Incentive Regulation and External Performance Measures: Operationalising TFP – Practical Implementation Issues

Further Report to Utility Regulation Forum

June 2001

CITIPOWER

Incentive Regulation and External Performance Measures: Operationalising TFP – Practical Implementation Issues

Further Report to Utility Regulation Forum

Prepared for general discussion by
CitiPower Pty
628 Bourke Street
Melbourne, Vic. 3000

Email: pfearon@citipower.com.au

June 2001

Preface

In its recently published Position Paper on the Review of the National Access Regime the Productivity Commission found that “Greater use of productivity-based approaches for setting price caps… would be desirable. Regulators should give priority to developing the external benchmarks necessary to implement such approaches”. CitiPower is heartened by such observations but notes that there is a widespread and poor understanding of the practical issues associated with productivity measurement, particularly in the context of external forms of incentive regulation.

CitiPower has prepared this Discussion Paper primarily in response to a general view that the debate should now move from the ‘philosophy of regulation’ to implementation issues. CitiPower trusts that this Discussion Paper will continue to promote informed discussion and policy development amongst industry, regulators and government.

Paul Fearon
General Manager Regulation and Strategy
CitiPower Pty
June 2001

Contents

1. Introduction

The Utility Regulators Forum has recently displayed interest in the role of external benchmarks in utility regulation. Most prominently, it commissioned a Discussion Paper on this topic entitled *Incentive Regulation, Benchmarking and Utility Performance.* CitiPower published a response to this Paper that supported the Forum's interest in the topic and its initiative in sponsoring relevant research. However, we also believed the Discussion Paper was too pessimistic about using external benchmarks in regulation. It also left an inaccurate impression about the challenges associated with computing some external benchmarks, particularly total factor productivity (TFP). Our response was generally well received by regulators and participants, which we believe is a hopeful sign. CitiPower has long believed that regulators and utilities generally share the same goals for regulation and differences regarding how best to achieve those ends can usually be reduced through constructive dialogue and debate.

In this spirit, we present this follow-up report to the Forum that addresses some concrete issues involved in implementing external regulation. This report will not, and is not intended to, 'solve' all implementation issues in advance of application. Indeed, this is probably not possible, since implementing a new regulatory approach invariably raises issues and requires choices to be made that cannot always be foreseen at the outset. Nevertheless, we hope that this report provides the impetus to begin addressing these issues in earnest. External regulation can enhance benefits to all Australian stakeholders and we believe the experience with this regulatory system to date shows that implementation issues can be successfully resolved so that external regulation fulfills its potential.

This report is structured as follows. Section two discusses the relationship between effective regulation and external performance measures. Section three discusses the basics of measuring total factor productivity. Section four discusses some experience with implementing TFP-based approaches in North America. There is an extensive history with using TFP in North American regulation, but in the interest of brevity we examine only the most relevant applications in the regulation of telecom, gas, electric and railroad services. Section five presents concluding remarks and discusses some preliminary options for dealing with issues that may arise when implementing TFP in Australian regulation (e.g. because of the less extensive data series or history of regulation).

2. Effective Regulation and Appropriate Performance Measures

This chapter discusses the relationship between effective regulation and the associated performance measures. This discussion will present the merits of external and building block approaches towards CPI-X regulation. It will also develop a framework within which the implementation issues can be explored. Although CitiPower has previously discussed some of these points on several occasions, it is worth reviewing some of the fundamental issues regarding external regulation before considering how this approach can be implemented.

2.1 The Building Block and External Regulation Alternatives

Nearly all energy utility services in Australia are regulated using CPI-X formulas. The Forum is no doubt aware that there has been a considerable debate about how best to implement CPI-X regulation. The two main alternatives have been termed the ‘building block’ and ‘external regulation’ approaches.

In the building block model, regulators set the terms of CPI-X formulas so that each utility’s revenues equal its projected cost of service over the next regulatory period. The building block method requires estimates of each utility’s asset base, capital expenditures, depreciation, operating expenses and demand growth over the regulatory period. The forward-looking revenue requirements also include a target rate of return on capital.

The building block approach to CPI-X regulation bears an undeniable relationship to rate of return regulation (RoR). As in RoR, the building block method is focused on determining a revenue requirement for each regulated firm. Both are ‘bottom up’ approaches that determine appropriate values for individual cost components. Unlike ‘classic’ rate of return, however, the building block approach uses multi-year cost and demand projections and generally collects allowed revenues using indexing formulas.

