

Incentive regulation and multi-year price controls: an application to the regulation of power distribution in India*

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Abstract

There is a perception among potential investors in electricity distribution projects in India that the price-setting methodologies employed by regulatory agencies are not conducive to long-term investments. Although regulators acknowledge the problem that present approaches lead to, they believe that the available information base does not support the development of credible multi-year tariffs. This paper evaluates whether this constraint is a barrier to the implementation of an incentive-based methodology and shows that this need not be the case. An IBRC (incentive-based revenue and cost pass-through) hybrid methodology that rewards companies for improvements in efficiency for cost items under their control is developed. The robustness of this approach is evaluated given the database of information available to regulators in India. These results are more generally applicable across other sectors and in other countries.

* The work is that of the authors and does not necessarily reflect the views of their respective institutions. This paper draws on work previously published as a mimeo *Setting multi-year tariffs in India: an assessment of some options* in October 2000 by Alexander and Harris. Alexander's work on this project commenced while employed by the Private Participation in Infrastructure Group within the World Bank.

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Introduction

In 1999, the Government of Orissa privatized the distribution assets of GRIDCO (Grid Corporation of Orissa) selling a controlling equity share in four companies. Three of these were sold to the Bombay Suburban Electricity Supply Co. Ltd and the fourth to a consortium lead by the AES Corporation. A number of other states, including Andhra Pradesh, Karnataka, and Uttar Pradesh, have announced their intentions to privatize parts of their distribution systems. The Prime Minister's Economic Council has also recommended that the privatization of distribution be implemented by state governments to reduce the high levels of theft and other non-technical losses seen today in India.

However, potential operators of these distribution assets have expressed concern at the lack of clearly defined paths for the prices that they will be allowed to charge to customers. SERCs (state electricity regulatory commissions) in India have thus far set prices on an annual basis, although some performance-based incentives have been introduced. This reflects their concern that the existing information base does not support the development of sufficiently accurate multi-year tariffs, making it likely that either excess profits would be made or companies would make high losses and ask the regulator to reopen the price control. Either of these outcomes could damage the credibility of the regulatory process.

In the next section, we review the present legal framework and the existing approaches to price setting by SERCs. Thereafter, the main approaches to providing multi-year price paths are reviewed. Following this, their applicability to conditions prevailing in India is reviewed. A methodology is developed around an IRBC (incentive-based revenue and cost pass-through) concept, which provides companies with incentives to reduce costs under their control and which passes on to consumers increases or decreases in costs outside of their control. Finally, the robustness of this approach under Indian conditions is evaluated. It should be noted that this paper concerns itself with the issue of creating incentives within a pricing regime, it does not tackle the following important issues.

- The cost-reflective nature of existing and future tariff levels
- The structure of tariffs.

Both of these are important issues that must be addressed but which do not directly impact on the overall design of the incentive regime as discussed here.

Price regulation of distribution in India: legal and regulatory framework and approaches adopted to date

Prior to the privatization in Orissa, India had substantial experience with private ownership and operation of distribution systems, with private electricity companies¹ regulated as licensees under the Sixth Schedule of the Electricity (Supply) Act, 1948. In essence, this schedule sets out that on a year-to-year basis, the profit earned by an operator should not, as far as possible, exceed the amount of reasonable return. The definition of a reasonable return is set in relation to prevailing government interest rates and the asset base.²

Reform legislation from the 1990s has allowed regulators to incorporate other factors into pricing decisions to provide these incentives. The Orissa Electricity Reform Act, 1995, specifies the existing legislation as one factor to be considered by the OERC (Orissa Electricity Regulatory Commission), but also includes the interest of consumers and other factors related, *inter alia*, to efficiency and good performance. The Act also requires the OERC to record its reasons for deviating from the Sixth Schedule in writing. The Andhra Pradesh Electricity Reform Act, 1998, adopts similar wording. The Electricity Regulatory Commissions Act, 1998, of the Government of India also allows deviation from existing legislation to promote efficiency, reflect the cost of service, and safeguard consumers. The new legislation, therefore, explicitly allows regulators to deviate from the Sixth Schedule. In practice, SERCs have followed the format of the Sixth Schedule closely,³ but have deviated substantially in that the full costs of supply are not reflected in tariff orders (Table 1).⁴

There are variations in the level of revenue reduction, sometimes explained by commitments to improve efficiency or by government subsidies. There are also differences in the approaches taken by SERCs to adjust the revenue sought by utilities. However, the pattern of substantial adjustments is consistent, as is the reliance on annual tariff reviews. SERCs have not yet adopted multi-year tariff orders, although these have been discussed in recent tariff orders and the UPERC (Uttar Pradesh Electricity Regulatory Commission)

¹ These are located in Ahmedabad, Kolkata, Mumbai, and Surat.

