Yardstick competition - a win-win setting?

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Abstract: Price cap regulation is favoured by many regulators of network utilities because it provides firms with an incentive to reduce costs. We question, however, whether this is indeed the most preferable alternative to cost of service regulation, which has recognised lower incentive power. We find, using a quantiative model, that yardstick mechanisms provide better cost reduction incentives because the allowed change in price (the cap) is based on exogenous factors and the firm is able to retain any savings which exceed those made by the industry on average. We also find, from the quantiative model, that the move from a price-cap to a yardstick regime may well constitute a pareto improvement. Regulated companies earn higher returns and customers benefit from lower prices. Bearing this base case result in mind we consider of how changes in the model's assumptions might affect the relative comparison. Specifically we consider how the form of the effort function and the incentive scheme within firms – which arguably differ between countries - impacts on the incentive properties of each regime. We also discuss the question of whether the length of the regulated firm's planning horizon (which is set as a five-year renewal period in the model) affects the relative incentive benefits of yardstick competition. These questions highlight the complexities which remain in the design of regulatory mechanisms, and thereby the areas which warrant further research in the future.

INTRODUCTION

What is the best way to regulate a network monopoly? This is a question that is frequently debated by policy-makers and regulatory agencies across Europe, indeed worldwide. The answer depends on the objectives of the regulatory regime. These generally include the delivery of:

- price reductions to consumers (ensuring political acceptability of the regime);
- a high quality of service;

- cost reduction incentives to the company;
- assurances to potential shareholders and debt-providers (creditors) that an efficiently run company will earn returns;
- low costs of regulation; and
- limited regulatory intervention in the day-to-day operations of the company.

Trade-offs need to be made across these objectives but any regulatory mechanism that is better than another at delivering these objectives would generally be considered preferable.

A similar list of objectives was considered by Littlechild (1983) when price cap regulation was chosen as the preferred means for regulating British Telecom. Since then, price cap regulation is an option that has been favoured by regulators in many sectors (e.g. water, gas and electricity) and in many other countries (e.g. Australia, Netherlands and the US).

This regulatory mechanism is often chosen because it provides cost reduction incentives to the company. By setting a cap on prices for a fixed period of time the regulator allows the company to earn higher profits by reducing costs since the resulting profits are retained until the next review and thereby provides them with an incentive to reduce costs and improve technical efficiency. The mechanism also delivers, through the X-factor and its revision of at periodic intervals, price reductions to consumers. At the same time, the regulated company is able to earn above normal returns during a regulatory period but these are reduced at each review.

Yardstick competition - a win-win setting?

Price cap regulation therefore delivers a number of the objectives of regulation but it is questionable whether it is the best available mechanism[1]. In particular, the revision of the cap at price reviews reduces technical efficiency by dulling the company's cost reduction incentive[2]. This is because the cost reduction decision is endogenous to the regulatory mechanism. The decision-maker in the company (i.e. the manager) takes account of future regulatory periods when choosing the level of cost reduction in this period. He knows that cost reductions today will result in a lower allowed price cap in the future and this extra factor is taken into account when making the cost reduction decision in each regulatory period.

Furthermore, the company's profits are reduced at each price review and, as cost reductions become harder to deliver, the level of profits may reduce over time. Shareholders and creditors concerned about the long-term may therefore

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1 Littlechild (1983) chose the price cap mechanism as the preferred option from a list of four alternatives including no regulation, cost of service regulation, an output related profits levy, and price cap regulation (local tariff reduction scheme). Other options, some of which have evolved since that time, were not considered.

2 We stress that cost reductions are delivered by the regime, as demonstrated by the experience in the UK electricity sector since privatisation. For example, Tilley and Weyman-Jones (1999) found that average annual growth in TFP for electricity distribution in the UK was 6.3% between 1990/91 and 1997/98, and Ofgem (2004) indicated that similar cost reductions were delivered since then. Indeed, the X-factors set by regulators in the UK have required companies to deliver large cost reductions to consumers - the average annual X-factor in electricity distribution between 1990/91 and 2004/05 was 3.75% (smoothing for P0 cuts), while in electricity transmission the average annual X-factor over the same period was nearly 3%. The issue therefore is not whether cost reductions exist but rather whether they are as high as they could be.

question the benefits delivered by the regime over time. In addition, the incentive to reduce costs may create a perverse parallel incentive to reduce quality of service. This concern is not addressed here but is discussed in Burns and Riechmann (2004). Finally, the costs of regulation are higher than originally envisioned by Littlechild (1983). Rather than being a simple light-touch regime, the determination of the X-factor at each price review involves, in practice, detailed analysis of large information sets and the collection of evidence from a wide group of stakeholders. This increases the costs of regulation for the regulatory agency and for the regulated companies. This issue is not addressed here but warrants further attention in future research.

Given these concerns we consider, using numerical analysis and a familiar regulatory model, whether a potential alternative mechanism, yardstick competition, is 'better' than price cap regulation[3]. Specifically, we examine whether a particular form of yardstick competition is more effective at delivering three of the regulatory objectives (price reductions, cost reductions, and provision of profits to the company) than the standard price cap mechanism[4].

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[3] The comparison between price cap regulation and yardstick competition applies both to ex-ante regulatory systems (i.e. network tariffs become effective only after costs have been checked and approval has been given by the regulation authority) and to ex-post regulation (i.e. network tariffs become effective at the time of publication, but authorities can review the appropriateness of charges later).

[4] In our analysis the share of operating and capital expenditure is fixed. We therefore do not consider trade-offs across these expenditure items but instead focus on changes in the level of total costs only. The extent to which the company may alter its share of capital and operating expenditure in

The main results from the model are as follows.

- Yardstick competition provides stronger cost saving incentives than price cap regulation. This is because the revenue adjustment at each regulatory review under yardstick competition is set exogenously from the company's own cost level.
- If a company's efficiency level is equal to the industry average, the specific form of yardstick competition may potentially make both the regulated company and consumers better off relative to price cap regulation.
- The improvements delivered by yardstick competition may also be realised if the company's efficiency level is below, or above, the industry average. However, the scale of the benefits delivered – under both regulatory mechanisms – will vary depending on the exact underlying efficiency position of the company (i.e. its inherent technology).
- The assumption made about the extent to which the manager cares about the share of company profits paid to him relative to his personal disutility of effort affects the level of cost reduction that is undertaken. We find that variation in the importance of profits relative to the disutility of effort might reflect institutional and cultural arrangements in different countries where

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response to the regulatory incentive mechanism is a subject that will be considered in future research. Initial analysis indicates that yardstick competition also has the desirable property to provide balanced incentives to reduce operating and capital expenditure.

Yardstick competition - a win-win setting?

performance-related pay is more or less common. The main result that yardstick competition is preferable to price cap regulation remains valid.

- We consider the impact of having a myopic manager who is not concerned about future regulatory periods. The change in the manager's planning horizon might reflect differences in the career paths of managers in regulated firms in different countries, with some individuals only staying in a company for a short period of time (e.g. the length of a single regulatory period) and others staying long term (e.g. for an individual's entire career). The relative gains from yardstick competition are not so clear-cut here as the incentive to cut costs is the same under both regulatory mechanisms.