Both rate of return regulation and the building block method also create incentives during the period between regulatory reviews. This has been termed ‘regulatory lag’ under classic rate of return regulation. Reviews under the building block approach take place at predetermined intervals. This is often not the case under classic rate of return regulation. However, the period between unscheduled rate cases can be significantly longer than the five-year standard term in Australian CPI-X regulation. All else equal, a longer regulatory lag strengthens performance incentives since firms retain the benefits of efficiency gains for longer periods.

An alternative approach to CPI-X regulation is to calibrate the indexing formulas using ‘external’ performance measures. Such performance measures are sometimes called benchmarks. In a regulatory context, a benchmark will be external to a utility if the utility’s own actions cannot influence the value of the benchmark. External benchmarks would therefore not use the utility’s own costs or expected costs to set the terms of CPI-X price controls.

Compared with the building block approach, external regulation represents more of a break from classic RoR. External regulation may therefore have more potential to overcome the problems that have traditionally been noted for rate of return regulation. To see this, it may be valuable to review briefly economists' critique of cost of service regulatory methods which, as noted, are also employed in the building block approach to CPI-X regulation.

2.2. Problems with Rate of Return Regulatory Methods

Economists believe that information asymmetries are at the heart of problems with rate of return regulation. If regulators knew the minimum cost of providing utility services and the efficient set of utility services, they could simply mandate that revenues equal these costs and establish corresponding tariffs. However, even experienced utility managers find it difficult to recognize which services should be offered and the minimum achievable cost of providing them. Moreover, the least-cost provision of multiple services usually involves the sharing of inputs, and the allocation of common costs to different services is inherently arbitrary. Given these complexities, regulators face a daunting task in identifying 'fair and reasonable' prices, particularly since they are apt to know less about the utility business than company managers. This is precisely the information asymmetry problem.

A redressing of information asymmetries between company managers and regulators requires substantial data exchange, processing and analysis. Regulators are aware that information asymmetries and the substantial sums of money at stake naturally create incentives to game regulatory reviews. Data collection and processing is designed to overcome information asymmetries.

However, time, resource and experience constraints make it inherently difficult to identify fair and reasonable cost levels through this approach. Regulators and staff generally lack the detailed knowledge on which to form independent judgments of efficient cost levels. By relying on data specific to a single utility, staff also do not have objective performance standards against which to judge company costs. These problems are likely to be magnified when regulatory agencies do not have experience with cost of service regulation. While the necessary skills can be built internally or provided by outside specialists, this can entail significant costs.

The application of rate of return regulation diminishes the incentives for efficient behaviour. Utilities whose prices depend on their own reported costs have less incentive to operate or invest efficiently. Managers know that efforts to trim unit costs result in short order in lower prices, so they are discouraged from turning in their best possible performance. The substantial data requirements and controversies involved in allocating common costs also makes the development of new tariffs and services cumbersome. As a result, utilities are likely to have fewer tariff and service offerings than comparable firms in competitive markets.

RoR also imposes significant regulatory costs. Company managers cannot fully utilize their business expertise when their attention is forever split between the utility's 'basic business' and the regulatory process. For example, utility personnel cannot bring diversification initiatives to quick and effective fruition when they must constantly consider and weigh the regulatory consequences. Under cost of service regulation, utility executives may also be rewarded for their skill in managing the regulatory process rather than for talents rewarded in competitive industries, like long-term vision, expertise, the ability to raise productivity or provide superior customer service. In this sense, cost of service regulation tends to distort a utility's corporate culture.

The importance of this last point should not be underestimated. The institutional economics literature underscores that these effects are critical for evaluating the impact of institutions on economic performance. Perhaps the premier figure in this field is Douglass North, who was awarded the 1993 Nobel Prize in Economics for his work. Dr. North writes that

> "(D)ifferent institutional rules will produce different incentives… the particular institutions will not only determine the kinds of economic activity that will be profitable and viable, but also shape the adaptive efficiency of the internal structure of firms and other organizations… rules that encourage the development and utilization of tacit knowledge and therefore creative entrepreneurial talent will be important for efficient organization."[1]

By distorting incentives, rate of return regulation diminishes the efficiency of utility operations and reduces the potential benefits from utility industries.

It should be noted that these deficiencies become more apparent in competitive environments. As competitive pressures increase, utility managers must have maximum incentives to contain unit costs. Even more importantly, managers must be able to respond quickly to unanticipated market developments. The unwieldy nature of the RoR regulatory process is not well suited to dynamic environments. It is therefore not surprising that RoR methods are often supplanted when competition increases in utility industries.

2.3. Advantages and Disadvantages of External Regulation

In contrast to the building block approach, external regulation does not focus on detailed examinations of each company's costs as the basis for its prices. Rather, external regulation is a more 'top down' approach that is explicitly designed to mimic the operation and outcome of competitive markets. To make this principle operational, it must be recognized that the trend in the prices charged by a competitive industry is equal to the trend in that industry's unit cost. The benefits of productivity growth are then passed to customers over time in the form of slower price growth. Because the *industry* unit cost trend is insensitive to individual firm actions, companies in competitive markets have strong incentives to improve their productivity.