² See Ahluwalia (1999) for a fuller explanation of the application of the Sixth Schedule.

³ This includes the details of the calculation of the asset base and the rate of return.

⁴ It could well be argued that Table 1 underestimates the scale of the problem. State-owned companies may well be influenced to ask for inadequate revenues to avoid the need for tariff increases, and the lack of auditing means that the out-turn is not well known.

Table 1 Reductions in revenue (billion rupees) imposed by state electricity regulatory commissions

	<i>Orissa 1998/99</i>	<i>Orissa 1999/2000</i>	<i>Andhra Pradesh</i>	<i>Maharashtra</i>	<i>Uttar Pradesh</i>
Revenue requested by utility	21.68	23.59	96.81	131.55	86.87
Revenue allowed by regulator	17.84	18.43	90.39	119.46	75.41
Total reduction in revenue	3.84	5.16	6.42	12.09	11.46
Total revenue reduction as percentage of revenue requested	17.7%	21.9%	6.6%	9.2%	13.2%

Note Revenue does not include an adjustment for non-tariff income.

Source Ahluwalia (2000)

provided incentives based on sharing of revenues if the company were to beat a set of pre-defined loss targets. With the exceptions of the Delhi Vidyut Board and the Kanpur Electricity Supply Board, no regulated entities have asked an SERC for anything resembling a multi-year price control.

The proposed Electricity Bill 2001 may well give regulatory commissions greater freedom to develop different principles for pricing. However, SERCs will remain concerned about inadequate data causing multi-year price controls that will damage the credibility of the regulator. Present approaches, however, do not provide a clear picture of how regulators are going to set prices, and consequently increase perceptions of regulatory risk. Finally, the lack of a clearer path for both prices or revenues means that efficiency improvements that require investments that have a payoff period of more than one year might be deterred.⁵

In the remainder of this section, we review two key issues relating to this: the quality of the information base used by SERCs in their price reviews, in particular loss levels (both commercial and technical) and the efficiency improvements generated by private distribution companies. The latter is of particular interest given concerns that a multi-year price control may prove too lax for a company and that excess profit will be made. For this, we draw largely on experience

⁵ What is evident is that any incentive created through these PBR (performance-based regime) schemes may well be of a limited duration. At the most, annual price reviews mean that any benefits of beating the incentives are quickly lost to consumers—forcing PBR to become more of a stick than a carrot since the benefits of the carrot only last for a year. This is true, for example, for schemes proposed by SERCs in India, which propose sharing of revenues from beating a loss reduction target, but do not provide price or revenue projections to provide a likely monetary value for these benefits.

from Orissa, which has a history of regulatory reviews of prices dating to 1997 and experience since 1999 of private management and ownership of distribution.

In their analysis of tariff filings, SERCs have focused on the difficulty of getting good estimates of the total losses of the regulated utility. Most states see metered sales at less than 50% of total sales. In its tariff order of May 2000, the APERC (Andhra Pradesh Electricity Regulatory Commission) said it was not possible to estimate the level of losses and to fix an appropriate loss target, and that the only reliable target to use was the level of billing (APERC 2000). The most recent OERC tariff filings, which were completed in January 2001, still exhibit a considerable amount of uncertainty over the loss levels reported by the four distribution companies.⁶ This suggests that it will be difficult in practice to use loss levels to precisely target a rate of return, particularly on a relatively low asset base.

Evidence submitted by the licensees to the OERC suggests a relatively slow decline in the level of losses, due to the poor initial state of the state electricity board (and successor company) grids, difficulties in instilling a commercial culture in staff, and the initial low levels of metering. The Central Electricity Supply Company of Orissa, one of the distribution companies, has reported a reduction of losses of around 3% a year, to a present level of around 43%. The other licensees have been reducing losses at a slower rate. However, billings and, in particular, collections have increased substantially faster, on average by nearly 20% over the period 1999/2000. Despite this, none of the companies have been able to reach cash break-even as of this date.

This suggests that profits in excess of those forecast are unlikely in the initial years of privatization in India and that the difficulty in accurately measuring key parameters such as losses needs to be taken into account in designing an appropriate regulatory approach.⁷

Options

While there is a continuum of price methodology options, they are usually simply classified under the following two broad headings (covering the extremes of the options).

- 1 Cost-plus (or rate of return), where the allowed costs are calculated on the basis of costs actually borne by the operator.

⁶The OERC comments that 'The authenticity of the loss level projected by the licensee has not been supported with verifiable data.' (OERC 2001, paragraph 7.3.2). The OERC then requested the licensee to perform surveys on feeders with metering of all consumers.

⁷Lack of information about losses is not unique to India. Many countries face similar problems. One example of a regulator trying to tackle this problem is provided in Regulation and Supervision Board (2001).

- 2 Incentive-based (price caps, revenue caps, etc.), where the allowed costs are calculated, at least partly, on the basis of external information.