The results of our numerical model suggest that policy-makers may wish to consider yardstick competition as a feasible alternative to price cap regulation. Depending on the company's current productivity level relative to the industry average, the yardstick regime may provide a pareto improvement over the standard price cap regime, making it more desirable from the perspective of consumers and shareholders and creditors.

However, the relative gains of yardstick competition over price cap ultimately depend on the characteristics of the manager within the company - whether he is myopic or not, and the extent to which his remuneration package is linked to the company's profits (i.e. the extent of the manager's incentive gearing). These within-company factors, which may be outside the policy makers' influence and which are expected to vary across countries, affect the distribution of benefits under both regulatory regimes. At the same time a healthy endogeneity should be considered: In the case of incentive regulation, shareholders benefit by giving

managers an incentive based contract. This implies that the within-company factors are likely to adapt to the regulatory environment. Furthermore, the level of benefits delivered under yardstick competition depend – as with price cap regulation – on the current technology of the company (i.e. its inherent efficiency level). Policy makers may therefore need to consider the relative efficiency of companies in the sector when determining whether, and how, to introduce yardstick competition. For example, it may be desirable to reduce the variation in efficiency levels before introducing a yardstick regime.

RELATED LITERATURE

Yardstick competition is most often associated with Shleifer (1985) who suggested that a franchised monopoly company could be provided with optimal cost reduction incentives if the allowed price was dependent on the costs of other 'identical' companies in the industry rather than the company's own cost level. Specifically the company's price is based on the mean cost of all other identical firms in the industry. Managers are assumed to make profit-maximising cost reduction decisions but it is recognised that managers will want to exert as little effort as possible if 'profits are not at stake'.

With this mechanism the regulated company chooses the welfare-maximising level of cost reduction (i.e. the socially efficient level). This is because the level of cost reduction undertaken by the company today does not influence future revenue levels. Shleifer also found that the incentive properties were retained if companies were heterogeneous (i.e. non-identical) but adjustments were made for observable differences when using industry costs as the basis for an individual

company's price. This analysis was undertaken in the context of cost of service (rate of return) regulation but the principles and results carry over, and indeed are strengthened, when fixed price cap mechanisms are considered.

Since then several authors - see for example Frontier Economics (2003), Helm and Yarrow (1988), Mayer (1999), Mayer and Vickers (1996), Sappington (2000) and Weyman-Jones (1995) - have developed the analysis to demonstrate how and why the company's cost reduction decision is improved if the regulatory constraint is based on exogenous but correlated information set (most often the average industry cost). Research by these authors focuses on the cost reduction properties of the yardstick regime and on the question of whether feasible and suitable exogenous benchmarks can be found to set appropriate X-factors.

Despite the expected benefit, yardstick mechanisms are not frequently observed in practice, although regulators in the EU are exploring options in this direction. Waddams Price (2000) provides an overview of the approaches that have been developed in Norway and the Netherlands. One potential reason for not using yardstick mechanisms is that they are difficult to design and implement and hence the regulatory costs involved may be high. In particular, the difficulty of finding appropriate cost benchmarks is often cited as a reason for not using yardstick competition[5]. The fact that some countries are developing yardstick measures suggests, however, that such difficulties are not insurmountable, even if

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5 For example, Laffont and Tirole (1993) argue that 'relative performance evaluation has not been used much in regulation' because' regulated firms are often not comparable. That is, idiosyncrasies often prevail over common features'.

initial upfront costs of changing the regulatory regime may be significant. Equity concerns are also often associated with yardstick competition. In particular, yardstick competition is expected to allow some companies to make high profits while others make losses. This may be a concern if companies are unable, from a technological perspective, to reach the same efficiency level.

We wish to show that the net gain arising from the change in regulatory regime - for consumers and the company - is significant enough to suggest that the regulatory costs involved are warranted. This is particularly true as the change in the regime will involve a one-off increase in the costs of regulation but a potential reduction in on-going costs as the regulatory regime becomes significantly simpler. Taking the literature on yardstick competition as our starting point, we therefore wish to explore and quantify the scale of improvement delivered by yardstick competition over price cap regulation.

Our analysis is similar to that of Schmalansee (1989) and Gasmi, Ivaldi and Laffont (1998). In these papers different regulatory regimes are compared using the numerical results of quantitative simulation models. Schmalansee emphasises that such numerical models 'are likely to play an important role in any serious application of incentive-regulation theory' given the problem of finding quantitative absolute solutions to theoretical optimisation problems in this area. Gasmi et al echo this sentiment by arguing that simulation exercises allow the theoretical properties of 'complex second-best models' to be explored and, importantly, can provide 'useful information to practitioners of regulation when used with well-calibrated models'.

Yardstick competition - a win-win setting?

Schmalansee (1989) uses numerical methods, and a simplified *static* model with a single monopoly company, to examine the impact of alternative linear regulatory rules on a company's cost reduction decision and the resulting levels of price, profit, consumer surplus and welfare. Yardstick competition is not considered explicitly but comparisons are made between regimes that do and do not link the price restraint to the company's actual cost level. Schmalansee found that exogenously set price caps provide 'superior incentives for cost reduction' in a standard model. However, the more uncertain the regulator is about future costs and the company's reaction to regulatory mechanisms, the greater the benefit delivered by regimes which link price to actual cost, particularly in terms of consumer surplus. Essentially, Schmalansee's numerical analysis indicates that the allocative efficiency loss arising from the gap between price and costs outweighs any technical efficiency gain from cost reduction when there is uncertainty. The importance of this depends on the weight that the regulator places on consumer surplus relative to producer surplus. Furthermore, the relative impact of the cost reduction decision on consumer and producer surplus would be expected to be different in practice where dynamic (inter-generational) considerations would also be considered by the regulator.

Building on Schmalansee's analysis, Gasmi, Ivaldi and Laffont (1996) use simulation techniques to compare the properties of different regulatory regimes. The range of regulatory rules examined includes the linear regimes considered by Schmalansee, a price cap regime that allows for downward price flexibility and a profit-sharing price cap regime. Numerical results are presented for effort decisions, price and profit schedules, and average values of consumer surplus and

welfare (for a range of weights on profits in the welfare function). With the simulation analysis the authors find that economic profits are higher under pure price cap regulation - i.e. where the price cap is not adjusted for actual cost levels - than other regulatory regimes and that profit-sharing mechanisms yield levels of welfare which are close to optimal levels. The analysis is based on a single period only and hence no account is taken of the dynamic implications of both the company's and the regulator's decisions. Furthermore, there is no analysis of yardstick competition.

Burns (1996) also uses the predictions from moral-hazard models and numerical examples to illustrate the optimal price, quantity and effort choices of a manager operating under different regulatory regimes, including price cap regulation as it operates in the UK and yardstick competition. As expected, cost reduction was found to be higher under standard price cap regulation than no regulation, and the extent of reduction increased with the length of the regulatory lag. Furthermore, a manager with a high discount rate (i.e. one that cares less about the future implication of current decisions) was found to make higher cost reductions in the first regulatory period. Burns also found that yardstick competition, where average industry profits are shared with consumers, 'is unambiguously preferable to price cap regulation on efficiency grounds because as well as delivering the same technical efficiency gains faster, there are allocative efficiency gains in the dynamic path to the long run'. A yardstick mechanism that is based on an adjustment for average industry cost - rather than profit - has lower incentive properties as the manager's cost reduction choices affect the industry average. If, however, an average is calculated excluding the company-

specific information the link between the cap and own-costs is removed and increased incentive properties are restored.

