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Agenda

Advancing economics in business

Fine-tuning RPI – X: the impact of changing the incentives mechanism

One advantage of RPI – X regulation is the incentive it places on companies to improve efficiency. If companies operate more efficiently than assumed when prices are set, they retain the benefits for the remainder of the review period. However, the UK experience has been to make various reforms to this 'basic' incentive with the aim of improving productivity. Has changing these incentives mechanisms led to increased productivity in the water industry?

When the water industry in England and Wales was privatised in 1989, the regulator, Ofwat, employed the RPI – X regulatory regime to incentivise firms to improve their productivity. Using yardstick competition—comparing companies' costs, controlling for operating environments and outputs—Ofwat was able to set cost-reduction targets (recently referred to as 'sticks' by the regulator) for companies. If companies could outperform the target, they were able to retain the outperformance for the remainder of a price control review (the 'carrot').

There have been several changes to Ofwat's approach since the first price control review in 1994 (PR 94). The two changes examined here are the strengthening of both the 'stick'—ie, making the initial targets tougher—and of the incentives through the introduction during the 1999 periodic review (PR 99) of a rolling mechanism for outperformance.

Since privatisation Ofwat has collected data on water companies' costs and outputs. This rich and valuable dataset is generally consistent over time, with the first dataset available in 1992/93, and allows the estimation of productivity gains over time, which might not be possible in other industries. The water sector is therefore the focus of this article; nevertheless, the principles are applicable to all regulated industries.

Changes in incentives

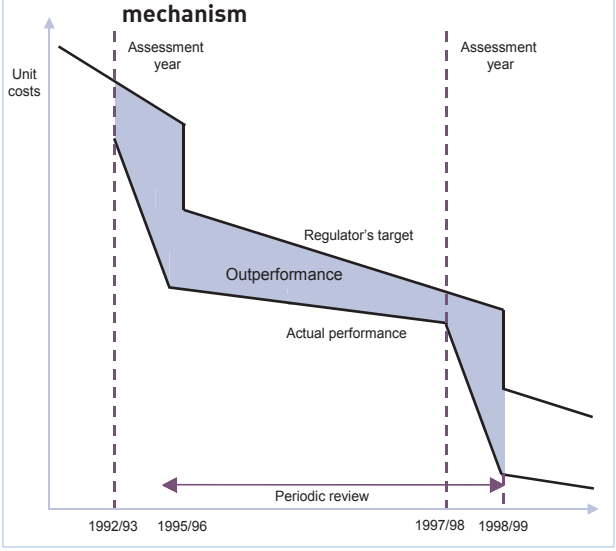
This article examines two main changes to the incentive regime used by Ofwat: the introduction of a rolling mechanism for retaining outperformance, and the changing balance of targets and potential outperformance. Both changes were introduced by Ofwat with the aim of increasing productivity. Using the methodology described below, this article tests whether this aim has been achieved.

Before the rolling mechanism was introduced, firms had an incentive to 'front-load' as much of their efficiency savings as possible (ie, to do as much as possible at the start of a review and as little at the end). This was because all savings were accounted for at the next review regardless of when they were made—ie, the benefits from an efficiency initiative undertaken in year 1 could be kept for four years, whereas if the same initiative was undertaken in year 4, the gains would be retained for only one year. However, this principle was complicated somewhat by the fact that there was a lag between the data used for the setting of future prices—'the assessment year'—and the year in which those prices came into force. As such, firms arguably had the strongest incentive to improve performance in the year following the assessment year and the start of the periodic review. Ofwat partly took this into account at the assessment for PR 99 by making an adjustment if the cost base increased between the assessment and the start of the review.

Figure 1 shows the process by which the regulator sets a target in the base year, giving firms an opportunity to outperform. Without a rolling mechanism for outperformance, there is an incentive to make efficiency savings early on in the periodic review, and so a step function in efficiency improvements is likely to be observed.