These basic options have been discussed in detail in many other places (for example, Armstrong, Cowan, and Vickers [1994]; Alexander, Mayer, and Weeds [1997]). So this section will focus on some of the other factors that can be included within the basic price control. These can be split into two separate areas.

- 1 The allocation of costs between controllable and uncontrollable elements, and the use of a pass-through mechanism for the latter.
- 2 Variants on the basic incentive mechanism through sliding scale (profit-sharing) and revenue controls.

Controllable costs

When considering a regulated company, it is useful to consider the split of costs into those that the management of the company can control and those it cannot. A regulatory commission should be seeking to provide the owners and management of a company with incentives to cut costs that are under their control and to insulate them from abnormal profits and losses arising from costs that are outside their control. For an electricity distribution company, costs are likely to be split along the lines shown in Table 2. Table 3 shows the relative importance of each type of cost element data using data from Andhra Pradesh.

As Table 2 shows, the degree of controllability is often far from a simple statement of being fully controllable or fully uncontrollable. Rather, two situations can arise.

- 1 Some elements of a cost may be controllable; for example, the basic wage rate may be set by general macro-economic conditions but the rate of wage inflation may be partly under the control of management.
- 2 The degree of controllability may depend on the timeframe involved. For example, rates associated with buildings may be seen as a fixed uncontrollable element since changing them would involve moving the office. This may not be possible in the next year, but could be possible over a 5-year period.

Determining how to allocate costs between controllable and uncontrollable is not straightforward. However, it is possible to do, and, as Table 3 shows, over 30% of the costs of an illustrative Indian distribution company can be considered as controllable. As such, providing incentives to reduce these costs can have a significant impact on prices.

Table 2 Initial thoughts on the degree of controllability

<i>Variable</i>	<i>Degree of control</i>	<i>Comment</i>
Demand (see comment on losses below)	Limited	Clearly the company can at the margin affect demand, but much will depend on general economic conditions, etc. In the Indian context, the interaction with loss levels has to be considered.
Generation and transmission costs	Very limited	Depends on the market model adopted. However, under the existing conditions in India any distribution company is dependent on a single buyer achieving efficiency in power purchase. If a multi-buyer model is adopted, greater power is passed to the company, but this may be initially limited depending on whether vesting contracts are put in place and over what period they cover.
Losses	Substantial	Assuming that the company can exercise control over employees, they should have control over this variable. As noted in the introduction, the high level of losses in the Indian power sector has led to their special treatment by regulators.
Labour costs	Some	As noted above, this cost category can be split into several aspects. The company clearly has control over some of these aspects. Exactly how much control will depend on the conditions set at the time of 'privatization' covering issues such as staffing and pay bargaining.
Material costs	Some	While material costs will be partly determined by the state of the existing assets (something outside the company's control), the company controls the processes by which it purchases spare parts and is able to control some of the substitutability between investment and repairs.
Rent and rates	Very limited	In the short term, it is difficult for a company to change the rent and rates bill. However, in the longer term, it is possible to shift towards low-cost buildings, etc.
Depreciation	Limited	Although much of the depreciation bill depends on the age of the assets and their costs, a company has the opportunity to argue that its assets should be revalued or asset lives altered. While these issues are then controlled by accountants, etc., outside the direct influence of the company, experience has shown that companies can have an influence on this.
Required profit	Some	If an optimum cost of capital (or even cost of equity) position is adopted by the regulator, companies have an opportunity to beat this target by finding cheaper sources of funding, possibly through manipulation of the tax position.
Investment costs	Some	Investment can be split into several aspects. The quantity of investment will depend on several factors including demand, quality, service expansion, and environmental obligations. Most of these are outside a company's control. However, the cost of investment may be partly affected by a company's decisions, as may the timing—there may be a trade-off between some repairs and investments or some demand-related investments may have some flexibility as to when they have to occur.

Table 3 Allocation between controllable and uncontrollable costs for an illustrative Indian distribution company

Element	Controllable	Initial cost (Rs million)	% of total costs
Controllable opex	Yes	9901.3	9.6
Uncontrollable opex	No	6044.1	5.9
Investment	Yes	7150.7	6.9
Required profit (based on 16% return)	Yes	1003.5	1.0
Generation and transmission charges	No	79249.9	76.7
Electricity distribution losses ^a	Yes	20605.0	19.9

^a Losses are part of the overall generation and transmission charge, but the company has some control over it.

Note These costs are an amalgamation of individual cost items.