1 D. North, *Institutions, Institutional Change, and Economic Performance,* Cambridge: Cambridge University Press, p. 81. While the term 'tacit knowledge' can be used in different ways, it most often refers to productive knowledge that is embedded in organizations and firms and takes effect through those organizations' routines and internal processes. In this sense, productive tacit knowledge is closely related to the idea of a productive 'corporate culture'.

The logic behind this important result merits explanation. The trend in the revenue of a competitive industry (ΔR) equals the trend in its cost (ΔC).

$$\Delta R = \Delta C$$

According to the economic theory of indexes, the trend in the revenue of any industry can be decomposed into properly specified indexes of the trends in the prices it charges (ΔP) and its output quantities (ΔY).

$$\Delta R = \Delta P + \Delta Y$$

The trend in the index of prices charged by a competitive industry is then the difference between the trend in its cost and the trend in its output quantity index. This is precisely the trend in the industry's unit cost index (ΔUC)[2].

$$\begin{aligned} \Delta P &= \Delta C - \Delta Y \\ &= \Delta UC \end{aligned}$$

Data on the unit cost trends of utility industries are typically not available in a timely fashion. In some countries, they are not available at all.

Another result of indexing theory has been used to make the competitive market standard operational. The growth rate in the cost incurred by an industry is the sum of the growth rates of a properly specified input price index (ΔW) and input quantity index (ΔX). It follows that the unit cost trend of an industry is the difference between the trends in the industry's input price index and its total factor productivity (ΔTFP) index.

$$\begin{aligned} \Delta UC &= (\Delta W + \Delta X) - \Delta Y \\ &= \Delta W - (\Delta Y - \Delta X) \\ &= \Delta W - \Delta TFP \end{aligned}$$

The trend in the TFP index of an industry is the difference between the trends in its output and input quantity indexes. It encompasses the effects of a wide array of developments that can cause the growth trend in the unit cost of an industry to be slower than the growth trend in its input prices. The developments include technological change, increased capacity utilization and economies of scale and scope.

Our exposition of this analytical framework helps to explain some major issues that are addressed when implementing external regulation. One is the TFP trend of the industry. A second is the success with which proposed inflation measures track industry input price inflation.

The X-factor can in principle reflect both considerations. Suppose, for example, that the CPI is used as the inflation measure. The CPI measures inflation in the prices of *final* goods and services. Indexing logic suggests that the input price inflation of the economy exceeds CPI inflation by the economy's TFP growth.

$$\Delta W^{economy} = \Delta CPI + \Delta TFP^{economy}$$

2 A unit cost index is the ratio of cost to an output quantity index. A simple example is the cost of power distribution per customer.

A CPI-X indexing formula that tracks the industry unit cost trend must then satisfy the following formula.

$$\begin{aligned}\Delta P &= \Delta W^{industry} - \Delta TFP^{industry} \\ &= \Delta CPI + \Delta TFP^{economy} - \Delta TFP^{industry} + [\Delta W^{industry} - (\Delta CPI + \Delta TFP^{economy})] \\ &= \Delta CPI - [(\Delta TFP^{industry} - \Delta TFP^{economy}) - (\Delta W^{industry} - \Delta AW^{economy})] \\ &= \Delta CPI - X\end{aligned}$$

It can be seen that the X-factor encompasses two terms. One is the productivity differential, i.e., the difference between the TFP trends of the industry and the economy. X is larger (slowing price growth) the greater is the productivity differential. The second term is the input price differential. This is equal to the difference between the input price growth trends of the industry and the economy. X is smaller (accelerating price growth) the larger is the inflation differential.

It is important to emphasize that *industry* rather than individual company measures are relevant for calibrating the CPI-X formula. This is necessary to comply with the competitive market paradigm. In competitive markets, the prices facing any firm are external to its costs or efficiency. Prices in competitive markets evolve in response to industry-wide trends in unit costs. Given the indexing logic above, it follows that industry TFP and input price measures should be used if CPI-X regulation is to mimic the outcomes and operation of competitive markets.

Compared with a building block approach, external regulation can simultaneously enhance performance incentives, facilitate marketing flexibility and reduce regulatory cost. Using data that are external to the firm in the CPI-X formula serves to break the direct link between a utility's own cost and marketing performance and its allowed prices. Because prices are based on external data, unit cost reductions do not decrease allowed rate escalation but go straight to the bottom line. This creates optimal incentives to control costs.