As with these papers our objective is not to provide an absolute measure of the benefits of one mechanism over another but instead to demonstrate the order of magnitude of the variation that arises. That is, as stressed by Schmalansee (1989), the focus is on identifying 'Good regulatory regimes' rather than finding an (theoretical) optimal mechanism.

We consider the level of cost reduction, the price (revenue) path and the return earned by the company under the two alternative mechanisms. This allows us to examine the effect of the change in the regulatory regime on all aspects of welfare (i.e. producer and consumer surplus) rather than focusing on the cost reduction incentives alone. In contrast to Schmalansee (1989) and Gasmi et al (1996) we allow for the dynamic implications of the company's and regulator's decisions to be taken into account, and we take account of the fact that the decision-maker in the company (i.e. the manager) may not be a simple profit-maximiser.[6]

MODEL DESCRIPTION

We use a quantitative model to compare the cost reduction decision of a single company under two alternative regulatory mechanisms. The company's productivity level is assumed to be equal to that of the industry on average. The

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6 On the other hand our paper does not address uncertainty.

choice of regulatory mechanism is announced in year 0 and introduced in year 1. The mechanism is expected to remain in place indefinitely (reflected as more than 200 years in our model). The manager of the company makes the cost reduction decision for all years, given the regulatory mechanism that has been announced, in year 0.

This framework establishes an optimisation problem and a standard solver is used to determine the optimal cost reduction choices of the manager[7]. We calculate, for the given optimal level of cost reduction, the impact on consumer surplus (approximated as the change in revenue) and the impact on producer surplus (approximated as the average annual rate of return earned by the company).

Alternative regulatory mechanisms

The model compares the properties of price cap regulation to those of yardstick competition[8].

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7 The solver finds the optimal level of cost reduction in year 1 of each regulatory period and year 2-τ (τ = 5 in the case of a 5-year price cap period) of each regulatory period. The choices in the first regulatory period are different to those in all other regulatory periods, for which the choices identical. With this simplification we focus on variation in cost reduction incentives within a period (i.e. between the first year of the period and all other years) rather than changes in these incentives from one period to the next.

8 A previous version of the model was constructed as part of a project undertaken by Frontier Economics for the UK *National Audit Office* (2002) that included an analysis of the advantages and disadvantages of the incentive mechanisms most frequently applied in practice in the UK. The model was later extended to include regulatory options that are being practiced, or discussed,

- With price cap regulation the duration of the regulatory period is assumed to be five years. At the start of each period the tariffs are adjusted to reflect the company's actual costs at the end of the previous period. During the regulatory period, a company is required to reduce its tariffs at a rate that reflects expected productivity improvements relative to productivity of the economy (e.g. in the UK tariffs are adjusted for the rate of inflation (RPI) plus or minus an industry productivity factor, X)[9]. Such a tariff reduction rate can either be defined specifically for one single company or as a general rate for the entire industry. A cost plus regime is similar to this regulatory mechanism but with adjustment of tariffs every year.
- With yardstick competition the duration of the regulatory period is much longer. In fact, if yardstick competition is applied rigorously, the companies' tariffs will no longer be adjusted to reflect their own cost. Rather their price path is set exogenously, based on the average industry performance. In our model we assume that an exogenous annual expected productivity improvement rate is set by the regulator. This is based on the observed cost

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respectively, in other countries and to allow for the impact of the regulatory regimes on the company's asset value and hence its return on capital to be examined. One variant of the model has, for example, been used to support German companies in their business planning strategies. Two additional extensions were considered in this paper, namely variation in the weights assumed in the manager's objective function and changes in the manager's planning horizon.

9 In the water sector the 'X-factor' has been positive in most years, reflecting the expected increases in costs. Negative or zero X-factors are observed more regularly in the energy sectors however.

reductions of the average firm[10]. Thus, prices are not related to the costs of the individual company but are rather adjusted by an amount that is out of the control of a company[11]. This is a practical form of yardstick competition delivering price reductions to consumers that reflect industry average performance - but where prices remain exogenous from the company's own cost level. In the terminology of price-cap regulation this corresponds to a price control period of indefinite duration. We assume in our model, to simplify the calculations, that the regulatory period under yardstick competition is actually ten years (and not indefinite). This is expected to be a reasonable approximation of how yardstick competition would work in practice. Beyond that and as we illustrate below, if the exogenous price path is set to reflect the average company's productivity improvement, then in the event that prices and cost were reviewed under yardstick competition (say after ten years) the regulator would observe that the average company's cost in any year would be (broadly) in line with tariffs and no further tariff adjustments would be required beyond those implicit in the yardstick adjustment. By imposing a price review after ten years we make a conservative assumption to take account of the fact that the manager may not

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10 Alternative adjustment rules that correspond with yardstick competition could be investigated. Our results would remain valid under such alternative schemes

11 Because the company in our model delivers the same cost reductions as the industry average (it is defined as an 'average' company), the manager always meets the exogenous X-factor and, hence, even after the ten year period the same X-factor is imposed because the average industry cost reduction is constant, in percentage terms.

consider an indefinite period credible. Such an assumption underestimates the potential benefits of yardstick competition.

With both mechanisms the company retains the profit earned from any cost reduction for the duration of the regulatory period. The company also faces a financial risk if the actual cost level is higher than that assumed by the regulator when setting the price cap. Cost reductions have been observed in practice however and it is generally assumed that, at least in initial years of a regulatory regime, the company can outperform the regulator's assumptions. Prices are therefore higher than actual costs, at least for the duration of the regulatory period.

The comparison of the incentive properties of the two regulatory mechanisms reflects differences in the length of the regulatory period and, most importantly, variation in the extent to which future revenues are linked to the company's own cost level. Under the price cap mechanism allowed revenues are adjusted at each five-year price review to reflect the company's own actual cost level at the end of the previous period. With the yardstick mechanism revenues are adjusted to reflect average industry costs at the start of each ten-year period. The company is assumed to be one of a sufficiently large number of firms in the sector so that the company's own performance has little impact on the average industry performance. Given that, this company is assumed to have an average industry performance.

We assume throughout that the regulator commits to using the same regulatory mechanism indefinitely and to not re-opening the contract during the regulatory period. The company considers the commitment credible. A number of

alternative regulatory mechanisms could be considered by the regulator - for example cost-plus, rolling incentive or profit sharing schemes - and the relative merits of these warrant attention. However, we focus attention on these two schemes only (price cap regulation and yardstick competition) to illustrate the possibility of improving on the already popular price cap regime.

Cost and profit functions

The company's level of economic profit is, as standard, total revenue minus total cost:

$$\pi_t = TR_t - C_t \tag{1}$$

We assume that output is constant, implying that the change in prices is equal to the change in total revenue set by the regulatory mechanism.