Refinements to the incentive regime

The regulatory system can be designed such that excessive profits are not earned. This is unlikely to be an issue in India in the short term. Significant debate was sparked in the United Kingdom when it came to light that companies were earning excess profits, which in many cases reflected in large pay increases and bonuses to management. One explanation was that initial price controls were lax, including an underestimation of demand that subsequently benefited the companies. Another cause was a series of events outside the control of the companies leading to significant cost savings that were captured by investors rather than consumers. The lessons from this experience were that regulators had to focus more on getting the controls right and ensuring investors only benefit from actions under the control of the managers of the company. Probability of excess profits can be controlled by

- ensuring companies only benefit from controllable cost savings—so making uncontrollable cost movements a pass-through item
- limiting the profits of the company through a profit-sharing/sliding scale regime
- focusing on controllable total revenue rather than on controllable cost for a unit
- placing limitations on revenue through a sliding scale regime
- re-basing an element of the control to capture costs diverging from levels forecast in the review.

The first of these steps builds on the earlier discussion on controllable costs. The others are described below.

Sharing of profit

This limits the profitability of a company once it moves above or below an acceptable range. For example, the acceptable range may be 15%–17% and then anything outside that range is ‘shared’ with consumers on an agreed basis. Here, if the sharing rate was 50% and the company earned 10%, then a mechanism would be needed to allow profits to increase to 12.5%. If profits were 20%, a mechanism to reduce profits to 18.5% would likewise be needed. These mechanisms can be a correction factor applied to the following year’s prices as utilized in the classic profit-sharing example of New York Telephone, or a stabilization fund, as used in Hong Kong. The properties of profit-sharing have been studied in papers such as Mayer and Vickers (1996) and the case for using this approach is far from proven, and is discussed in the following section.

Revenue caps

An approach that has gained support in the United Kingdom is that of focusing on the total required revenue for a business, based on demand assumptions, and then setting this on a CPI-X (consumer price index – x) based approach. This still provides incentives for cutting costs but limits the upside for management to those factors not under their control, such as unanticipated demand increases. It is still possible for a company to earn excess profits as a result of an unanticipated demand increase, but this is limited because any over- or under-recovery of revenue is corrected for the following year normally with financing of costs or interests included.

Sharing of revenue

This approach captures the revenue focus from revenue caps but then treats revenue like profits. Thus, if revenue is above a certain point some of the revenue is returned, and if below, higher revenues are then allowed for.

Rebasing the control

One suggestion that has recently been put forward in the United Kingdom as a solution to information problems is that annual mechanistic rebasing should occur (Mayer 2001). Uncertainty regarding assumptions about the future means that even well-processed regulatory decisions can lead to significant excess profits. As an alternative to reopening the whole regulatory decision, Mayer proposes a mechanical solution that maintains incentives for outperforming other companies in the sector while correcting for generic misassumptions. This solution depends on ensuring that the average

industry market value is equal to the average industry regulatory asset base—a semi-replacement cost valuation of the assets. This ensures that the average return earned is equal to the industry cost of capital, but divergences between companies within the industry are still possible.

Choosing between these variations of the basic incentive approach depends on having a framework for trading off the advantages and disadvantages of each refinement, especially since many of the refinements are not mutually exclusive.

Framework for choosing the appropriate approach

When assessing the options and their applicability in any specific case, it is important to consider the following criteria.

- *Incentives for efficiency savings* What are the management rewarded for and what perverse impacts might incentives for efficiency savings have? This is also linked to the allocation of risk between the various stakeholders, in turn partly dependent on the cost structure of the company and the controllability question.
- *Incentives for regulatory gaming* Regulatory gaming is the situation whereby withholding information, or presenting information in a specific way, will be advantageous to the company and lead to it receiving a more favourable outcome. For example, under a price cap any growth in demand beyond that originally forecast increases profits for the company, giving it an incentive to underestimate demand growth at the time of the regulatory review (for a discussion of the various ‘gaming’ incentives, see Alexander and Shugart 2000) (*Risk, volatility and smoothing: regulatory options for controlling prices*).
- *Political acceptability* Although regulation is often independent of politics, the reality is that politicians may become involved if excess profits (losses) occur.
- *Ease of implementation* Ease of implementation takes two forms.
 - Whether the regulatory body has the skills, information, and resources to calculate and monitor the application of a regime.
 - Whether the costs of an option are greater than the benefits. If a refinement will lead to only a small improvement in incentives yet is costly in terms of information and monitoring, then it is likely that the refinement should not be applied. Regulation should only be undertaken when the benefits are greater than the costs.
- *What new information is required each year* Price and revenue caps require less information within a price review, being restricted to that required to check where average prices and total revenues

(respectively) are relative to the annual level specified in the cap. Profit-sharing requires the annual calculation of returns and increases the level of regulatory risk because more variables can be reviewed with the possibility of investments or costs being disallowed.

- Extent to which the control formula can incorporate new data on factors outside the control of the company.

Having established a set of criteria by which any proposal can be measured, it is now possible to determine what, in our opinion, is the appropriate solution for electricity distribution in India. Clearly, any specific case should be considered on its own merits, but our overall view of the sector is given in Table 4.