External regulation may further enhance performance by allowing many operating restrictions to be relaxed. This is especially true of marketing flexibility. When utility revenues are based on external indexes rather the company's own costs, prices of monopoly services can be insulated from the company's involvement in competitive markets. This reduces concerns about cross subsidies and the impact of uncertain competitive market initiatives on core customer tariffs. Light-handed regulation of non-core services is then possible. A company can also have more leeway in its purchases from affiliates and in its depreciation policies.

External regulation can also have a beneficial effect on regulatory cost. The cost and contentiousness of regulatory reviews can be substantially reduced. Unlike the building block approach, reviews will focus on industry TFP and input price trends rather than detailed examinations of company costs. Detailed cost reviews expose regulators to the same information asymmetries that are the heart of problems with cost of service regulation.

The combination of stronger performance incentives and reduced regulatory costs can have a salutary effect on utility management. Managers are likely to be more effective as attention shifts towards the marketplace from the regulatory process. Stronger incentives to perform may also develop skills that can facilitate expansion of the utility business via mergers and acquisitions and successful involvement in other markets.

All of these features become more important when competition increases in utility markets. This is currently the case for energy utilities in much of Australia. In most states, competition has been introduced in energy wholesaling and retailing and related areas such as metering and connections. There is less competition for energy transportation, but some competition does exist and more alternatives are developing. For example, many large gas customers can switch to alternative fuels and have competitive bypass options. Some large electric users engage in self-generation and use distribution networks only for standby service. Greater bypass of power networks is becoming feasible through distributed generation (DG) technologies. DG refers to small scale generating units that can be located 'on the customer side of the meter', or outside of the utility distribution system. DG is increasingly becoming viable for more customers, including industrial parks, shopping malls, apartment complexes and even individual residences.

External regulation can allow utilities to respond to competitive developments in ways that enhance customer benefit. For example, pricing flexibility may allow delivery tariffs to be redesigned so that they better reflect the drivers of power delivery cost. Cost reflective tariffs are more likely to deter inefficient bypass of utility services. Distribution prices linked to external data also help to insulate remaining customers from any bypass that may occur.[3]

External regulation also encourages utilities to discover new uses for their assets and expertise in related markets. Accordingly, it can be instrumental in facilitating efficient diversification. One example may be DG services. For example, distributors may offer customers a package that includes the purchase of a DG unit, a service and maintenance contract and standby power deliveries in the case of failure. Utilities possess other company-specific assets that may be profitably deployed in some competitive markets. Companies will have both less incentive and ability to pursue these opportunities if the regulatory process includes cumbersome cost of service processes.

These advantages of external regulation may be offset by some disadvantages. The biggest concern is business risk, or the possibility that price restrictions will not track trends in external business conditions that affect a company's costs. Relevant business conditions include weather, the business cycle, prices of competing energy products and government policy. Windfall gains and losses occur to the extent that the input price index does not reflect changes in these conditions.

As we discuss later in this report, many of these risks can be mitigated through careful design of external regulation plans. It should also be noted that utilities are also exposed to often greater regulatory risk, such as inappropriate price adjustments in response to political pressures. CitiPower believes that well-designed external regulation is likely to entail fewer regulatory risks than a building block approach. We also believe that a higher level of business risk under external regulation is acceptable provided that utilities are also given an opportunity to earn a higher return. When prices are set by external performance measures, utilities will enjoy higher returns whenever they are able to outperform the industry as a whole. Moreover, these higher returns will not automatically be ratcheted down to the industry's presumed cost of capital at rate reviews, as typically occurs under building block approaches to CPI-X regulation.

3 Under building block methodologies bypass creates a situation where the remaining rate base is recovered from fewer customers. This can only be avoided by often complex and arbitrary optimisation of the rate base by regulators.

2.4 Benefit Sharing

Regulators are understandably interested in seeing that customers benefit from improved performance. There are alternative methods for sharing benefits and these usually differ under the building block and external approaches to regulation. Here we briefly review different benefit-sharing approaches.

Before doing so, however, we believe it is important to recognize that appropriate benefit-sharing provisions allow welfare improvements for *both* shareholders and customers. It is incorrect, then, to point to higher utility earnings as evidence of the 'failure' of price cap regulation.[4] Higher utility earnings are consistent with successful CPI-X regulation as long as customers also benefit compared with a continuation of the status quo.

2.4.1 Benefit Sharing under the Building Block Model

Benefit sharing under the building block approach occurs in two primary ways. One is to distribute benefits to customers at the time of the regulatory review. Under this approach, shareholders are allowed to benefit from efficiency gains during the regulatory lag between reviews. When revenues or tariffs are reviewed, however, prices are adjusted to reflect the firm's estimated cost of capital. Ratcheting prices down to the cost of capital effectively distributes earnings above this return to customers.