Total revenue

The level of total revenue is determined by the regulatory mechanism that is in place. Specifically, under the price cap mechanism total revenue in the first year of a regulatory period is set equal to total cost in the last year of the regulatory period. This results in the familiar P_0 cut used by regulators to share historic savings with consumers at the start of each regulatory period. In the remaining years of that regulatory period total revenue is equal to the previous year's total revenue adjusted by an exogenous X-factor. This gives us, assuming a five-year regulatory period:

$$\begin{aligned} TR_1 &= C_0 \\ TR_t &= TR_{t-1} \times (1 - X) \;\forall\; \text{t=2 to 5} \end{aligned} \tag{2}$$

We note that if the regulatory period were set equal to one year this price cap mechanism would be equivalent to cost plus regulation. X is assumed to be equal to 2% in our model[12]. This is a rather conservative assumption of the extent of possible cost savings compared to what has been observed in practice.

Under the yardstick mechanism total revenue in each year of the regulatory period is equal to total revenue in the previous year reduced by an X-factor that is the same in each year[13]. We set that factor to reflect the long term efficiency band that companies achieve under yardstick competition. This approach is thus comparable to one where revenue is adjusted on an annual basis to the average industry wide efficiency improvement. The implied X-factor here is 3.9% p.a. The company is assumed to be one of many and hence to have a minimal impact on the revised value of X. The company's previous cost decisions therefore do not affect any change in the X-factor at the start of the regulatory period. This gives us:

$$TR_t = TR_{t-1} \times (1 - X_i) \;\forall\; \text{t=1 to 10, i=number of regulatory period} \qquad (3)$$

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12 We have set the X-factor under price cap regulation to 2% p.a. This is a factor at which our average firm would earn a nominal rate of return under a cost of service regime (a price cap regime with annual adjustment).

13 For technical reasons discussed earlier, after ten years (the assumed length of the regulatory period with this mechanism), the X-factor is adjusted to reflect the average industry productivity. As the manager just meets the X-factor in each year (the average manager meets the average industry cost target), the tariff adjustment after year ten is the same because in our model the average industry performance does not change.

In our model, the X-factor under yardstick competition is set at 4% per annum which is equal to average industry productivity performance under such a regime. As the company is assumed to be of average efficiency it just delivers this cost reduction target in the standard analysis.

The differences between the two regulatory mechanisms are therefore:

- the extent to which the revenue adjustment in the first year of a new regulatory period depends on the company's own cost level; and
- the length of the regulatory period.

These factors directly impact on the incentive properties of the regulatory regimes.

Total cost

Total cost in each year is equal to annual operating expenditure plus the annual depreciation charge plus a return on the company's asset base[14]. This measure of total cost is consistent with that used by regulators in the UK and other countries when assessing required revenues of the company. The change in total cost from one year to the next reflects a change in the level of depreciation and the level of effort undertaken by the manager.

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14 We assume that there is no growth in physical output and hence investments are assumed to be for replacement only. The cost of capital is assumed to be equal to 7%.

The company's total cost level (net of depreciation) in any year is therefore equal to the previous year's cost less the level of cost reduction undertaken by the manager (i.e. the manager's level of effort, e)[15]:

$$C_t = C_{t-1} - e_t \quad (4)$$

There are two dimensions to the manager's effort level - an operating expenditure reduction and a capital expenditure reduction. The manager chooses both elements of effort simultaneously[16]. We assume that the share of operating and capital expenditure is fixed and do not consider trade-offs which the manager may make across these cost categories.

The manager's disutility of effort

The level of cost reduction is determined by the manager's decision about how much effort to undertake. Effort is disliked by the manager (i.e. leisure is preferred to work) and hence the cost reduction decision depends on the level of disutility associated with effort. We assume that the disutility increases with the level of effort and that effort becomes harder, and hence is disliked more by the

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15 We assume that the company is initially in a steady state. Annual Opex is 100, annual Capex is 25 and the asset life is 40 years, the regulatory asset base ("RAB") is constant at 1000 and there is a straight-line depreciation of 2.5%. Capital costs are calculated as depreciation plus the rate of return on the mid-year average of the RAB (7%).

16 The differentiation into operating and capital expenditure is not critical to the conclusions of our analysis.

manager, the lower the level of costs at the start of the year[17]. To reflect this we use the following disutility of effort function in our quantitative model:

$$U(e_t) = -\frac{e_t^{\ a}}{C^b_{\ t-1}} \tag{5}$$

We assume that parameter a is equal to 2 and parameter b is equal to 0.22[18]. These values are calibrated such that the level cost reduction under price cap regulation in the model is consistent with the levels observed in countries such as Great Britain and Norway[19]. The exponential form of the function is also consistent with the assumptions used by Laffont and Tirole (1993) and others when considering the design of optimal regulatory mechanisms.

Manager's objective function

The manager earns a fixed basic wage, *w*. In addition, we assume that the manager earns utility from the company's level of profit. This is because the manager's salary is also linked in some way to the profits earned by the company. For example, a company may have a formal performance-related pay scheme in place or it may simply reflect the fact that a manager who shareholders view as a

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17 This is consistent with the idea that there is diminishing potential to improve productivity and the closer a company is to the efficiency frontier the harder it becomes to deliver an extra unit of cost reduction.

18 Again, the conclusions of our analysis do not critically depend on the precise parameter values.

19 We note that while the numerical values that are determined by the model are affected by these parameter values the general results on the relative merits of the alternative regulatory regimes are unaffected.

good performer (because of the high profits delivered under his management) will earn a higher wage on the job market[20]. The closer the link between the manager's salary and profits the more weight he will place on these profits when making his effort decision.

An increase in effort will therefore deliver benefits to the manager, through the increase in current profits. This needs to be traded-off against the direct disutility associated with expending effort. This suggests that the manager has a utility function that is equal to the weighted sum of the company's profit level and the manager's disutility of effort. In this way the manager cares about both the interests of shareholders and his personal interests. The utility function in a given year t is[21]:

$$U_t = w + \alpha\pi_t + (1-\alpha)U(e_t) \qquad (6)$$

We assume initially that the manager places equal weight on profits and the disutility of effort (i.e. α=0.5). The implication of alternative weights, perhaps reflecting differences in the extent to which the manager's salary is linked to performance, are explored later[22].

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20 At the other extreme a manager who shareholders view as a poor performer might expect to be sacked or demoted, resulting in a lower potential wage on the job market.

21 We assume that the manager is risk neutral and cares only about the profit level rather than potential variation in that level.

22 As a proportion of total operating expenditure this is comparable to a wage of £120,000 in the UK electricity distribution sector. Such a wage is consistent with salaries of senior executives of these companies. We stress however that our conclusions are not dependent on the value of the basic

The manager's effort decision today may also affect future profits, depending on the extent to which the regulatory mechanism links allowed future revenue and the company's current costs. The manager will take this extra dynamic factor into consideration when making his effort choice. Specifically, in our model, the manager chooses, in year 0, the effort level for all future years given the regulatory regime that is to be introduced. He chooses a level of effort for year 1 of the first regulatory period, year 1 of every other regulatory period and year 2 to 5 of every regulatory period. The model output is therefore simplified so that the level of effort at the start of each regulatory period after the first is the same (in % terms) and the level of effort in subsequent years of each regulatory period is the same (in % terms). This allows us to consider variation in the incentive to reduce costs within a regulatory period (i.e. between year 1 and other years) but we do not consider variation in the cost reduction incentives across periods (except for between the first period of a regulatory regime and all other periods).

