# 26 Efficiency and Innovation in Network Industries

## Regulation and Innovation

Network industries play a major role in economic growth and development and it is, accordingly, vital that they operate efficiently. Energy prices are fundamental to a country's competitiveness, and reducing reliance on non-renewable energy sources is essential to sustainability objectives. World Bank data also suggest that the spread of telecommunications services, especially mobile voice and broadband, gives a significant boost to GNP.[1]

The challenges created in the face of climate change increase the importance of adequate incentives for investment in regulated industries. They are often both capital- and energy-intensive. Rising energy prices or direct energy-saving measures may be brought to bear. This may necessitate solutions based on replacing capital expenditure with operating expenditure. It will probably involve more extensive use of information technology, and of metering and telemetry. The right incentives have to be brought into play to achieve these results.

The traditional organization of utilities as monolithic state-owned enterprises was generally inimical to efficiency and technical advance.[2] However, there is no guarantee that privatization would rectify the situation, as incentives towards efficiency will depend upon the structure of the industry, the degree of regulation it is subject to, and the form of regulation.

The impact of the form of regulation is illustrated by the now familiar contrast between rate-of-return or cost-plus regulation and the operation of price caps. Under rate-of-return regulation in its pure form, the regulated company receives enough revenue to cover its costs. If it gets more efficient, it has to cut its prices. It may have an incentive to install more capital equipment if its allowed rate of return on capital employed exceeds what it actually cost it to borrow on capital markets, but the decision to invest is based not on efficiency but on the desire to 'gold-plate'. Although this is an exaggeration of

[1] World Bank, *Information and Communications for Development: Extending Reach and Increasing Impact* (Washington, DC, 2009), 35–50.

[2] J. Netter and W. Megginson, 'From State to Market: A Survey of Empirical Studies on Privatisation' 2001 39(2) *Journal of Economic Literature* 321–89.

how rate-of-return regulation actually works, the lack of incentive for efficiency remains limited.

What about price caps? In principle, a long-term price control does give an incentive for efficiency. However, as noted in Chapter 25, price caps are based on forecasts which are subject to an increasing margin of error as they extend into the future. Concerns about excess profits being earned or losses incurred effectively limit the term of price cap. This almost inevitably introduces an element of cost-plus into the process. When a cap is reset, the regulator's starting point is almost unavoidably the existing level of costs, in the sense that the initial data-set for projecting costs forward is inevitably current observed costs. This introduces an element of cost-plus into the process.

A consequence of this is that, as shown below, the firm's returns to efficiency gains are reduced. In particular, if an efficiency gain is won near the end of the price control period, very few of the benefits go to the firm, as the resulting cost reduction is almost immediately reflected in lower prices in the next control period. Various methods have been implemented to mitigate the resulting effect on incentives to reduce cost. Essentially, they allow some kind of 'carry-over' of efficiency gains by the firm from one price control period to the next.

The problem is illustrated in Figure 26.1. Suppose a regulated company is considering two alternative means of realizing a particular outcome. For example, the options might be two alternative technologies for a water treatment plant. One (project A) uses a tried and tested technology, with