Regulators have realized that this approach to benefit sharing can have undesirable effects on incentives. In particular, it can create incentives for companies to postpone efforts to improve efficiency near the end of a review period. To the extent that the timing of such efforts is variable, companies will have incentive to put off efficiency-improving initiatives that would otherwise be pursued near the end of a price control until the subsequent control takes effect. The reason is that postponing such efforts allows companies to retain the benefits from these efforts for a longer period.

Some regulators have attempted to counter these incentives through efficiency carry-over mechanisms. For example, in Victoria, designated efficiency gains have been phased out over a five-year period after they are registered. In any given year, efficiency gains are generally measured as the difference between forecast and actual expenditures. Separate efficiency carry-over mechanisms have been specified for operating and maintenance (O&M) and capital expenditures.

While this benefit-sharing approach does offset some of the incentive problems of immediately distributing benefits to customers, it does create other difficulties. As we noted in our response to the Discussion Paper, the amount of the carry-overs are inherently sensitive to how O&M and capital expenditures are defined. The Victorian distribution businesses (DBs) employed different approaches towards capitalizing and expensing costs and different cost allocation policies and this inevitably affected the magnitudes for the carry-overs. Several DBs objected to the ORG's methods and, following appeal, ORG issued an amended version of its Price Determination.

4 This point was made in the Utility Regulators Forum Discussion Paper.

In addition, this approach also relies on forecasts of specific cost items. Basing allowed prices and future efficiency carry-overs on forecasts can create incentives to game these forecasts to each party's advantage. Gaming incentives will exist for the company and outside interested parties. Regulators are also exposed to information asymmetries in attempting to sort through competing notions of appropriate forecast expenditures. Invariably, efforts to overcome these asymmetries can lead to the sort of detailed cost examinations and micromanagement that we believe incentive regulation is designed to overcome. We therefore believe that, while it has some theoretical appeal, the practical implementation of efficiency carry-over mechanisms is likely to create some of the same incentive problems as classic rate of return regulation.

2.4.2. Benefit Sharing under External Regulation

There are three basic ways to share benefits under external regulation. These are through consumer dividends, rolling X-factors and earnings-sharing mechanisms. We deal with each of these options in turn.

Consumer dividend. A consumer dividend shares benefits by adjusting the X-factor. In external regulation, the CPI-X formula is calibrated to track the unit cost trend of the relevant industry. If the inflation factor tracks the industry's input price trend, then an X-factor equal to the industry's long-run TFP trend allows the CPI-X formula to grow at the same rate as industry unit cost over the long run. A consumer dividend would represent an increment that is added to the industry TFP trend. The CPI-X formula will thereby grow less rapidly than long-run growth in industry unit cost. By slowing the growth of prices relative to the industry's long-run price trend, consumer dividends benefit consumers.

An advantage of using a consumer dividend to share benefits is that it does not affect the company's performance incentives. The amount of the dividend is determined *ex ante* rather than during the term of the indexing plan. Because the company's performance under the plan does not affect its allowed prices, it has strong incentives to control costs and market aggressively.

One difficulty in implementing consumer dividends is that there is often little conceptual and empirical basis for choosing appropriate dividend levels. One option for providing a more sound foundation for choosing consumer dividends has recently been suggested.[5] This approach would set the stretch factor at a value that has been found to be reasonable in other plans, such as 0.5%, and use benchmarking methods to determine when it is appropriate to remove the stretch factor. For example, the stretch factor can be eliminated when benchmarking studies demonstrate that the company's cost performance is significantly lower than expected. This result implies that the utility's customers are already benefiting from superior performance levels, so that further benefit sharing over and above that reflected in the industry unit cost trend is not necessary. This benefit-sharing approach would remain external to the firm since the level of the dividend would not depend on the company's performance gains. It would also be consistent with the operation of competitive markets, where firms that are above-average performers are able to earn above-average returns.

5 L. Kaufmann, *External Benchmarks, Benchmarking and Power Distribution Regulation: A Critical Evaluation*, Report to the National Electricity Distributors Forum, May 2001.

Rolling X-factor. Another benefit-sharing approach is through a rolling X-factor. Here, the X-factor is adjusted based on productivity performance according to a formula that is established at the outset of the plan. For example, the X-factor can be updated annually on the basis of new TFP data. If productivity growth increases under the plan, the X-factor will increase. Updating the X-factor in this fashion therefore flows through a portion of benefits achieved under price caps to customers.