The manager's choices are made to maximise the net present value of his utility over more than 200 years (i.e. over a period which is longer than the manager's expected working life)[23]. This reflects an implicit assumption that the manager expects to stay in the company indefinitely. We consider later the implications of replacing this manager with a manger that only expects to stay in the company

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wage. We also assume that the wage paid to the manger is equal to 0.5 in order to ensure his participation

23 The 200-year period is chosen as a proxy for decision-making with an infinite planning horizon.

for a limited period (e.g. the length of the regulatory period) and is therefore myopic when making his effort decision.

Formally, we assume that, in year 0, the manager chooses the level of operating expenditure reduction and capital cost reduction in the first year of each period and in years 2-5 of each period to maximise the following dynamic utility function[24]:

$$\sum_{t=1}^{\infty} \beta U_t = \sum_{t=1}^{\infty} \beta \left[w + \alpha \pi_t - (1-\alpha) U(e_t) \right]$$
$$\beta = \frac{1}{(1+r)^t} \qquad (7)$$

The annual discount rate, r, is set equal to 7%. With this objective function the higher the level of cost reduction undertaken, the higher the level of profit in the current regulatory period, the higher the disutility of effort today and the lower the level of discounted future revenues if a price cap mechanism is in place. This is because the level of cost reduction undertaken today affects future revenues. It is the relative trade-off across these factors that the manager must consider when making his operating and capital cost reduction decisions.

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24 The model allows the manager to make different operating and capital cost reduction decisions. The level of reduction can vary in the first year of the first regulatory period and in the first year of each subsequent regulatory period. The chosen level of operating and capital cost reduction is the same in years two to five of each regulatory period. That is, the manager cannot vary the cost reduction decision annually. In this way the focus is on incentives at the start and end of each regulatory period rather than mid-period incentives. This simplifies the model considerably but may reflect a departure from decision-making in practice.

In summary, the model allows us to vary the following parameters in the manager's objective function:

- the extent to which revenues are adjusted, at the start of each regulatory period, to reflect the company's own cost level (i.e. the choice of regulatory mechanism);
- the length of each regulatory period (five years for price cap regulation and ten years for yardstick competition);
- the wage earned and the weights placed on profits and disutility of effort;
- the shape and position of the disutility of effort function; and
- the discount rate.

Taking these constraints into account, the model then solves the manager's optimisation problem by choosing values for the following six variables:

- the level of operating expenditure reduction in year 1 of the first regulatory period;
- the level of operating expenditure reduction in year 1 of all other regulatory periods;
- the level of operating expenditure reduction in years 2 to 5 of all regulatory periods;
- the level of capital expenditure reduction in year 1 of the first regulatory period;

Yardstick competition - a win-win setting?

- the level of capital expenditure reduction in year 1 of all other regulatory periods; and
- the level of capital expenditure reduction in years 2 to 5 of all regulatory periods.

The impact of these choice variables and the chosen model constraints on cost and revenue reductions are discussed below and shown in Figure 1 and Figure 2 respectively.

Model output

The manager chooses the level of effort that maximises the net present value of utility over time[25]. This gives us the optimal level of cost reduction given the regulatory mechanism. The quantitative model also produces, given the regulatory mechanism which is assumed and the resulting optimal level of effort, the change in prices faced by consumers and the rate of return earned by the company. This allows us to determine how consumer surplus (approximated here by prices) and producer surplus (approximated here by the rate of return) compare under the alternative regulatory mechanisms. We also examine how these numerical results change when the model assumptions are altered. In this way the model allows us to undertake a welfare comparison and understand the distributional consequences of changes in the regulatory mechanism.

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25 Formal calculation of the optimal effort choice for a similar objective function can be found in Laffont and Tirole (1993)or Armstrong, Cowan and Vickers (1994).

THE BENEFITS OF YARDSTICK COMPETITION

Under price cap regulation the manager chooses the level of effort that maximises his objective function, taking account of the fact that future revenue allowances will be reduced to reflect current reductions in costs. This results in a familiar ratchet effect problem whereby the manager is reluctant to reduce costs to the current optimal level because of the expectation that the regulator will react to this by reducing prices in the next regulatory period. The level of cost reduction is therefore dulled by the endogeneity of costs in the regulatory mechanism, although the incentive to reduce costs remains as long as the manager's utility function is non-negative with some cost reduction.

With a yardstick mechanism future revenue does not depend on the current level of the company's own costs. This is because the required change in prices is determined exogenously from the company's cost level. In this case the manager only needs to consider the trade-off between the current disutility of effort and the increased profits that can be earned from lower costs. There is no profit reduction associated with reduced costs. Higher cost reductions are therefore expected with this regime as the marginal net benefit from each unit of cost reduction is higher than is the case with the standard price cap.

Our quantitative model confirms these expected results. The degree of cost reduction delivered by each mechanism is shown in Figure 1. We see that cost reduction is higher for the yardstick regime than for the standard price cap regime. Both regimes deliver higher cost reductions than cost plus regulation. We also note, as an aside, that the cost reduction incentives in the price cap regime vary within the regulatory period. The manager will make more cost reductions

early on as this will allow him to earn the maximum available benefit from each unit of effort. This is because all cost savings are retained until the end of the regulatory period only and hence those that are made later in the period are retained for a shorter length of time. In contrast, under yardstick competition the manager's choice of cost reduction in any year does not affect future revenue requirements and hence the regulatory mechanism does not influence the decision about which year to make the cost savings in.