Table 4 Assessment of options against the criteria

Criteria	Comment	Viable options
Cost allocation	The majority of the controllable costs is fixed once the demand forecast for the coming period is known. When losses are considered a controllable cost, these should not be considered as a fixed cost.	Focus on revenue-based approaches rather than price-based ones.
Efficiency savings	Possible for the majority of direct distribution costs—about 50% of the total electricity cost (once distribution losses are included as a distribution cost)	Incentive-based systems are appropriate.
Potential for gaming	Significant potential, especially in relation to losses and demand.	Focus on revenue-based approaches.
Political acceptability	Need to ensure that significant excess profits are not earned.	Focus on profit-sharing and revenue-based approaches. Shorter periods e.g. 3 rather than 5 years to control an option.
Implementation	Information availability is a problem. Existing resource base for regulators is limited, making monitoring difficult.	Find systems that are mechanical once the initial multi-year tariff is set. Concern about applying profit-sharing owing to the subjective nature of profits.
New information issues	Expectation that new information will become available over the next 3–5 years.	Ability to improve estimation of future costs, especially in relation to losses, suggests a shorter period might be appropriate. Profit- or revenue-sharing mechanisms could also be used to deal with extreme outcomes. Mechanisms for re-basing by independent review of key variables could also provide some opportunity for adjusting the values of certain parameters, e.g. losses.
Impact of additional external factors	Given the nature of the state of reform in the sector it is possible that future shocks will occur.	Provided that the shocks are on the uncontrollable costs this will not be an issue if cost pass-through is adopted.

Although profit-sharing meets some of the requirements of the criteria, it does not meet all. This is especially true with respect to potential for gaming, implementation, and low asset base.

- *Potential for gaming* Profit-sharing may lead to companies having incentives to (1) manage accounting numbers to lower profits (lower profits are preferable in all cases except inasmuch as investors may downgrade a company owing to low reported profits) and (2) delay efficiency savings if by smoothing gains less, or none, of the gains have to be immediately shared with consumers.
- *Implementation* The need to directly establish profitability, the impact of uncontrollable costs on profitability, and the amount to be shared will ensure that intrusive annual regulation will be required—something that will place undue pressures on the developing regulatory commissions in India and increase the amount of regulatory uncertainty in the system
- *Low asset base* Most distribution companies in India have low asset bases compared to revenues and costs, given present valuation approaches and historically low levels of investment. As an example, a one per cent reduction in losses (translated fully into increased revenue) could lead to a near-doubling of the rate of return. A profit-sharing scheme will have presentational difficulties since the bands may appear very large on paper when expressed as a percentage of assets. Reducing the band would dampen incentives to reduce losses.

A system based on a revenue cap with cost pass-through for non-controllable costs would seem most appropriate given its stronger ability to allow real incentives for the company while controlling for political acceptability. It would also appear to be more easily implemented—the only annual adjustment should be mechanical.

A partial solution: an incentive-based revenue and cost pass-through methodology

Given the discussion in the previous section, our preferred approach will be one that focuses on revenue but allows uncontrollable costs to be passed through. Consequently, if revenues were forecast for 5 years, the only annual adjustments would be to incorporate

- inflation
- efficiency savings (the 'X' value)
- over- or under-recovery of revenue compared to the control
- mechanical correction for out-turn uncontrollable costs being different from forecast.

The control could look something like

$$R_{t+1} = R_t \times (1 + CPI - X) - C_t - A_t$$

R is the level of revenue,⁸ CPI is the level of inflation, X is the expected efficiency gain in controllable costs (corrected for the fact that controllable costs are only one element of the required revenue), C is the standard revenue-cap correction for over- or under-recovery of revenue (for example, if demand, or the composition of demand, was different from that forecast), and A is the adjustment for uncontrollable cost elements, the elements of which are defined upfront at the start of the price control.⁹ The distinction between C and A is relatively arbitrary. A simpler model could be proposed where those two elements were combined. However, for the sake of clarity in the argument the model has been specified with the two separate elements.

Building on Table 3, the items that would be treated as uncontrollable, and hence subject to a pass-through, would be generation costs and part of the operating costs, which account for over 80% of total costs in this example (with generation costs by far the dominant element).¹⁰ These would be forecast forward for the length of the price control period, but changes in these costs relative to forecast values would be reflected annually through the formula given above. It should be noted that this does not assume an immediate transition to full cost recovery, which would be unrealistic given the present situation in India. An increase in revenues towards full cost recovery, based on assumptions about improvement in efficiency, would need to be incorporated in the model.

To illustrate how the model would work, we consider three scenarios.¹¹

1 Out-turn demand diverges from forecast demand.

⁸In the context of India, where billed and collected revenue are quite different, it is worth emphasizing that the target should be set on billed revenues.