An advantage of a rolling X-factor is that it can retain strong performance incentives. This is fairly clear if the X-factor is based on the industry TFP trend since, in most industries, industry productivity growth will be relatively insensitive to the TFP of a single company. If a company's TFP under price caps does not significantly affect the X-factor which is based on industry TFP growth, the company has strong incentives to perform.

The company's performance incentives are weaker if the rolling X-factor is based on its own TFP performance. The reason is that the company's own performance gains lead in part to less price escalation. Nevertheless, if regulators can commit to a formula based on a multi-year average of TFP growth, one factor promoting strong incentives is that the company has nothing to gain from 'gaming' the formula. That is, the company can only manipulate the X-factor in its favour by foregoing productivity gains. But it has no incentive to do so because a one-year reduction in productivity reduces X by only a fraction of that decline whereas current profits immediately reflect the full impact of lower productivity growth.

One disadvantage is that performance incentives may be harmed if regulators cannot fully commit to a predetermined formula for updating X. For example, company managers may suspect that future regulators will respond to current productivity improvements by making methodological changes that lead to even higher X-factors. In this case, the company may have incentives to underperform.

Earnings-sharing mechanisms. Earnings-sharing mechanisms (ESMs), sometimes called 'sliding-scale' mechanisms, are probably the best known method of benefit sharing. An ESM typically adjusts a company's allowed prices when its rate of return has been in a certain range over a recent historical period. The mechanisms are established in advance of their use and typically function for several years. The most widely-used earnings rate measure is return on equity (ROE).

In North America approved ESMs vary significantly in several ways. The most important difference is the share of surplus (and/or deficit) earnings assigned to customers. This share may change in different ranges of the ROE. Many plans feature a range (called a deadband) in which prices are not sensitive to ROE fluctuations. Immediately beyond the deadband, the customer share is commonly 50%. In some plans, it increases substantially when ROE is extraordinarily high and falls substantially when it is extraordinarily low. Such plans are said to be characterized by 'progressive' sharing mechanisms. Alternatively, a 'regressive' ESM reduces the customer's share of benefits as ROE increases. Some plans are symmetric in the sense of featuring both rate decreases when earnings are high and rate increases when earnings are low. Other plans provide for rate adjustments only when earnings are high.

There are both advantages and disadvantages with using ESMs in rate regulation. One clear disadvantage is that ESMs can weaken incentives for cost cutting and marketing. Utility managers clearly have less incentive to undertake such efforts if doing so leads in part to price reductions. ESMs can also raise concerns about discounting and other methods of marketing flexibility since the revenue 'losses' may be recovered from remaining customers. Because of these concerns, marketing flexibility may be restricted. A continued focus on earnings also maintains the potency of inherently controversial issues like utility-affiliate transactions and cost allocations between core and non-core services. Regulatory attention to these issues can both discourage profitable diversification and impose regulatory costs through ongoing monitoring and evaluation.

Not withstanding these problems, earnings sharing has some important potential benefits. It is a predetermined and automatic means of adjusting prices for a wide range of external developments that could otherwise produce windfall gains and losses for the utility. By mitigating the potential for windfalls, earnings sharing can extend the time period during which the utility can operate without plan review. The extension of regulatory lag ran in principle have a positive effect on incentives that more than offsets the negative incentive effects of the sharing itself.

ESMs also have features that make them attractive in regulatory reviews. One is that they are relatively simple and easy to understand. They also clearly align the interests of shareholders and customers and their benefits appear to be transparent and easily computed (i.e., the amount of additional utility earnings distributed to customers or retained by shareholders). ESMs will also, by design, keep utility earnings within politically acceptable bounds and hence may build consensus among parties to a regulatory review. For all of these reasons, ESMs may be viewed favourably in terms of fairness.

2.5 Evaluation

In principle, external regulation offers the potential for significant gains compared with the building block approach to CPI-X regulation. External regulation generally creates stronger performance incentives, allows for greater operational flexibility and has a more salutary effect on corporate culture. At the same time, it must be recognized that there is considerable flexibility in how both external regulation and building block CPI-X regulation are applied. These differences in application can affect the relative merits of the approaches. In particular, under some benefit-sharing approaches (particularly ESMs), the CPI-X formula will no longer be completely external to firm operations. This will tend to reduce the strength of incentives, but this approach may still be worthwhile because of the factors cited above. CitiPower believes that the most appropriate approach towards benefit sharing under external regulation is a topic that will and should receive greater attention.

Regardless of the benefit sharing approach adopted, certain performance measures are critical to operationalising external regulation. The most important of these is the trend in industry TFP. Regulators need to have greater understanding in how industry TFP is measured and how some important issues regarding TFP measurement have been addressed in other regulatory jurisdictions. We turn next to this issue.