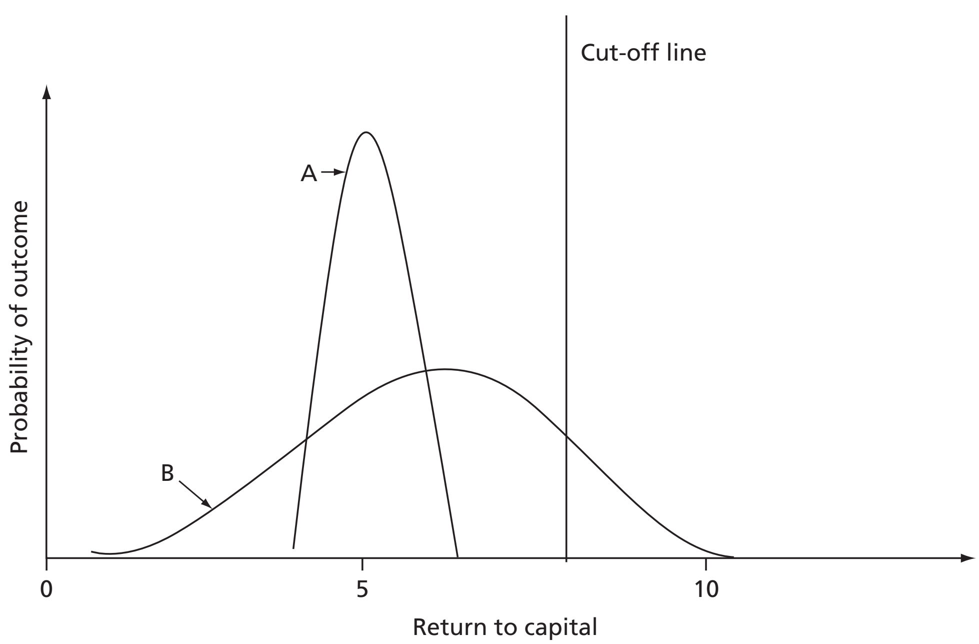


**Figure 26.1.** The effect on project choice of truncating high returns

nearly certain outcomes. A second innovative approach to achieving the same outcome (project B) is also available, which yields a higher average but more variable return. The expected distribution of returns for the two are shown in the figure. It is clear that B has the higher expected (average) return.

Absent regulation, the firm which was broadly neutral to risk would choose project B, on the strength of its higher expected returns. But now suppose that regulation operates in the way described above, and that rate-of-return or cost-plus elements in it bring about a situation in which, if the project earns high returns, the regulator brings prices down accordingly. This would happen if, in setting prices for a new control period, the regulator started from observed costs.

To represent this, we assume that prices are reduced if the 'cut-off line' in the figure is reached. In other words, where returns lie above that level, the distribution is 'truncated'. Eliminating this segment of the distribution brings the returns the firm gets from B to the same level as returns from A. B still has the same downside, or risk of failure. It also probably requires more managerial effort. As a result, A is likely to be chosen—not only this year but next year too.

The obvious regulatory response is to extend the degree to which the regulated firm can keep excess returns—in other words, to move the cut-off line to the right. If this is done skilfully, both investors and end users can benefit: investors because they are allowed to keep higher returns, if they eventuate, and end users because in this case the 'better' project B is chosen, and more generally, innovations are implemented. This drives costs down in the long run and may also improve quality of service.

Some regulators are fully aware of this issue.[3] But implementing it is not without difficulties. If an innovation introduced by a regulated firm turns out to be very successful in the event, end users may well forget the risks involved in implementing it, and resent the high returns the firm is making. Fear of this outcome may deter the regulator from making the reform.

Several of the revisions to the regulatory regime, under the title RIIO, made by the UK energy regulator focus on innovation.[4] Some augment the returns to successful regulation, in the manner described above. Another strand is an innovation stimulation package designed to allocate money on a competitive basis to promote sustainable energy. Amongst other things, this would allow for awards or prizes to be awarded to parties developing new commercial solutions. A similar proposal has been made in the water sector.[5] The notion

[3] See OFWAT, *The Role and Design of Incentives for Regulating Monopoly Water and Sewerage Services in England and Wales* (2010).

[4] OFGEM, *RIIO: A New Way to Regulate Energy Networks* (October 2010). RIIO stands for **R**evenue set to deliver strong **I**ncentives, **I**nnovation, and **O**utputs.

[5] M. Cave, *Independent Review of Competition and Innovation in the England and Wales Water Sector* (2009).

of prizes for innovation, which goes back at least as far as the Longitude Prize offered in 1714 by the British government for a device capable of establishing a ship's longitude, has made an unexpected reappearance in regulatory policy.[6]

What else can a regulator do to promote innovation, in addition to improving regulatory incentives? It is natural to look to competition as an important instrument. There is significant evidence that industries where there is more intense competition exhibit more innovation than monopolies,[7] although some argue that both monopolies and very fragmented sectors are poor at innovation, and that the best results are gained in markets with a small number of rivalrous producers.[8] This suggests that unbundling strategies described in Chapter 23 are likely to promote innovation.[9] The problem is that the reliance of all firms in the market on a common input, access to which the regulator has mandated, may limit the extent of product or service differentiation and thereby the scope for innovation. However, it is unlikely that an end-to-end monopoly with no unbundling would produce better results in terms of innovation.

