardstick competition desirable? This leads to the two following propositions.

Proposition 2.1 *The necessary conditions to implement yardstick competition are:*
1. the regulator needs to dispose of at least two firms.
2. the firms has to be comparable.
Firms are said to be comparable when:
1. their performances are affected by some common environmental variables.
2. production technologies are correlated.

The first part of proposition 2.1 is quite straightforward. If a regulator wants to use yardstick competition, he would need to some comparable firms so that he could benefit from informational externalities from them. Firms are comparable relatively to two aspects: similarities in their operating environment, and/or similarities in their production technologies. What is more problematic is whether the regulator can use a comparable firm that is not directly under his own jurisdiction. The reason is that different regulatory constraints could introduce some heterogenous factors, and comparing a national firm against a foreign one operating under another regulatory could yield undesirable results for the regulated national firm, if it can be implemented.

Proposition 2.2 *Yardstick competition can deliver a better outcome from a static efficiency point of view whenever there are some shadow costs of public funds, and whenever firms' performances are correlated. In the case where there is no shadow costs to public funds, an individual scheme is as good as any scheme based on relative performance evaluation mechanism.*

It is quite clear from this section that yardstick competition let the regulator

benefits from informational externalities. Information costs are reduced as the regulator, through exploiting underlying correlation between agents, can compel the agent to reveal its private private information more easily. He will no longer need to depress as much effort as he would have needed to under an individual incentive scheme. This is due to the fact that common uncertainties can be "filtered out" thourgh yardstick schemes, leaving the firms with "less" private information. As such, a less amount of rent is necessary to ensure truthful revelation of the firms' private information.

3 Some limits on relative performance evaluation

It should be pointed out that relative performance mechanism generally, and more particuliarly yardstick competition, do have some limits. Particularly, when the relationship between the regulator and regulated firms is dynamic, ratchet effect could arises. Furthermore, relative performance evaluation mechanisms relies heavily on the fact that regulated firms will not collude: they will not use any cooperative strategies. In reality, collusion may arise and this would seriously undermine the effectiveness of yardstick competition. In this section, we will first discuss concerns that the regulator may not be able to deliver the desired equilibrium, first in the static case, then we consider the possibilities of cooperative strategies among firms before finishing with some dynamic issues.

3.1 Incentive distorsion in a static setting

While it is true that relative performance evaluation can generally do as well as an individual incentive scheme when agents' outputs or performances are

correlated, one should not forget that agents can decide on other strategies besides the one that the principal would like to impose. One of such strategies in a static setting is pointed out by Dye[1984]. He notes effectively that making an agent's payoff dependent on other agents' output may create some undesirable incentives. For one, an agent may try to work towards thwarting its opponents' efforts, instead of working towards improving its own performance. This would , needless to say, undermine the efficiency of relative performance mechanisms.

Gibbons and Murphy[1990] argue too in favour of the same danger. They emphasize the fact that payment schemes based on relative performance "... *instead of absolute performance distorts the worker's*[agent's] *incentives whenever the worker*[agent] *can take actions that affect the average output of the reference group ...*".

Under an individual scheme, such strategies do not appear, as an agent's payoff depends necessarily on its own efforts or actions. There will be no interest for an agent in trying to work towards anything else but to improve its own performance.

Baker[1992] confirms the statements above. He notes that relative performance mechanism will provide non-distorting effects when one agent's actions do not have an impact on the reference group. However, such a distorsion can still make relative performance mechanisms attractive when compared to an individual scheme where there is such distorsion in incentives. Particularly, relative performance evaluation is still attractive when it reduces the variance of the performance measure upon which an agent's payoff is based and especially when the principal is faced with risk-averse agents. The reason is that, in spite of this unwanted effect, relative performance mechanism allows a better trade-off between incentive and risk-sharing. When agents are risk-neutral (which is the case we are more concerned[7]), we suspect that

[7]We are more interested in the risk neutral case as in the economic litterature, it is

the reason will not hold, therefore making yardstick competition an better regulatory scheme only when agents' action do not have an impact on the reference group's measure.

3.2 Collusive behaviour

Another problem that could arise is that throught the discussion, we have implicitly assume that agents do not cooperate. When the principal uses relative performance evaluation, agents may have incentives to cooperate or to collude. In such a case, needless to say, relative performance performance would be inefficient in providing incentives. As collusion can seriously undermine yardstick competition, it is important to check into the issue.