3. Measuring Total Factor Productivity

This chapter provides an introduction to TFP measurement. It is not intended to be a complete description of how TFP could necessarily be measured for energy utilities in Australia. Any number of concrete issues must dealt with when undertaking a TFP study. For that reason, there is no 'cookbook' approach towards measuring TFP and care must be taken when implementing any study. Nevertheless, there has been a great deal of consensus on many issues in TFP measurement in other jurisdictions and regulators are likely to benefit from a consideration of the basics of TFP methods.

3.1 TFP Basics

TFP indexes are designed to compare the overall efficiency with which enterprises use capital, labour and other production inputs to produce goods and services. Comparisons can be made between firms at a point in time or for the same firm (or group of firms) at different points in time. Each TFP index is the ratio of an output quantity index to an input quantity index. An output quantity index is a summary comparison of the amounts of goods and services produced. An input quantity index compares the quantities of production inputs used.

When implementing TFP, a number of salient issues need to be addressed. These include the form of the indexes, the definition of cost and input prices and the computation of input quantity and output quantity indexes. We deal with these issues in turn.

3.2 Index Forms

Constructing input and output and quantity indexes involves aggregating various inputs and outputs, respectively, into a single comprehensive measure. There are a number of different index forms that can be used for these aggregations. Economists have done extensive research on the properties of a large number of different index forms.

This research has revealed that certain index forms are 'superlative' and especially well suited to productivity measurement.[6] A superlative index is one that will yield the same productivity measure as a so-called 'flexible form' production function that places few underlying restrictions on the underlying production technology. Accordingly, a superlative index will generate results that are consistent with a wide range of technological relationships between input and output quantities.

6 For example, see W.E. Diewert (1976), 'Exact and Superlative Index Numbers', *Journal of Econometrics*, 115-145.

The two superlative index forms are the Tornqvist index and the Fisher Ideal index. Because of their attractive theoretical properties, these index forms are also almost universally employed in productivity research. Some researchers have recently emphasized that the Fisher Ideal index has many properties that make it attractive in regulatory applications.[7]

3.3 Defining Cost

3.3.1 Scope of Costs

According to the indexing logic presented in chapter two, the growth in the input quantity index is equal to the growth in a cost index minus the growth in an input price index. Appropriate total cost and input price measures are therefore critical for computing input quantity indexes.

There are two main components of utility cost. These are operations and maintenance (O&M) costs and capital costs. Both the O&M and capital cost measures used in TFP research should correspond to the services being regulated. For example, for power distribution regulation in Victoria, the costs used in TFP measures should not include costs associated with services that are designated as 'excluded services', such as metering or customer-requested services, that are outside of the scope of the price control. Costs should also not include the costs of contestable services, such as retailing.

However, costs should include an allocation of both corporate, administrative and general expenses and general plant that may be used in the provision of both regulated and other services.[8] Utilities may differ in how they allocate these costs in their regulatory reporting. This is particularly likely to be the case in different Australian states, since there is currently no standardized reporting format. This is not problematic in TFP research provided that the total amounts of these cost items are known. In that case, the researcher can simply apply a common allocation formula across all firms in the sample.[9]

3.3.2 Capital Cost

Since capital accounts for the largest share of utility cost, it is important for capital to be measured in a rigorous and standardized manner. In Australia, one factor that promotes capital cost standardization is that initial capital stocks for energy utilities are typically given by their optimized depreciated replacement costs (ODRC). Depreciated replacement

---

7 See W.E. Diewert and K. Fox (2000), 'Incentive Indexes for Regulated Industries', *Journal of Regulatory Economics*, 17:1, 5-24.

8 Administrative and general expenses consist mainly of corporate allocations of IT, overheads, salaries for personnel not assigned to line positions, and expenses for general office supplies and outside services. General plant consists mainly of structures and improvements not allocated to specific functions, communications equipment, office furniture and equipment, and transportation equipment.

9 Unlike in cost of service reviews where actual allocations can have a significant impact on the level of revenue requirements and therefore prices, cost allocations will have a much smaller impact on the trend in industry TFP .

costs are determined by taking an inventory of the assets allocated to a company, adjusting their quantities for accumulated depreciation, and multiplying the resulting quantity of each asset by its replacement costs. The 'optimized' element of this valuation takes effect by removing redundant assets from the final value. In most cases, optimization is either ignored or leads to relatively minor changes in asset values.