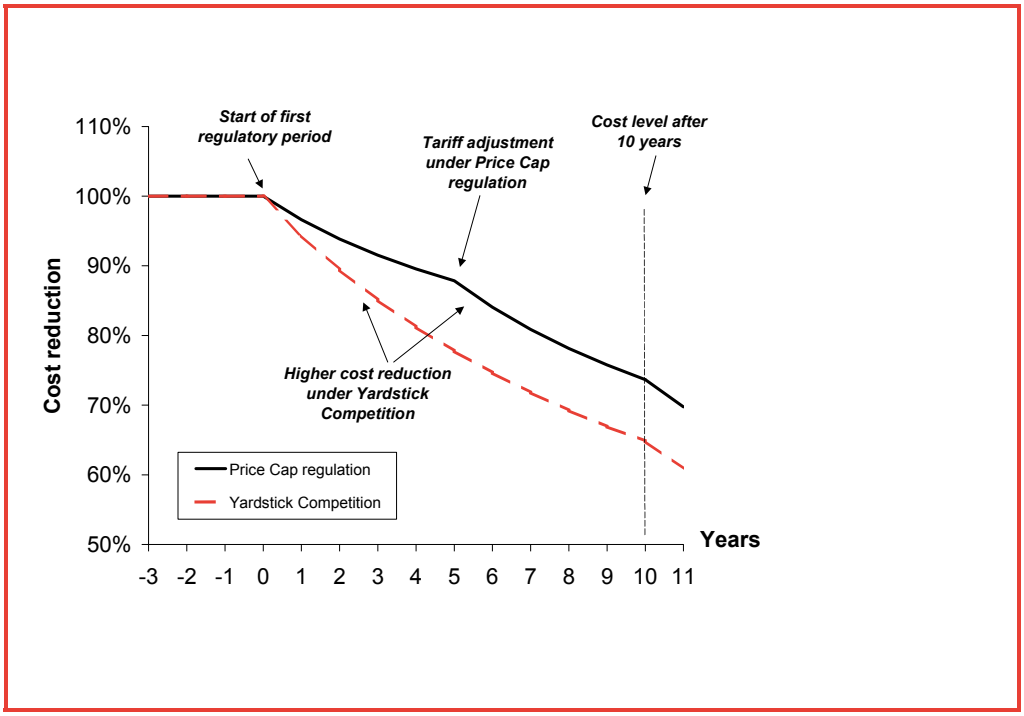

Figure 1: Cost reduction with price cap regulation and yardstick competition

Source: Frontier Economics

The cost savings realised under price cap regulation and yardstick competition are shared with the consumer in the form of revenue, and hence, price reductions. This is shown in Figure 2, where the company's own cost savings are shared with customers after five years under price cap regulation while the

Yardstick competition - a win-win setting?

industry average cost savings are shared with customers after ten years under yardstick competition.

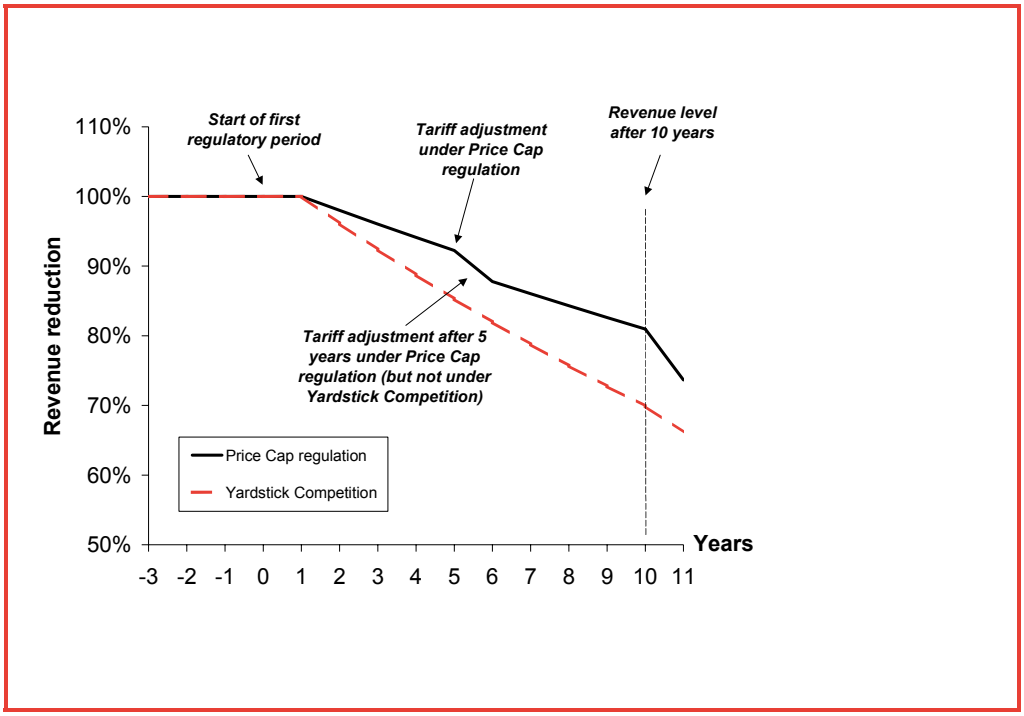

Figure 2: Revenue reduction with price cap regulation and yardstick competition

Source: Frontier Economics

It is not only the consumer who benefits from yardstick competition, but also the company itself. Given the tariff reductions of 2% p.a. for price cap and 4 % p.a. for yardstick competition assumed in our example, profits of 7.8 % or of 8.1 % can be realised under price cap regulation or yardstick competition, respectively. Under cost plus regulation the company will only earn a return that is close to the 7% cost of capital. These profits are by no means guaranteed. Rather, these are the profits an average company can realise if it reacts to the respective regulatory approach applied in an appropriate way. Companies with an excellent

Yardstick competition - a win-win setting?

performance can even supersede these profits and, consequently, consumers can benefit from even higher price reductions.

Table 1 compares the level of cost reduction, price reduction and the company's average annualised return on capital (i.e. profitability) under each regulatory mechanism for the first ten years of the model. As expected, the model shows that cost reduction is higher under the yardstick mechanism and that this allows for higher price reductions. Furthermore, the company earns a higher return on capital with this mechanism as a result of retaining a higher proportion of the net present value of cost savings made. Again it should be noted, that both regimes are preferable to cost plus regulation for consumers and shareholders because cost saving incentives are lower with this regime and above normal profits are only retained for at most one year.

Regulatory regime	Duration of regulation period	Cost reduction after 10 years	Revenue reduction after 10 years	Average annualised return on capital[1]
Price cap with required 2% p.a. revenue decrease within the regulation period	5 years	26%	19%	7.8%
Yardstick competition with 2% p.a. revenue decrease during the regulation period to reflect average industry efficiency	10 years	33%	17%	9.5%
Yardstick competition with 4% p.a. revenue decrease during the regulation period to reflect average industry efficiency	10 years	35%	30%	8.1%

Table 1: Comparison of costs, revenues and profits

[1] *It is assumed that the weighted capital costs of the regulated company amount to 7 %.*

Note: Figures are stated after adjustment for inflation - i.e. they reflect real changes. Tariff reductions from 2nd year of the regulatory reform.

Source: Frontier Economics

The results of the model therefore suggest that both the company and consumers may be better off with yardstick competition, and no one is worse off. That is, a move from price cap regulation to yardstick competition may well result in a pareto improvement, at least for the average cost company. This benefit would need to be considered alongside differences in the regulatory costs of each regime over time but we expect that the yardstick mechanism would remain

preferable even when this additional cost dimension is taking into account[26]. We therefore conclude that a transition away from standard price cap regulation towards a *transparent* yardstick approach, with clear and binding regulations, would constitute an improvement for both consumers and most regulated companies.

By essentially ignoring the improved information available — i.e. updated information on the company's own cost level — the regulator removes the ratchet effect problem associated with price cap revisions and delivers a potential welfare gain. However, to do this the regulator must be willing to accept that the company will earn above normal profits for some time and he must be patient as price reduction will only be delivered after cost reductions have been achieved. Both these factors may not be acceptable — perhaps because the regulator is under political pressure do reduce corporate profits and deliver price reductions today — and hence, as predicted by Sibley (1989), that regulator might be unable to commit to not using the data on the company's own costs once it became available. Credible commitment to the exogenous yardstick mechanism is therefore required for the cost reduction incentives to be provided.