Another form of competition might have an effect on efficiency and innovation in network industries. This is capital market competition, which takes the form of takeovers of underperforming assets by better managed companies which can deploy those assets more efficiently, make more profit from them, and hence bid more for the underperforming company's shares. This may be an optimistic version of how the takeover market works. For example, mergers and acquisitions may be directed at increasing market power rather than enhancing efficiency. And acquirers might be driven on by optimism and the desire to get bigger, rather than by anything else. Nonetheless, there are reasons to believe that the discipline of the capital market is more likely than not to be a stimulus to efficiency.

This generates a conflict between improving efficiency by this means, and the development and use by the regulator of a database of regulated firms' comparative performance which can be used to expose poor performers. The next section describes how this can operate.

[6] See L. Cabral, G. Cozzi, V. Dencolo, G. Spagnolo, and M. Zanza 'Procuring Innovation' in N. Dimitri, G. Piga, and G. Spagnolo (eds), *Handbook of Procurement* (Cambridge, 2006), 483–529.

[7] See R. Blundell, R. Griffith, and J. van Reenen, 'Market Share, Market Value and Innovation in a Panel of British Manufacturing Firms' (1999) 66 *Review of Economic Studies* 529–54; see also F. Etro, *Competition, Innovation and Anti-trust: A Theory of Market Leaders and its Policy Implications* (Berlin, 2007).

[8] P. Aghion, M. Bloom, R. Blundell, R. Griffith, and P. Howitt, 'Competition and Innovation: An Inverted-U Relationship' (2005) 120 *Quarterly Journal of Economics* 710–28.

[9] For a discussion of this complex issue, see J. Vickers, 'Competition Policy and Property Rights' (2010) 120 *Economic Journal* 375–92.

Analysis of comparative performance plays a particularly large role in the regulation of the England and Wales water and sewerage industry. At privatization in 1989, a special merger regime was set up, which now means that any merger between two water companies, where the turnover of at least one is more than £10 million, must be examined by the UK Competition Commission to establish whether the merger prejudices the regulator's ability to make comparisons between different water companies for the purpose of regulating them.[10] If the Commission makes this finding, it can prohibit the merger, require a divestment of assets, or require the companies to cut prices.

As a result of this provision, only one merger took place among the 20 or so companies between 2004 and 2010. A recent independent review of competition and innovation in the sector has proposed weakening substantially this limitation on the normal operation of the capital markets.[11]

## Benchmarking

A major problem in setting forward-looking price controls is to forecast the level of efficient costs at some future date—typically the end of the price control period—which can be used to set a limit on permitted prices at that date. The trajectory of efficient cost will typically depend on:

- the rate of growth of output. The output being regulated is typically produced in conditions of natural monopoly, which normally means that there are increasing returns to scale (see Chapter 22 above). This in turn means that unit costs fall as output rises. When it rises very fast, as has been the case in the telecommunications traffic as a result of broadband, this may be a major effect. This issue can be addressed by estimating the degree of economies of scale in the sector in question, possibly on the basis of past observations of cost changes. But such observations will also be affected by the two additional factors listed below.
- the level of cost reduction of best practice producers. Costs will fall in most sectors as a result of technological progress, for example developments in the use of information technology. Sectors will vary in the rate at which such developments are attainable by firms which are 'on the frontier', or at the theoretical limit of efficiency. Technical advance has probably been faster in telecommunications, as a result of the application of digital technologies, than it has in water, where advance occurs much more slowly.

[10] Competition Commission, *Water Merger References* (London, 2004).
[11] M. Cave, *Independent Review of Competition and Innovation in Water Markets* (2009).