⁹Both C and A should be corrected for the level of interest so that the company is no better or worse off in real terms.

¹⁰The tariff being considered here is the final retail tariff, which comprises generation, transmission, distribution, and supply costs. If we were to just focus on the distribution and supply elements, then the vast majority of costs would be controllable. However, in the Indian context it seems most appropriate to consider the final total retail tariff. Our arguments would not be changed if we just focused on the distribution and supply costs of the final tariff: all that would happen is that the equation would be written slightly differently.

¹¹These and other scenarios are 'quantified' through simple financial modelling in Alexander and Harris (2000) (*Setting multi-year tariffs in India: an assessment of some options*).

- 2 Planned investment announced at the price review is not undertaken.
- 3 Losses prove easier to deal with than anticipated by the regulator.

The first of these is the classic situation that revenue caps were designed to address. In the following year, the *C* term adjusts revenues so that the over- or under-recovery of revenue is corrected for. So, while the company may appear to make exceptional gains or losses in the year of the divergence, the following year, *ceterus paribus*, a compensating level of return will be made. Thus, if demand was underforecast and actual revenues were 100 million dollars more than expected, although the company reports an additional 100 million dollars of profit in this year, the following year will see a decline of 100 million dollars (plus an imputed return) in profits, making the average return equal to that forecast.¹² The company will have bought more energy in bulk but will not be penalized since this is treated as uncontrollable and hence subject to an automatic pass-through.

While determining the price control, it will be necessary for the regulator to determine, with inputs from the companies and other stakeholders, what an appropriate level of investment should be. This investment should be clearly linked to levels of quality of service. The company then has an incentive to deliver the quality of service at a lower than forecast level of investment, so that it is able to earn higher profits. If it is able to do so, revenue is unchanged but profits are higher. Equally, if delivering the agreed levels of service costs more than forecast, the company will suffer lower levels of profits. Divergences in investment from that forecast are an issue that has caused significant concern to regulators. One notable case was the 'clawback' of investment undertaken by the Office of Regulation of Electricity and Gas (Northern Ireland) in the late 1990s, which was subsequently supported by the appeals body in the United Kingdom, the Monopolies and Mergers Commission (Monopolies and Mergers Commission 1997). While the circumstances behind this action may have been unique, it does illustrate that investment must be considered carefully.

What happens if losses are reduced faster than forecast? In the simple model of the IBRC detailed above, the following outcome would occur. Since losses are lower than forecast, revenues will be higher—either because less electricity is required to meet the existing demand

¹² Of course, the reality would be a little more complex. There would be additional uncontrollable costs that would be incurred in the first year and then corrected in the following year that will mitigate to some extent the positive impact of unanticipated demand.

or because more units are now being collected. Under the revenue cap, this increase in revenue will be corrected for in the following year through a lower allowed level of revenue. Consequently, it would appear that there is no incentive to reduce losses beyond that forecast by the regulator, placing pressure on the regulator to provide credible estimates of what is possible in what is an informationally demanding situation. This is discussed in more detail below.

Implementation issues: is the IBRC approach too simple?

One of the problems with regulatory regimes is that the devil is in the detail. While it is possible to establish what, on the surface, appears to be simple controls to ensure appropriate incentive properties, often a whole raft of additional elements of the regime are grafted on to the simple equation. While this may be appropriate in some cases, all regulators should investigate whether the refinements provide more of an addition than the costs that they impose on the regulator and the company. This sort of cost-benefit analysis of regulation is regularly undertaken in countries like Australia and provides a useful touchstone for regulators and ensures that 'regulatory creep' does not occur.

Two areas of concern regarding the incentives inherent within the IBRC approach arose when considering the scenarios illustrating the operation of the system. This section of the paper considers the possible solutions to these concerns and sets out the pros and cons of making the IBRC approach more complex to overcome these concerns. Any specific application of this type of model should address each of these concerns in the context of the state or country to which the model is being applied. We outline here the options that can be followed if the issue is felt to be significant enough to require correction.

Investment

Finding an approach that adequately incentivizes investment is the Holy Grail of regulation. No regulator has yet achieved this situation, although some have moved closer than others to achieving this. Refinements to the simple IBRC approach to improve the positive incentives for investment without creating perverse incentives for under- or over-investment must be measured against the 'deepening' of regulation that is required to establish whether investments have been delayed for appropriate reasons, etc.¹³ Increased intrusion

¹³ Here, deepening should be translated as greater intrusion by the regulator on an ongoing basis requiring enhanced regulatory resources and greater reporting costs to the company.

would not be necessary if it was possible to determine an appropriate set of service indicators that could be accurately measured. A focus on outcomes would allow the regulator and company to agree on an appropriate investment programme that would deliver the desired outcomes and then give the regulator a measure of whether the company was failing to deliver its part of the bargain. Sadly, this clear link between investment and outcomes is not possible.