The introduction of the rolling mechanism has meant that any savings made are retained for five years, regardless of when in the price control they are achieved, thereby removing this timing distortion. In addition, this change in the regulatory contract has strengthened the benefit from outperformance (ie, increased the size of the carrot) since, on average, companies now retain the benefits for longer.

Figure 1 Incentives in the absence of a rolling mechanism



As well as changing the 'carrot' in terms of the incentives to undertake efficiency improvements, Ofwat has strengthened the 'stick' by increasing the performance targets from 2% in PR 94 to 2.4% in PR 99 (Ofwat has subsequently changed the incentives again for PR 04 with a stick of 1.4% and a carrot of 1.0%). Whether this would be expected to improve the incentives for efficiencies is an interesting debate. On the one hand, it is clear that changing the level of the target results in no change in the marginal incentives on companies—ie, if this target is 'easy', firms will still wish to outperform it by as much as possible, while if it is 'tough' they will still want to get as close to the target as possible. On the other hand, based on experience, firms' shareholders will expect a certain return, and the company will seek to deliver that return regardless of what the regulatory target for productivity is. In this view of the world, where investors are 'return satisfiers' rather than 'return maximisers', setting a tough productivity target, assuming that it is feasible, will result in a greater incentive to make productivity improvements. The following analysis looks at whether the strength of the stick has any impact on company productivity.

Assessing productivity

The established approach to measuring productivity changes in multi-input, multi-output contexts, as in the water industry, is to use Malmquist indices computed with data envelopment analysis (DEA). Partial factor productivity estimates (such as unit cost reductions) are likely to produce biased estimates of productivity gains compared with multiple-output factor productivity measures, such as Malmquist indices. This is because changes in the relative values of different cost drivers are not captured in the single output-based cost reductions. To avoid this potential bias and to attain a more robust estimate of past movements in productivity, a Malmquist index approach is adopted to estimate productivity growth from 1992/93, when data first became available, to 2001/02.

Another major advantage of Malmquist indices is that they allow a company's overall productivity change between two points in time to be divided into two separate items. This takes into account the fact that productivity change may be due to a combination of industry-wide productivity change over time, which in turn reflects changes in the technology[1] used by the industry and/or its cost structure, and efficiency change at the company level. Malmquist indices can be broken down into the following components.

– *Frontier shift*—how the position of the efficiency frontier has moved over time. This is estimated as the geometric average of the frontier shift relative to the company's input/output mix at two points in time. A positive value suggests that the industry has achieved productivity gains over time, while a negative value implies that productivity has regressed. This frontier shift is also specific to particular input/output mixes.

The regulator's tools defined

Data envelopment analysis

DEA uses linear programming techniques to find the 'best' virtual producer for each real producer. If the virtual producer is better than the original, either because it achieves more output with the same input, or the same output with less input, the original producer is deemed inefficient. DEA selects the efficient observations and constructs a frontier from them, disregarding those observations that are inefficient.

There are two main advantages of DEA analysis. First, it is non-parametric, in that companies are compared without assuming a functional form (an equation that describes the relationship between variables in a model) for a cost or production function. Second, it permits comparisons between companies for non-economic variables, such as performance and quality indicators.

Malmquist indices

A Malmquist index is an index number that enables the comparison of productivity between two time periods and two companies. The index allows the productivity improvement to be broken down into a catch-up effect (ie, how much the firm has caught up with the industry best practice over the period) and a frontier shift (ie, how much the frontier, specific to the firm, has moved).

Malmquist index = catch-up effect × frontier shift

Malmquist indices represent an extension of total factor productivity (TFP). TFP assumes that all inputs are used optimally such that TFP growth represents a shift in the frontier (ie, technical progress).