Notice first that under individual incentive schemes, and being local monopolies in separated markets, firms do not have any incentives to collude because their payoff does not depend on their counterparts' actions. There is will no reason for them therefore to coordinate their actions in order to obtain a higher payoff[8]. Conversely, in making a firm's payoff dependent on other agents' performance, firms regulated under the same yardstick scheme will have interest to play cooperative strategies, especially if they can be better off playing such strategies than behaving in a non collusive manner. Collusive behaviour could make yardstick competition completely inefficient, making the regulator worst off than under an individual scheme.

As Laffont and Martimort[2000] show that by using yardstick competition to exploit the correlation between firms, the regulator is in fact creating incen-

accepted that firms can be seen as risk neutral agents.

[8]Let us note however that collusive strategies are possible when firms compete to obtain a local monopoly market when the market is attributed through competition *for* the market mechanism. However, this aspect of the problem is beyond the concern of our present discussion.

tives for firms to collude. This collusion is made all the more easier by the fact that when firms are correlated, deviations are more easily detectable, making collusion easier. Moreover, the higher the correlation between firms' environment, the homogeneous are their individual options, making the distance between a collusive agreement and their individual options smaller. Collusion is therefore a more interesting solution ofr firms when correlation among them is strong.

As such, in considering only adverse selection problem, Laffont and Martimort[2000] show that the regulator should introduce collusion-proof constraints to discourage firms from playing cooperative strategies. Such constraints leads to distorsion in productive efficiencies in order to reduce the cost of collusion-proof constraints, and deliver a "third-best" equilibrium. However, even with such constraints, yardstick competition can still be able to deliver a better outcome than an individual scheme, as distorsions introduced by collusion-proof constraints may not be as important as the ones introduced by an individual one. *In fine*, individual schemes are only better if there is perfect correlation among the agents.

It should be noted however, that the collusion-proof constraints only ensure that such a non-cooperative equilibrium exists, but firms could still play other cooperative strategies and the regulator cannot be sure of a non-cooperative outcome[9].

Tangerås[2002] confirms this when he considers the case with an effort term. In incorporating collusion-proof constraints, the regulator will have to further distort efforts required from lower productivity firms, while implementing more efficient level of efforts for higher productivity firms. He goes on the argues that the regulator could discourage collusion by impeding side payments among agents, or/and by setting a structure of punishments and/or

[9]This is due to the fact that the regulator is incapable of imposing the non cooperative equilibrium. In other words, while this equilibrium exists, the authors are not capable of demonstrating that it is unique.

rewards.

It would seem that yardstick competition is particularly vulnerable to collusive behaviour. Even when distortions under a yardstick scheme when correlation is weak among firms are less important than individual scheme, one should note that yardstick competition relies upon the very correlation to be efficient. When a regulator desires to implement yardstick competition, collusive behaviour among firms should be accorded a particular attention. Otherwise, as long as correlation is not too high, one could still think that yardstick competition could do better than an individual scheme.

3.3 The two regulatory schemes under a dynamic setting

In reality, the relation between a regulator and the regulated firms are dynamic in nature. The regulator's commitment power in this case becomes very important. In particular, whenthe regulator is not able to commit himself, firms will not reveal its private information, knowing that the regulator will use such information against it in the coming future. This is known as the "ratchet effect".

The optimal individual incentive scheme in a dynamic setting would then depend on the regulator's ability to commit himself to a scheme:

- If he can perfectly commit himself, then the optimal scheme is the independent static one for each period. In this case, he would avoid the ratchet effect, but we would have a second best outcome.
- If the regulator can only commit to deliver some specified future rents, then there is a trade-off between solliciting information and distorting

productive efficiencies. The regulator may use pooling strategies that prevent him from distinguishing different types of firms.

The above results are discussed in Armstrong and Sappington[2002] in further details. Partial pooling strategies[10] are a means for the regulator to increase his "commitment powers" by assuring firms that he will not extract the firm's rents with a certain probability. Notice as well that when the regulator cannot commit himself, distorsions that will be introduce can depress productive efficiency so much that it would be preferable that he does not have access to thr firm's private information. The regulator uses the pooling scheme in this case. In a nutshell, in order for the regulator to acheive the *ex ante* optimal equilibrium, he has to consent to some *ex post* inefficiencies.