Again, analysing past experience and projecting it into the future can be helpful here, provided the impact of other factors is eliminated.

- the gap at the start of the price control period between a regulated firm's actual performance and best practice. This is likely to be large at the start of operation of incentive regulation. If price caps work as they should, it should diminish over time. Where a gap exists, the regulator has to decide how quickly it is reasonable for it to be closed. This might be in the course of the period for which the price control is being set. If the gap is large, it might be longer.

Benchmarking is applied to the last of these problems. It operates on the basis of collecting comparable data covering several firms; adjusting for differences in 'environmental factors', or factors outside the firms' control which affect their costs; and choosing a particular observation or an average of observations to act as the target to which the regulated firm should aspire.

It is immediately obvious that this procedure does not yield an estimate of theoretical best practice or of the technological frontier. If all the observations are of inefficient firms, the best that comparisons can deliver is a 'least worst' observation. If, as usually happens, the whole sample is subject to some kind of dysfunctional regulation (incorporating elements of cost-plus, for example, which may encourage inefficiency), this can be a serious problem.

We will discuss two examples of benchmarking: first an example based on international benchmarking in the telecommunications industry; then benchmarking in the water and electricity sector in the UK.

It is the practice in New Zealand, when a network input in telecommunications is mandated to be made available by the incumbent to its competitors, for the regulator to set an initial pricing principle based on benchmarking, which is then followed if appropriate by a full cost-modelling exercise. In the case to be reviewed here, in which a benchmark was sought for the price of unbundled local loops (the annual cost of providing a copper connection between end users' premises and the local telephone exchange), the regulator, the Commerce Commission, was required to undertake 'benchmarking against prices for similar services in comparable countries that use a forward looking cost-based pricing method'.[12]

The procedure involved the following steps:

(a) Identify countries in which similar services were provided.
(b) Eliminate those countries that do not use a forward-looking cost-based method.

[12] New Zealand Commerce Commission, *Standard Terms Determination for the Designated Service Telecom's Uunbundled Copper Local Loop Network*, Decision 609 (7 December 2007), 20–32.

(c) Select comparability criteria to identify comparable countries within the group which used a forward-looking cost-based method (and provided similar services).
(d) Apply benchmarking to that group of countries.

Application of the first two tests left 15 country observations, as well as 51 observations from the 50 states in the USA and the District of Columbia.

Statistical tests were then applied to identify which factors appeared to affect costs (or cost-based prices) in the sample. This revealed a clear and strong relationship between the unbundled copper loop prices and the proportion of urban population, and weaker relationships between the same prices and the number of lines per 100 population and population density. A search was then made of the data to identify countries or states which exhibited values of these three variables similar to those observed in New Zealand. Eleven were found.

The cost-based prices in these 11 jurisdictions are in local currencies and need to be converted into New Zealand dollars at an appropriate exchange rate. This was done at an average of the exchange rate over the past 10 years at the Purchasing Power Parity (PPP) exchange rate.[13]

In this case, the Commission adopted the median of the 11 rates (here the sixth highest or sixth lowest). In earlier exercises, it had chosen a different point in the sample; but in this case it gave reasons for choosing the median.

The second example is of the use of comparative analysis in the electricity supply and water and sewerage industries in England and Wales. The benchmarking here is done on a national basis, and is made possible because the industry is structured regionally, with each regional electricity company or water company serving a specified area.[14] This simplifies the process, amongst other things by removing the need for exchange rate conversions.

In the electricity and water industries, benchmarking has been used at the time of periodic price reviews. Essentially, the regulator has sought to identify, on the basis of comparative cost observations, and after adjustment for environmental factors, which firms are relatively efficient and which are relatively inefficient. Because the sample is small, it is not possible to eliminate divergent observations as was done in the New Zealand case above. Instead, all observations are used and attempts are made to identify and remove the effects of environmental variables.

This can be done in various ways. Figure 26.2 shows information which might be collected about the average costs of supplying water to different areas, characterized by different population densities. The minimum costs,

[13] A PPP exchange rate is one which makes a fixed basket of goods and services cost the same in both countries.