Some of the other approaches to dealing with divergences in investment are as follows.

- 1 Annual reporting of investment including an explanation of any divergence.
- 2 Detailed investigations of any divergence over the life of the price control period at the end of the price control period, with a correction to ensure that any unacceptable divergence is revenue neutral.
- 3 Shortening the price control period—making it easier to forecast the investment requirements over the period and so limit the opportunities for exploitation.
- 4 Excluding investment from the initial price control but then rolling-up actual investment and including it with an *ex post* adjustment at the end of the period to allow the recovery of prudently undertaken investment.¹⁴

It should be noted that these approaches are not necessarily mutually exclusive and may even have complementary effects.

The first approach requires greatly enhanced regulatory auditing resources. However, even this would be less intensive than present practices in India of reviewing annual investments before they are added to the rate base (along the lines of the 'used and useful' concept). Similar issues arise with the fourth approach. Rolling-up investment at the end of the period also raises questions about the ability of companies to meet the financing costs of the investment prior to the recovery of costs at a later date. It also introduces another potential source of regulatory discretion.¹⁵ Overall, the second

¹⁴ This approach has been adopted in Abu Dhabi and a variant, focusing only on unanticipated investment, has been utilized by OFWAT, the water regulator in England and Wales.

¹⁵ In Abu Dhabi, the approach of setting the price controls without regard to capital expenditure forecasts was discussed in a series of consultation papers and was applied with the agreement of the companies concerned. The process of consultation also identified the criteria to be used by the regulator when deciding whether actual expenditures should be included in the regulatory asset base. The *ex ante* publication of such criteria limits regulatory discretion. The regulator also satisfied itself that the approach to capital expenditure would not result in undue price volatility between price control periods.

approach is more appropriate—reviewing the last price control period as an input to the determination of the forecasts for the next price control period is a key element of the price determination process.

Given the relative importance of investment, especially when compared to the desire to create incentives and the significance of losses, it is probably not appropriate to limit the price control period to, say 3 years rather than 5. However, given that most distribution companies will need substantial investments, this might be an appropriate refinement of the IBRC in some circumstances.

Losses

The losses scenario showed that the IBRC provides no incentive to reduce losses beyond those forecast by the regulator. This raises some concerns in that

- information on losses is limited (as discussed earlier) and consequently regulators may find establishing credible and testing forecasts of losses difficult
- the lack of incentives means that improving the information database through companies striving to outperform the target will not occur.

Given the quantitative importance of losses within the financial framework of the distribution companies, the question of whether greater incentives for loss reduction should be incorporated into the formula must be addressed.

Several options are available for increasing the incentive for loss reduction. We consider two here—many others may exist, but these two serve to illustrate the approach to refining the model. These options are

- 1 any increases in revenue that are not associated with an increase in electricity purchases by the distributor can be kept by the company as higher profits and
- 2 a separate item relating to measured losses is introduced into the formula whereby losses are directly calculated and incorporated into the model.

Although both options provide incentives, they do this in different ways and have different information needs.

With an approach based around the level of revenue and electricity sales rather than having to directly measure the level of losses, the focus is on the impact. This approach tries to separate the two elements of movements in revenue, namely

- 1 increases or decreases in the level of demand and
- 2 improved collection of bills or reduction in technical losses.

To distinguish between the two revenue drivers, the level of electricity purchases is used. If demand is increasing and the level of losses is unchanged, then more electricity will have to be purchased. However, if for the same level of electricity purchases greater revenue can be recovered, this must be through a reduction in losses. As such, the company can be incentivized to reduce losses by applying this correction factor.¹⁶

Establishing the form of such a control is relatively straightforward. Revenue can be split into four elements.

- 1 The number of units of electricity purchased by the distribution company
- 2 The generation and transmission price per unit of electricity purchased
- 3 Distribution costs
- 4 Losses (comprising technical and commercial).

By considering the calculation of forecast and actual revenue using these elements, it is possible to get an estimate of the change in losses from those forecast. It is this impact that you would want to allow the company to retain. This estimate has to be derived from the total generation purchased information, owing to the lack of reliable metering data. Something like the following could be employed.

$$TG_t^f = [N_t^f \times G_t^f \times (1 + I_t^f)]$$

where TG is the total generation cost, N is the kWh collected from consumers as estimated by the company,¹⁷ G is the generation and transmission price per billed kWh, and I is the proportion of losses. The superscript f denotes a forecast figure and there is a time subscript t .

Any divergence in actual TG not explained by a divergence in one of these elements must be due to a change in losses, the element that we wish to isolate and incentivize the company to control.

It is possible to estimate the losses that actually occur by solving the equation

¹⁶ Some issues relating to the practical application of this methodology may arise if individual tariff levels are not established by the regulator. These implementation issues are not insurmountable and interact with the general revenue-cap elements of the control.