Figure 2 Productivity growth over time

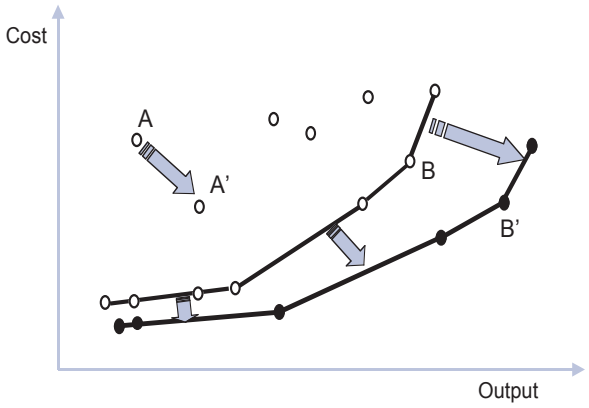
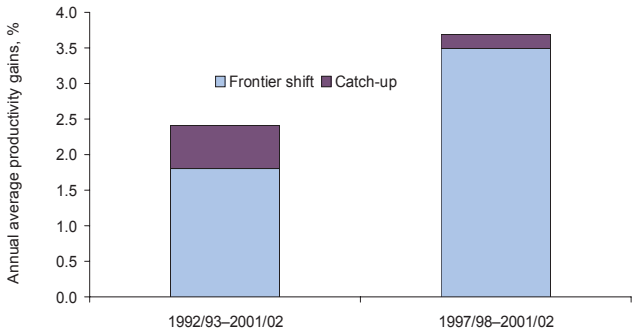


Figure 3 Productivity in water: catch-up and frontier shift (% per annum)



Source: Oxera modelling.

As such, the frontier could improve at some points and regress at others.

– *A company's catch-up*—in terms of relative efficiency (as estimated by Ofwat's comparative-efficiency assessment at the price review), how has the assessed company's relative position with respect to the frontier changed over the timeframe examined? This is estimated as the company's relative efficiency at the end of the period divided by that at the start of the period. A positive value reveals that the assessed company achieved efficiency gains over and above the productivity gains of the whole industry; a negative value suggests that the gap to the frontier company has increased—ie, the company has failed to keep up with the frontier movement.

Figure 2 demonstrates the difference between catch-up and frontier shift. Company A is judged to be inefficient relative to its peers; however, it is improving over time (moving from point A to point A') by lowering costs and increasing output allowing it to catch up to the efficient frontier. Company B is already judged to be efficient and hence any further efficiency gains it makes move the efficiency frontier outwards.

Results

The estimations for the frontier shift and Malmquist indices presented in this article are based on the overall water service regression models that were identified using an econometric modelling approach.

The results show that, over the period (1992/93 to 2001/02), the water industry has achieved annual average productivity gains of 2.4%. In the later years (1997/98 to 2001/02), average productivity gains of 3.7% per annum were achieved (see Figure 3).

Figure 3 shows that, not only has the total level of productivity increased, but also that a larger proportion of this productivity growth has come from frontier shift. The move towards more frontier shift and less catch-up is corroborated by evidence from the convergence seen in Ofwat's relative efficiency report,[2] where many of the companies are in the top efficiency bands compared with ten years earlier when there was a much larger spread of relative efficiencies. This convergence around the frontier is what might be expected following several RPI – X price controls when inefficient firms are set targets to catch up to the best-performing firms. Ofwat has acknowledged that much of the initial relative inefficiency has been removed from the industry (although it considers that there is still scope for improvement) and, as such, wants to shift the focus of incentives to moving the frontier forwards:

> The results of the efficiency analysis this year show just how much companies have improved. The spread of company performance has narrowed with all companies now within 25% of the benchmark performance. However, this still leaves a number of companies with considerable scope to catch up with their peers. We have turned our attention to improving incentives to outperform our assumptions for the best companies (an increasingly large group) to push the boundary of efficiency forward.[3]

The impact of incentives

To understand how changes in incentives have affected productivity, it is important to understand the timing of the review process.

To set a price control review, the regulator has to collect data in advance, issue a consultation and undertake the analysis. This means that, typically, a price control review is based on data collected two years prior to the review starting. For example, in PR 99, Ofwat's primary dataset related to 1997/98.