The only study we know of concerning relative performance mechanism and the ratchet effect is Meyer and Vickers[1997]. They argue that when the regulator cannot explicitly use relative performance evaluation mechanism, comparing agents' performance is beneficial when the correlation of agents' temp-invariant hidden characteristics is stronger than their time-dependent one. In fact, when the time-invariant characteristics is strongly correlated, the regulator could rely less on other agents' performance to deduce its value for a certain agent. To the extend that an agent's second period payoff depends less on another agent's first period performance, the agent would be less constrained to restrain its first period efforts, thereby dampening the ratchet effect. They further argue that the British reulatory policy has such an "implicit" yardstick competition feature, as comparisons are only used during price cap reviews.

When one consider explicitly an agent's pay on performance of its counterparts, they show that yardstick competition can have two effects: an insurance effect which is always positive, and the ratchet effect which is ambiguous.

[10]That is the regulator induces with a certain positive probability to have a pooling equilibrium.

From the point of view of the ratchet effect, it is difficult for us to compare the two regulatory schemes. The framework used by the different authors to study this question somewhat differs. Intuitively, we could only suggest implicit comparison for the regulator can be beneficial, and that which scheme is better would depend a lot on the regulator's ability to not extract all rents stemming from agents' private information. Indeed, even under the dynamic setting, if the regulator could commit to deliver some rents, it is not sure that yardstick competition would not do better or worst than an individual scheme. Furher research into the subject is needed in order to understand how the two different scheme would behave when ratchet effect is an important issue.

Although yardstick competition allows the regulator to reduce informational costs and delivers a better outcome, under some circumstances, an individual scheme can be preferred. By making an agent's payoff dependent on other agents' performance, the regulator creates an environment that is more complex than the one under an individual schemes. With yardstick competition, agents could devise various strategies, and the resulting equilibrium may not be the one the principal desires. Thus, one cannot conclude that yardstick competition will work well under all circumstances. The efficiency if yardstick competition relies heavily on what strategies are available to the firms, and at what cost certain of such strategies can be avoided.

4 Impact on some regulatory variables

While yardstick competition generally reduce information costs that the regulator needs to bear, and thus seem to be superior over an independent incentive scheme, one should not hastily rush to the conclusion that it is a superior regulatory instrument to independent schemes. Indeed, monopolies

often provide essentiel services to the economy and to the society as a whole. As such regulation should often take into account a lot of other variables, such as investments and quality of the service provided. One should therefore examine how yardstick competition and individual schemes interact and impact on these dimensions, before one can decide whether one or the other should be preferred by the regulator. In this section, we will discuss on these dimensions.

4.1 Investments incentives

Investments are often a means for a firm to improve its future productivity. When there is asymmetric information between the regulator and the regulated firm, the regulator's commitment powers become important in determining the firm's investment incentives. The reason is clear: asymmetric information makes improvements in the firm's productivity unobservable to the regulator. When using an incentive long-term contract without the power to commit, the regulator could expropriate informational rents from future productivity improvements. This, in turn, dampens the firm's investment incentives in the first place, as returns from investments will be reduced by the regulator trying to appropriate some, if not all, rents stemming from the investment. This is the hold up problem analyzed by Williamson[1975]. Moreover, under non-commitment, investment could be socially inappropriate, in the sense that the firm may not specialize its investment sufficiently: the firm can preserve "outside opportunities" by delibrating investing in more general technology rather than choose to invest in specific technologies.

Sobel[1998] and Dalen[1998) both analyze how yardstick competition affects firms' investments incentives. In Sobel[1998] argues that investment incentives are more distorted under yardstick competition than under an individual one. Indeed, a firm's investment incentives is enourage by the propective of future rents that an investment could generate. As yardstick competition

can give the regulator accurate information on agents' productivity, when the regulator has limited commitment powers, he would be tempted to use such information to extract agents' rents stemming from their investments[11]. Anticipating this, agents will underinvest. Yardstick competition thus reinforces the hold-up problem, the regulator being able to have access to agents' private information in a less costly manner using yardstick competition.

The choice between yardstick competition and an individual scheme would depend on the shadow cost of public funds. When there is no cost in public funds, argues Sobel[1998], the regulator should favor an individual incentive scheme to emphasize on providing adequate investment incentives. On the other hand, when the shadow cost of public funds are high, informational costs will be high for the regulator, and he should prefer implementing yardstick competition.