[14] In fact, there are ten water and sewerage companies in England and Wales, and an additional nine water-only companies.

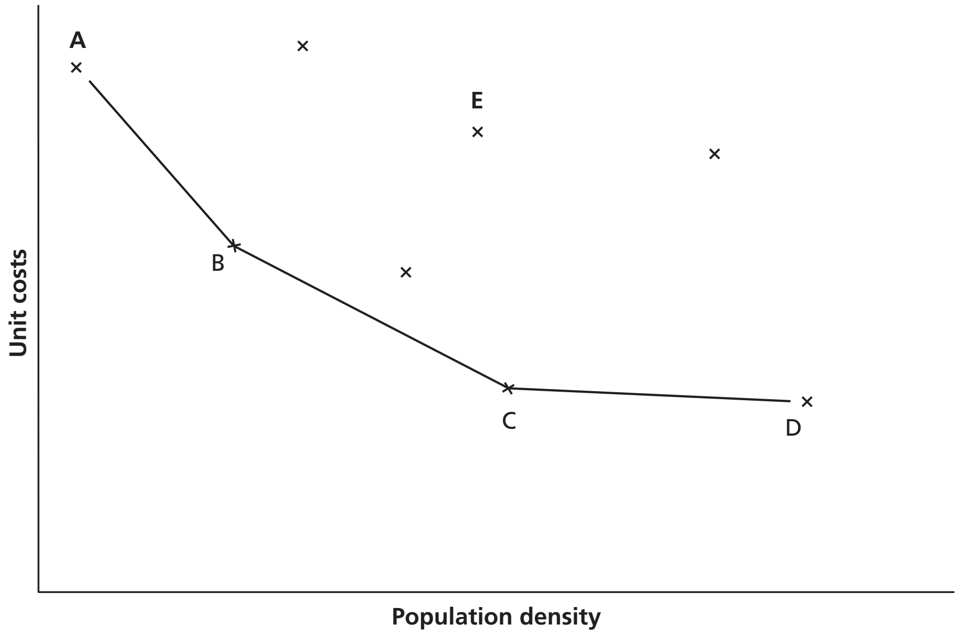


**Figure 26.2.** Identifying the efficiency frontier
Each × represents the population density and unit costs of an operator.

known as the efficiency frontier, are shown by the line in Figure 26.2 , which is found by connecting the lower envelope of cost observations. Other operators can then be graded on the basis of the proximity of their cost observation to the frontier. Firm E, for example, is far from the frontier, suggesting the existence of a considerable inefficiency gap, and scope for ‘catch-up’. The regulator would, therefore, be justified in assigning to firm E a relatively high value of X in the RPI−X price cap formula. Operator B, by contrast, is on the frontier and might be assigned a value of X which reflected only the trend in cost reduction available to an efficient operator, ignoring ‘catch-up’.

These, or similar, techniques have been employed by the UK water and energy regulators in their price control reviews for water and sewerage companies and for regional electricity companies. Inevitably, there are disputes over which relevant environmental factors should be taken into account. For statistical reasons to do with the limited number of observations available, only a relatively small number of environmental variables can be accommodated.[15] This gives firms an opportunity to promote their own favourites—those which show their performance in the best possible light. The regulator has to make its own decisions as to which approach to adopt.

[15] This problem can be resolved if it is possible to assemble and use a ‘panel’ of data for several years for each company. See S. Kumbhakar and A. Horncastle, ‘Improving the Econometric Precision of Regulatory Models’ (2010) 38(2) *Journal of Regulatory Economics* 144–66.

The procedures described above were used by Ofwat in setting its price controls for the period 2010–15.[16] Efficiency targets are set for both capital and operating costs. In relation to operating costs, all observations fell in the top three of bands A to E, and three-quarters of these were in bands A or B. Where firms fell short of the assumed efficiency frontier, it was assumed that they would make up 60% of the shortfall in the five-year price control period. The catch-up factors range from 0 to 2.9% a year for water and from 0 to 2.2% a year for sewerage.