Because of the issues relating to the timing of the assessment, the years following the data collection are included in the analysis of productivity for each periodic review. Table 1 shows how the lack of a rolling

Table 1 Annual average productivity change by Malmquist indices and frontier shift (%)

	PR 94 (I) 1992/93–1995/96	PR 94 (II) 1995/96–1997/98	PR 99 (I) 1997/98–1999/2000	PR 99 (II) 1999/2000–2001/02
Water industry productivity				
Malmquist index (original model)	2.2	1.3	2.4	5.0
Catch-up	1.5	0.8	–1.8	2.2
Frontier shift	0.7	0.5	4.2	2.8
Ofwat operating efficiency target (stick)	2.0	2.0	2.4	2.4
Rolling incentive mechanism (carrot)	No	No	No	Yes

Source: Oxera calculations.

mechanism to smooth out the distribution of efficiencies meant that the water industry achieved twice as much catch-up in the first half of the period after the assessment year as it did in the second half.

At the point of assessment for PR 99 (1997/98), it is plausible that firms were expecting a similar approach and achieved similar performance to that of the first half of PR 94 in aggregate, although this was mainly achieved through frontier shift rather than catch-up. Frontier shift was considerable during PR 99, and it increased the relative inefficiencies between companies, as comparatively inefficient firms struggled to match the performance of those at the frontier. This explains the negative value seen in this period.

However, the announcement of the proposed rolling mechanism in March 1999, and its confirmation later the same year, meant that, in the second half of the period after the assessment was made, the expected fall-off in performance was not seen—indeed, the opposite was observed. The second half of the review saw stronger performance than the first, despite a reduction in the rate of frontier growth. A possible explanation for this is the increased incentive to undertake efficiency initiatives.

Productivity in PR 99 was stronger than in PR 94—this may be explained in part by the increased cost reduction target (from 2% to 2.4%), which made the required minimum efficiency gains higher.

Ofwat has changed the incentive mechanism for PR 04 by explicitly splitting the total potential for improvement into a stick of 1.4% and a carrot of 1.0% for base water service provision. It remains to be seen how reducing the stick will affect the productivity of firms operating under RPI – X regulation.

Conclusions

Average productivity growth in the water industry has been around 2.4% per annum since privatisation. Ofwat's policy of using yardstick competition to reduce relative inefficiencies has meant that, initially, productivity gains came from firms catching up to their peers, but in subsequent reviews, more efficiency gains came from the increased use of new technologies and management practices, leading to growth of 3.7% per annum between 1997/98 and 2001/02.

The changes Ofwat has made to the regulatory contract with firms, by adjusting the balance of sticks and carrots and introducing the rolling mechanism for outperformance, appear to have played a significant role in increasing the productivity in the industry over time. This contrasts with industry expectations that, following privatisation, productivity gains were likely to fall over time as the majority of the inefficiency was removed and firms began to find it more difficult to cut costs once they had reached the efficient frontier.

Since PR 99, Ofwat has made further adjustments to the regulatory contract by providing incentives for firms to move the frontier outwards in the form of bonuses of 1.5% higher allowed expenditure for defining the frontier and of 1.25% for being within 5–25% of the frontier. Ofwat's previous changes to the incentive regime appear to have been largely successful and it will be interesting to see whether its more recent changes can also induce significant productivity gains, or whether the industry's expectation that the majority of the possible efficiency gains have already been achieved is correct.

[1] The term 'technology' is used here in its performance measurement definition, which includes actual technological change (ie, in terms of capital employed) and changes in management practices, corporate structure and general improvements to best practice.
[2] Ofwat (2004), 'Water and Sewerage Unit Costs and Relative Efficiency: 2003–04 Report'. The issue of convergence is also discussed in Oxera (2005), 'Has Yardstick Competition had its Day?', *Agenda*, September, available at www.oxera.com.
[3] Ofwat (2004), op. cit.

If you have any questions regarding the issues raised in this article, please contact the editor, Derek Holt: tel +44 (0) 1865 253 000 or email d.holt@oxera.com

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