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26 As noted by Burns and Riechmann (2004) regulatory mechanisms which provide strong cost reduction incentives may lead to a subsequent reduction in quality of service. This risk should be considered by the regulator with both mechanisms considered here and appropriate quality of service incentive mechanisms designed. These quality mechanisms are not considered here.

IMPLICATIONS FOR A COMPANY WITH ABOVE OR BELOW AVERAGE EFFICIENCY

We assume in our model that the company's efficiency level is equal to the industry average efficiency. That is, the company's ability to reduce costs is the same as for the industry on average. This 'average company' earns above normal returns under both regulatory mechanisms (i.e. above the cost of capital of 7%), but earns higher average annualised returns on capital with yardstick competition than with price cap regulation. This would imply that the average firm should favour yardstick competition.

If, however, the company's efficiency level is above or below the industry average the relative merits of price cap regulation and yardstick competition may change for the company in question. The company's ability to reduce costs may be higher or lower than the industry on average, depending on historical performance. This historical performance, in turn, may be a result of the manager's effort function (i.e. the extent to which effort is costly to the manager) and/or the extent to which the manager's utility is linked to the company's profits (i.e. the incentive gearing rate). We consider the above as variation in the weight placed on profits below and examine here the impact of effort being more or less costly for the manager.

We consider the case of a manager who has a higher than average disutility of effort, for example because he is inefficient and hence finds it harder to reduce costs by one unit than the manager in the average company or because he places a high weight on the opportunity cost of leisure. The cost reductions in this case

would be lower than with the average manager. The price reductions delivered to customers are therefore also lower and the company earns a lower average annualised return on capital. In this way customers, the manager, and shareholders and creditors suffer if the manager is less efficient at cost reduction than the average manager in the industry.

We allow for the below average company in our model by assuming that the manager's disutility of effort is twice as large as it was in the standard analysis. That is:

$$U(e_t) = -2 \times \frac{e_t^a}{C^b_{t-1}} \quad (8)$$

As shown in Table 2 the cost reduction, revenue reduction and average annualised return on capital are lower under both regimes. In particular the company is making below normal returns (the return is less than the 7% cost of capital) because the manager is unable to meet the required per annum reduction in costs. This shows that neither form of regulation protects shareholders or creditors if the manager proves to be inefficient. However, yardstick competition continues to provide higher price reductions and an average firm earns higher returns with yardstick competition. However, a below average firm earns lower returns with yardstick competition. A similar result is found when the manager is more efficient than the average manager at reducing costs (e.g. the disutility of effort is half as large as it was in the standard case), with cost reduction, price reductions and annualised returns being higher than is the case with the average manager. Yardstick competition continues to provide higher benefits than price cap regulation.

Yardstick competition - a win-win setting?

Regulatory regime	Duration of regulation period	Cost reduction after 10 years	Revenue reduction after 10 years	Average annualised return on capital[1]
Average firm				
Price cap with 2% p.a. revenue decrease within the regulation period	5 years	26%	19%	7.8%
Yardstick competition with 4% p.a. revenue decrease during the regulation period to reflect average industry efficiency	10 years	35%	30%	8.1%
Below average firm				
Price cap with 2% p.a. revenue decrease within the regulation period	5 years	14%	14%	6.9%
Yardstick competition with 4% p.a. revenue decrease during the regulation period to reflect average industry efficiency	10 years	24%	30%	6.4%

Table 2: Costs, revenues and profits of the average and below average manager

[1] *It is assumed that the weighted capital costs of the regulated company amount to 7 %.*

Note: Figures are stated after adjustment for inflation - i.e. they reflect real changes. Tariff reductions from 2nd year of the regulatory reform.

Source: Frontier Economics

Our findings suggest that policy-makers should continue to prefer yardstick competition to price cap regulation, independent of the company's inherent

efficiency level. However, it must be recognised that neither regulatory regime will protect inefficient companies from making losses (i.e. not recovering the full cost of capital) and both regimes perform better if the company is at or above average industry efficiency. The model therefore highlights the fact that incentive regulation is likely to overcome inefficiencies - such as inefficient incentive gearing within firms or the existence of managers that place too high a weight on the cost of undertaking effort (i.e. too high a weight on leisure). We also highlight that incentive regulation introduces incentives on shareholders to replace less efficient managers by more efficient managers. In other words: incentive regulation creates an opportunity to turn a technically inefficient firm that earns normal returns into a high performing firm that earns above market returns.

ALTERNATIVE OBJECTIVE FUNCTIONS

This comparison of price cap regulation to yardstick competition is based on the assumption that the manager places a weight of 0.5 on profits and on the disutility of effort in his objective function. Preferences across these variables are likely to vary by manager, however, and hence the weights in the objective function are expected to differ. There are two primary reasons for this.

- First, individuals will place different relative values on salary and leisure time arising from variation in personal preference functions. For example a manager who has alternative sources of wealth may place a higher value on his leisure time and less value on the performance-related salary earned from the regulated company.

- Second, and most importantly, the extent to which a manager's salary is linked to the company's profit will vary by organisation. This will affect the degree of importance that the individual manager places on the profit element of his objective function. For example, if the majority of a manager's salary is dependent on the company's profit level he will place high weight on that element relative to the disutility of effort.

Personal preferences and the remuneration package which the manager faces will therefore influence the relevant weights in the objective function and may affect the performance of yardstick competition and price cap regulation. For example, it is sometimes argued in public debate that incentive regulation would not work in certain countries due to cultural differences (e.g. where the value of leisure time is high) and differences in incentive gearing for managers. We used our model to explore this issue.

We consider the implications of alternative weights on the manager's effort decision in our quantitative model. The higher the weight placed on profit the more benefit the manager gets from increased effort today and the lower the relative size of the disutility of effort. The manager is therefore expected to deliver higher cost reduction in this situation, resulting in higher revenue reductions and annualised rates of return for the firm. In contrast, if a low weight is placed on profits in the objective function, the manager gets less benefit from increased effort today and is more concerned about his disutility of effort. This results in lower cost (and hence revenue) reductions and lower annualised returns to the company. It remains the case, however, that the incentive power of yardstick competition is higher than the power of price cap regulation.

Yardstick competition - a win-win setting?

Regulatory regime	Duration of regulation period	Cost reduction after 10 years	Revenue reduction after 10 years	Average annualised return on capital [1]
Base case: 50% weight on profits and 50% weight on disutility of effort				
Price cap with 2% p.a. revenue decrease within the regulation period	5 years	26%	19%	7.8%
Yardstick competition with 4% p.a. revenue decrease during the regulation period to reflect average industry efficiency	10 years	35%	30%	8.1%
20% weight on profits and 80% weight on disutility of effort				
Price cap with 2% p.a. revenue decrease within the regulation period	5 years	7%	11%	6.5%
Yardstick competition with 4% p.a. revenue decrease during the regulation period to reflect average industry efficiency	10 years	14%	30%	5.2%
80% weight on profits and 20% weight on disutility of effort				
Price cap with 2% p.a. revenue decrease within the regulation period	5 years	45%	32%	9.6%
Yardstick competition with 4% p.a. revenue decrease during the regulation period to reflect average industry efficiency	10 years	55%	30%	12.2%

Table 3: Costs, revenues and profits for objective functions with different weights on profits and disutility of effort

[1] *It is assumed that the weighted capital costs of the regulated company amount to 7 %.*

Note: Figures are stated after adjustment for inflation - i.e. they reflect real changes. Tariff reductions from 2nd year of the regulatory reform.