The regulator found that the tendency over previous price controls for firms' efficiency levels to converge was not exhibited over the 2005–10 period, possibly because of changes in incentives which gave good performers in 2005 an enhanced incentive to improve their performance.

## Yardstick Competition

Benchmarking is a tool available to the regulatory agency to assist it in setting forward-looking cost-based prices. But it can be taken further to represent a complete mechanism for setting price controls. In this form it is known as yardstick competition. This involves placing similar firms in competition with one another with respect to their cost levels, even if they are not competing in the same services market.

To explain how it works, we suppose that there are 100 identical towns served by identical water companies. Clearly, a regulator could try to establish the efficient costs of a representative company, and set prices on that basis. However, this comes up against the regulator's problem that the firms probably know more about their costs than it does—the problem of informational asymmetry. It also fails to exploit the fact that many observations are available. As an alternative, therefore, the regulator could proceed as follows:[17]

(i) Collect information on the actual cost of providing water by each of the 100 companies;
(ii) Allow each company to charge a price for water equal to the average cost of the other 99 companies.

The beauty of this arrangement is that each operator is set a price which depends not on its costs but upon the costs of the other operators. Its

[16] OFWAT, *Future Water and Sewerage Charges 2010–2015: Final Determinations*, 2010, pp 106–14. See also OFWAT, *Scope for Efficiency Studies*, 2009.

[17] This approach was first formalized by A. Shleifer, 'A Theory of Yardstick Competition' (1985) 16 *Rand Journal of Economics* 319–27. See also M. Armstrong, S. Cowan, and J. Vickers, *Regulating Reform: Economic Analysis and British Experience* (Cambridge, 1994), 74–7.

revenues are thus detached from its costs, in the manner of the 'high-powered' price caps discussed in Chapter 25. If the company is unusually efficient, its costs will beat (i.e. be lower than) the average of the rest, and it will make good profits. If its costs are above average, it will make a loss. Its revenues do not depend in any way upon its own costs and so it has the maximum incentive to reduce them. The process should thus drive all operators down to the most efficient costs, with prices set accordingly.

Unfortunately, a number of difficulties lie in the way of implementing this regime. The first arises because prices normally have to be set before the cost observations are made. This can be overcome by introducing a lag, so that this year's prices are based upon last year's average costs, possibly adjusted to take account of expected productivity gains.

Second, there is the risk of collusion. If the operators organize together and agree to maintain their costs at an unnecessarily high level, each will be entitled to a correspondingly higher price, and will be spared the effort of producing efficiently. If the number of firms involved is small, then this will be a serious danger, but, as in other contexts, the risk of collusion diminishes as the number of firms grows.

Third, there is the obvious problem that regulated firms typically do not provide their services in identical circumstances. The areas they serve differ in terms of topography, factors such as climate and soil, and the level and structure of demand: both the size of the population and the breakdown of demand between business and residential users of services will vary from place to place. These factors will influence unit costs in ways which should be taken into account in setting prices. It would be possible to estimate the relationship between environmental factors and costs in the manner described in the previous section, use that estimated relationship to approximate the costs of all firms in a uniform or standard environment, allow each firm to set a price equal to the average of such standardized costs, and then adjust each price back to match the specifics of each firm's own environment. But this takes us some way from the simplicity of yardstick competition.

## Conclusion

Efficiency and innovation are key to a successful regulatory regime. This chapter has first discussed ways in which incentives can be designed to encourage efficiency and innovation; this basically involves moving away from cost-plus regulation. Competition of various kinds can also be deployed to encourage innovation.

We then examined how regulators can collect information which helps them set stretching but realistic efficiency targets for firms within the framework of a price cap. It is clear that benchmarking on an international basis can provide a solution. Unlike the approach of yardstick competition, it relies upon a set of judgements made by the regulator—judgements which firms are likely to contest. Nonetheless, benchmarking has been successfully applied as either a temporary or a permanent feature of price controls throughout the world. It has thus played an auxiliary role in implementing what has become a very popular form of incentive regulation.