According to Dalen[1998], yardstick competition will only dampens those investments that have a spillover effect on the whole of an industry. Firms will be discourage from investments that impact on general productivity of an industry (industry-specific investments) would affect all firms in the reference group of a yardstick scheme. The reason is simple: such investments do not ameliorate the investing firm's performance relatively to that of it's opponent. The investing firm will not stand to gain from such an investment. Moreover, yardstick competition permits the regulator to filter away this dimension of firms' private information, thereby reducing rents that firms could otherwise benefit from such investments.

On the contrary, investments that impact solely on a firm's private idiosyncratic productivity (firm-specific investments) are encouraged under the yardstick scheme. Indeed, as yardstick competition does not allow the regulator to assess this part of the agents' private information, prospective of securing some rents through such idiosyncratic private information (productivity)

[11]In Sobel[1998]'s framework, investments impact on the value of the future adverse selection parameter.

encourages the firms to invest on firm-specific technologies.

One could see that an industry's technological configuration is an important dimension to consider before deciding on yardstick competition or individual schemes. When technologies do not have important spillovers, it is reasonable to think that yardstick competition can perform better than an individual one. Otherwise, whether one scheme could outperform the other would deepens on the arbitrage between informational externalities and investment incentives.

4.2 Quality of service

Overseeing to the quality of service or product produced by a monopoly is part of the regulator's job. However, quality often comes with a price, and the question is therefore: would firms sacrifice quality in order to reduce their costs under a yardstick scheme?

Tangerås[2003] examine this question, and shows that yardstick competition can in fact increase the quality of a service or a product. This astonishing result is du the fact that under an individual incentive scheme, the regulator would depress a firm's cost reducing efforts and quality so that he could reduces rents that have be to given up to ensure the firm's truth-telling. As usual, as the yardstick scheme reduces informational costs for the regulator, he could then introduce less distorsion into efforts and quality provision, making yardstick competition better than an individual one where quality is concerned.

However, Tangerås[2003]' result relies on a crucial assumption: that there is no quantity regulation, meaning that the regulator will not impose a certain quantity that the monopolist has to produce in the contract. An exemple

where quantity is not regulated can be found in the case of hospitals, where the regulator do not impose upon the hospitals a quota or a number of patients for which he would reimburse the hospitals treatment costs. When quantity is regulated as well, Tangerås[2003] states: *"yardstick competition would actually lead to a reduction in quality if expected quantity in equilibrium were a decreasing function of expenditures on quality improvements"*. However, he argues that if there were quantity regulation, *"the supply of quality would have been too high under an individual scheme in the first place"*. Consequently, it would seemed that the provision of quality is not compromised under yardstick competition, and as such, this scheme would perform better than an individual one.

Where provision of quality is not a problem under a yardstick scheme, making yardstick competition an attractive option as it reduces informational costs of the regulator, investment incentives is more problematic. When one takes into account investments incentives, yardstick competition can outperform an individual one when informational costs are high or when technologies do not have a strong spillover effect.

5 Conclusion

An important consequence of yardstick competition is that it reduces informational costs. When there is common underlying uncertainties on agents' private information, the regulator can sollicit them more esaily than using an individual scheme. However, as we have seen, such benefit do not come without costs: for one, in using yardstick competition, the regulator introduces a more complex environment and agents will have more strategies to choose from. The resulting outcome may not be the one desired by the regulator, even in a static framework when agents' could work towards thwarting

each other's performances. Collusion is another possible equilibrium strategy. Such possibilities could undermine the efficiency of the comparison mechanism. One solution might to be to use international benchmarks to deter collusion, but then it would perhaps not be appropriate to include foreign monopolies regulated by a different principal with a different objective in the reference group. This question merits to be studied further on.

Moreover, yardstick competition could have a negative impact on certain important industrial varaibles. For instance, we have seen that it dampens investment incentives when there are important spillover effects. When such an issue is important to the regulator, yardstick competition should be avoided.

As such, whether yardstick competition can outperform an individual scheme is really a question that should be examined on a case by case basis. One should look into various possible strategies and imporant dimensions of an industry before opting for an individual scheme or a yardstick one. Possibly, a combination of the two schemes a possible, and could yield a better result. One such argument is given by Meyer and Vickers[1997], where yardstick competition could be use implicitly when the ratchet effect is important. However, to understand how the yardstick scheme affects the ratchet effect, further research is required.