¹⁷ Ideally one would use actual sales but these are not readily verifiable in most states in India given low levels of metering.

$$I_t^a = \frac{TG_t^a}{N_t^a \times G_t^a} - 1$$

where *a* denotes an actual figure. The impact of the change in losses (*L*) can then be estimated and the company rewarded accordingly.

$$L_t = I_t^f - I_t^a \times N_t^f \times G_t^f$$

This approach relies on information reported by the company. Incentives for loss reduction are high, since the company effectively keeps the generation cost per unit of electricity—consequently, it may be appropriate to share the impact, although this does raise issues about incentives as noted above with other sharing systems. Since it is not possible to distinguish between reducing losses and selling more, the company may also get rewarded for demand increases.

The second approach would be to measure the losses directly. This would then allow a simple correction factor to be introduced, which captured the exact change in losses. This type of approach was modelled in Alexander and Harris (2000) (*Setting multi-year tariffs in India: an assessment of some options*), where losses were included analytically as a controllable cost, with reductions in losses over and above that forecast being kept by the company, and excesses above those forecast being borne by the company. This requires reasonably accurate measures of losses, arguably something that the companies have failed to provide, including those that have been privatized.

Losses are by far the most important of the controllable costs and consequently whatever incentives possible should be provided for their reduction. Correspondingly, we would recommend that the IBRC formula be recast as

$$R_{t+1} = R_t \times [1 + CPI - X] - C_t - A_t + L_t$$

L_t is a measure of the impact of changes in losses relative to the level of losses forecast. Initially we would recommend that the simple revenue-based calculation be used. This is limited in terms of the incentives it provides but is easy to implement. If the companies can start to provide improved information on losses then we would recommend moving to a more direct measure of the change in losses which provides greater incentives for the companies—if anything, this is a

good way of determining whether the investment in improved metering is worthwhile.

A third modification would be to move towards a price-cap regime, where a price per unit sold is established (with adjustments for changes in the per unit costs of uncontrollable cost inputs such as bulk power purchase costs). This would have the advantage that any increase in sales would be retained by the company, providing clearer incentives for loss reduction. This would, of course, suffer from the same deficiencies that were noted for price caps in the section on 'Framework for choosing the appropriate approach'. It could be argued, however, that in the short term, it would be a possible transitional option and that as long as companies were investing to meet demand and increase sales, they should not face an incentive regime that blunts their interest to do this.

Which of the options described above is suitable could be examined by modelling the impact of the different controls under various assumptions, including the accuracy of loss estimates.

Conclusions

This paper has attempted to show that it is possible to construct a multi-year price control formula for the Indian power sector which creates incentives for companies to operate efficiently, limit the benefits enjoyed by companies to controllable cost items, so keeping the return 'fair', provide forward-looking price paths that will help provide certainty to investors,¹⁸ and is relatively administratively light-handed. This can be done within the informational constraints that presently exist in the Indian power sector by focusing on information that is available and can be audited and by incorporating new information on parameters in the control formula as they become available.

Our initial IBRC model, however, is probably too simplistic. Losses are clearly an important issue and, as such, a correction for these should be introduced to provide enhanced incentives for loss reduction. This is one area where information is a constraint. Our proposal to overcome this is simple and consequently does not create as high a degree of incentive as would be achieved with good information on losses. However, the focus on a simple model makes implementation possible and also creates an incentive for the companies to improve their measurement of losses if this will be advantageous to the companies. As such it is a good model to determine the appropriate

¹⁸ Consumers also appreciate certainty about the price path since it allows them to plan future expenditure. Having prices that move significantly from year-to-year may make some budgeting decisions difficult for both industry and households. Providing certainty to consumers through a multi-year price path helps overcome this.

level of investment in metering that is required for each distribution company. There is no 'one size fits all' answer to the problems faced by SERCs. The solution developed in this paper is an illustration of the way in which some aspects of the problem can be considered and overcome.

At present, in India, high transmission and distribution losses and low levels of collection efficiency mean that present tariff levels do not provide a base for covering costs. Evidence to date suggests that reductions in losses and improvements in collections will not be rapid. There will be a need to introduce price increases while making realistic assumptions about efficiency improvements if private management and capital is to be introduced. It is important to note that there is no regulatory approach that can get around this difficulty. Whichever approach is adopted will need to deal with these fundamentals. The advantage of the proposed approach is that it sets out more clearly the revenue path for the company and provides incentives for improved efficiency.

There are a large number of issues associated with setting multi-year tariffs that this paper does not touch on and, clearly, a great deal of work is required to make this operational. However, one advantage of the proposed approach, as compared to present approaches, is that it frees up more time for SERCs to focus on issues such as the quality of service provided by the companies and their responsiveness to consumers.

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