Source: Frontier Economics

Table 3 compares the level of cost reductions, price reductions and average annualised return earned on capital for three scenarios: the base case of 50:50 weights on profits and disutility of effort; 20:80 weights on profits and disutility of effort; and 80:20 weights on profits and disutility of effort. These cases

illustrate the variation that can arise when the manager is making a trade-off between minimising the disutility of effort and maximising the firm's profit level. We find, as expected, that when a lower weight is placed on profits, the level of cost reduction reduces, in this case quite significantly. This results in lower revenue reductions for consumers and a lower annualised rate of return for the company. When the weight placed on profits is particularly low (i.e. 20%) the manager chooses to not meet the regulator's efficiency target (i.e. the cost reductions required by the X-factor) and the company makes below normal returns. However, a pareto improvement continues to exist if we move from price cap regulation to yardstick competition. This also remains true when we consider the case where a high weight is placed on profits. In this sense the weights used in the manager's objective function do not alter our main argument but only alter the level of cost reductions, revenue reductions and annualised average rates of return delivered by each regulatory mechanism. In the case of a management that places a high weight on the disutility of effort the resulting return is below our models market return of 7%. Shareholders would have a choice of accepting this, replacing the manager with one who does not dislike effort as much or increase the incentive gearing in the management contract. Rational shareholders should adopt one or both of the last two options. This implies that 'cultural' differences may be a static concept that does not take into account the dynamics one incentive regulation is introduced. At any state, yardstick competition outperforms price cap even in an environment where a lower weight is attached to profits.

Yardstick competition - a win-win setting?

IMPLICATION OF A MYOPIC MANAGER

So far we have assumed that the manager is concerned about the long-term implications of his current effort choice on future revenue and hence profit levels. That is, he maximises the net present value of the weighted sum of profit and the disutility of effort over an infinite planning horizon. In practice managers may not be concerned about the future revenue implications of current decisions, perhaps because they do not intend to work in the company for a long period. Indeed, the cost reduction properties of a number of regulatory mechanisms, most notably that proposed by Vogelsang and Finsinger (1979), are dependent on the assumption that the company does not consider the impact of current decisions on future regulatory decisions. Such managers will be myopic when making their effort choices and this will affect both the level of cost reductions that are undertaken and the comparison between price cap regulation and yardstick competition.

When faced with a price cap mechanism, a myopic manager will not be concerned about the future revenue reduction arising from the decrease in costs today. The link between future prices and the company's own costs is therefore removed - at least from the manager's perspective - and hence the level of cost reduction is expected to be the same as with yardstick competition.

However, under the price cap mechanism the regulator continues to base revenues at the start of the regulatory period on the company's own costs at the end of the previous period. This does not arise with yardstick competition and, hence, the level of price reductions may be different with price cap regulation than yardstick competition even though the cost reduction incentives are the

same. However, the exact difference between the price reductions delivered will depend on the X-factor applied under each mechanism. Similarly, the average annualised rate of return earned by the company may be different with price cap regulation than with yardstick competition because the company's profits are adjusted after five years under the price cap regime only.

If a manager is myopic it is no longer clear that yardstick competition is better than price cap regulation. This is because the cost saving incentives under both regimes is now the same and the impact on price reductions and the company's annualised return depends on the X-factor that is set and the length of the regulator lag. Both regimes can therefore be designed to deliver similar benefits (or losses) for both consumers and shareholders and creditors.

CONCLUSIONS

We use a numerical model to compare the impact of price cap regulation and yardstick competition on cost reduction, revenue (price) reduction, and the annualised average return of the company (i.e. returns to shareholders and creditors). These variables are of interest because they reflect the parameters of interest to policy-makers when deciding how to regulate network monopoly companies.

Initially we assumed that the manager made decisions at the time that regulation was introduced for the long-term and that when making those decisions he maximised the net present value of his objective function that placed the same weight (0.5) on profits and the disutility of effort. We also assumed that the company's costs were equal to industry average costs. We found, in this base case

scenario, that yardstick competition delivers, on average, higher cost reductions, a higher annualised average rate of return for the company and lower prices for customers relative to the standard price cap regime. This suggests that a move from price cap regulation to yardstick competition may be pareto improving, a result that would no doubt be of interest to policy-makers and regulators. Both regimes are considered preferable – from the perspective of consumers and shareholders – than cost plus regulation.

The conclusion that yardstick competition is pareto improving continues to hold when we allow the company to be above or below average and when we allow the manager to have different weights on the profit and disutility of effort terms in his objective function. These factors affect the level of cost reductions delivered, and hence the levels of revenue reductions and annualised rates of return, but do not affect the relative performance of the two regulatory mechanisms. The conclusion of pareto improvement would also hold for a comparison between yardstick competition and cost-of-service regulation noting that cost-of-service regulation can be characterised as price cap regulation with a none-year lag (revenue adjustment) period.

However, when we consider a change in the planning-horizon of the manager, so that he is assumed to be myopic, the comparison between yardstick competition and price cap regulation is not so straightforward. We expect that the cost reduction incentives are the same under both mechanisms, because in both cases the manager does not consider the fact that cost decisions today may impact on future revenues. Given this, we expect that a regulator can design both a price

cap regime and a yardstick regime to deliver similar results and, hence, the case for choosing one mechanism over another is not so clear.

The results of our model suggest that, in general, yardstick competition is pareto improving relative to price cap regulation. However, policy makers should be aware that this result would not necessarily hold if company managers were expected to focus on the short-term only. Furthermore, when considering the precise characteristics of the industry which is to be regulated, it is useful to note that the level of cost reductions, revenue reductions, and annualised average rates of return will be higher if, when regulation is introduced, the companies are close to or above average industry productivity levels and manager's are provided with high incentive gearing (e.g. they have salary regimes which are largely linked to the company's profitability). This will be true for both regulatory regimes considered here.

Our assessment of the merits of yardstick competition relative to price cap regulation assumes that policy makers are most concerned about increasing welfare by increasing consumer and producer surplus. However, a regulator may be concerned about factors other than welfare improvement when deciding on the preferred regulatory mechanism. For example, the regulatory costs associated with both options would be compared. Furthermore, the regulator may care about the profile of prices rather than the long-term impact on prices only. Price cap regulation, which allows the regulator to determine the company's price profile for each regulatory period, may be preferred to yardstick competition, which does not allow for the price profile to be fixed by the regulator. A possible middle ground might be a regime that adjusts revenues, and hence prices, every

five years but which uses yardstick principles to make the adjustment (i.e. the adjustment is based on average industry costs rather than the company's own costs).

Several options for future research can be considered which would build on the outputs from the existing model. These include a more detailed analysis of the relative impact of regulatory mechanisms on operating and capital cost reduction. In addition, an evaluation of profit-sharing salary schemes in different sectors and countries would be of interest, together with an assessment of the different level of cost reduction delivered given the manager's incentive gearing.

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