References

[1] Mark Armstrong and David Sappington, *Recent developments in the theory of regulation*, A chapter for the forthcoming Handbook of Industrial Organization, 2002.

[2] Emmanuelle Auriol, *Monopole ou doupole: l'effet de comparaison*, Annales d'Economie et de Statistique **31** (1993), 1–31.

[3] Emmanuelle Auriol and Jean-Jacques Laffont, *Regulation by duopoly*, Journal of Economics and Management Strategy **1** (1992), no. 3, 507–533.

[4] Stanley Baiman and Joel S. Demski, *Economically optimal performance evaluation and control systems*, Journal of Accounting Research **18(supp)** (1980), 184–220.

[5] George P. Baker, *Incentive contracts and performance measurement*, The Journal of Political Economy **100** (1992), no. 3, 598–614.

[6] Björn Bartling and Ferninand von Siemens, *Inequity aversion and moral hazard with multiple agents*, Working Paper, 2003.

[7] Jacques Crémer and Richard P. McLean, *Optimal selling strategies under uncertainty for a discriminating monopolist when demands are interdependent*, Econometrica **53** (1985), no. 2, 345–362.

[8] ———, *Full extraction of the surplus in bayesian and dominant strategy auctions*, Econometrica **56** (1988), no. 6, 1247–1257.

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

[10] Ronald A. Dye, *The trouble with tournaments*, Economic Inquiry **22** (1984), no. 1, 147–149.

[11] Robert Gibbons and Kevin J. Murphy, *Relative performance evaluation for chief executive officers*, Industrial and Labor Relation Review **43** (1990), no. 3, 30–51.

[12] Jerry R. Green and Nancy L. Stokey, *A comparaison of tournaments and contracts*, Journal of Political Economy **91** (1983), no. 3, 349–365.

[13] Bengt Holmström, *Moral hazard in teams*, The Bell Journal of Economics **13** (1982), no. 2, 324–340.

[14] Bengt Holström, *Moral hazard and observability*, The Bell Journal of Economics **10** (1979), 74–91.

[15] Paul L. Joskow and Richard Schmalensee, *Incentive regulation for electric utilities*, Yale Journal on Regulation **4** (1986), no. 1, 1–49.

[16] Jean-Jacques Laffont, *The new economics of regulation ten years after*, Econometrica **62** (1994), no. 3, 507–537.

[17] Jean-Jacques Laffont and David Martimort, *Mechanism design with collusion and correlation*, Econometrica **68** (2000), no. 2, 309–342.

[18] Jean-Jacques Laffont and Jean Tirole, *Using cost observation to regulate firms*, The Journal of Political Economy **94** (1986), no. 3, 614–641.

[19] ———, *A theory of incentives in procurement and regulation*, MIT Press, 1993.

[20] Edward P. Lazear and Sherwin Rosen, *Rank-order tournaments as optimal labour contracts*, The Journal of Political Economy **89** (1981), no. 5, 841–864.

[21] Margaret A. Meyer and John Vickers, *Performance comparaisons and dynamic incentives*, The Journal of Political Economy **105** (1997), no. 3, 547–581.

[22] Dilip Mookherjee, *Optimal incentive scheme ith many agents*, Review of Economic Studies **51** (1984), 433–446.

[23] Dag Morten Dalen, *Yardstick competition and investment incentives*, Journal of Economics and Management Strategy **7** (1998), no. 1, 105–126.

[24] Barry J. Nalebuff and Joseph E. Stiglitz, *Information, competition, and markets*, The American Economic Review **73** (1983), no. 2, 278–283.

[25] ———, *Prizes and competition: towards a general theory of compensation and competition*, The Bell Journal of Economics **14** (1983), no. 1, 21–43.

[26] Andrei Schleifer, *A theory of yardstick competition*, The RAND Journal of Economics **16** (1985), no. 3, 319–327.

[27] Joel Sobel, *A reexamination of yardstick competition*, Journal of Economics and Management Strategy **8** (1999), no. 1, 33–60.

[28] Thomas P. Tangerås, *Collusion-proof yardstick competition*, Journal of Public Economics **83** (2002), no. 2, 231–254.

[29] ———, *Yardstick competition and quality*, Working Paper, 2003.