The ODRC values bear a resemblance to capital stock measures that, if the necessary data are available, can be computed using so-called 'perpetual inventory' methods.[10] Both methods adjust capital data for the effects of inflation and depreciation. In a perpetual inventory equation, this is done by adjusting the capital additions booked in a given year for inflation and depreciation since that year. The series of inflation and depreciation-adjusted capital investment data are then aggregated to derive a capital stock. While it is generally not possible to do this in Australia because of the shorter data series, comparable inflation and depreciation adjustments are applied at the outset when estimating ODRC values. Moreover, regulatory reporting in some states (such as Victoria) require that the ODRC capital values be updated to include the effects of inflation, depreciation and capital additions and disposals since the time of the valuation. This is consistent with perpetual inventory method towards measuring capital stocks.

One well-established method of measuring the costs associated with capital is through what is known as a service price approach. This approach is based on the economic value of utility plant. It has a solid basis in economic theory and the scholarly literature.[11] It also has ample precedent in cost research and regulatory proceedings. Most TFP studies that have been used by regulators to calibrate X-factors have employed a service price approach. This method has also been used by respected official sources in other jurisdictions such as the Bureau of Labor Statistics of the U.S. Department of Labor in computing multi-factor productivity indexes for the U.S. private business sector and for several subsectors, including the utility services industry.

Under a service price approach, capital cost is the sum of tax costs and non-tax capital costs. The non-tax cost of capital in a given year, *t*, can be expressed as the product of a capital service price index and a capital quantity index. The formula may be stated formally as:

$$CK_t = WKS_t \cdot XK_{t-1}$$

where in each period t, CK_t is the non-tax cost of capital, WKS_t is the capital service price index and XK_{t-1} is the capital quantity index value at the start of the period. As discussed above, the capital quantity index can reflect either ODRC values and subsequent plant additions or it can be computed according to a perpetual inventory equation. The service price index is based on the cost of providing capital services in a competitive rental market. Both indexes require a mathematical characterization of the process of plant depreciation.

Non-tax capital cost is the product of the capital quantity index and WKS_t^{other} where:

$$WKS_t^{other} = r_t \cdot WKA_{t-1} + d_t \cdot WKA_t - (WKA_t - WKA_{t-1})$$

10 Perpetual inventory methods are typically used to derive capital stocks for US energy utilities in TFP studies.

11 See Hall, R. and D.W. Jorgensen (1967), 'Tax Policy and Investment Behavior', *American Economic Review*, 57: 391-414, for a seminal discussion on the use of service price methods for measuring capital cost.

The three terms in this formula correspond to the three components of non-tax capital cost. These are, in order, the opportunity cost of capital, depreciation, and capital gains. The service price approach has previously been applied in Australia (e.g. in TFP studies submitted by three of Victoria's power distribution businesses), but the specific measures used to implement this formula may be subject to refinement.

The opportunity cost of capital is often measured by economy-wide or industry returns. For example, in the Victorian DB studies, the opportunity cost of capital was measured by the user cost of capital in the Australian economy, using data in the National Income Accounts.[12] Other capital cost measures can also be considered. Unlike building block or cost of service proceedings, however, estimated TFP trends are not nearly as sensitive as revenue requirements to different capital cost measures. One reason is that, since it is a trend measure, only changes in capital costs will impact the change in TFP.

The depreciation rate used in the service price should be consistent with that used to establish capital asset values. This includes both the assumed pattern of depreciation (e.g. straight line or geometric rate of decay) as well as the specific depreciation rates and/or service lives for different assets. The *WKA* term in this equation is a capital asset price. It is usually measured by a measure of construction costs. Since construction costs can vary markedly by location, this measure should be as specific to utility service territories as possible.

3.3.3 Operation and Maintenance Costs

Operation and maintenance costs include both labour and non-labour O&M. Labour O&M will include the salaries, pensions and benefits of all utility labour plus an allocation of administrative and general labour costs. As noted, the labour O&M measure should reflect the labour expenses incurred in providing regulated utility services. Non-labour O&M costs include a wide variety of materials, rentals and miscellaneous input costs, including the costs of services contracted from third parties. Again, the non-labour O&M costs should pertain to the costs associated with providing regulated utility services.

3.4 Input Prices

Input prices are typically specified for capital, labour and other O&M inputs.
This breakdown of production inputs has been widely used in scholarly research and regulatory applications. The input price for capital is the service price index described above. The price of labour for each is typically calculated as the labour expense (salaries and wages and pensions and other benefits) incurred by the utility per full-time equivalent employee. Because of their diverse character, prices for other O&M inputs are often assumed to be the same in a given year for all companies. These prices are often assumed to grow at the same rate as a broad inflation measure such as the national CPI.

12 For a discussion of how the user cost of capital was computed, see *CitiPower Performance: Results from International Benchmarking,* p. 16.

3.5 Input Quantity Indexes

The input quantity index is computed by aggregating the quantities of labour, other O&M inputs and capital inputs into a comprehensive input quantity measure. The quantity for an individual input will be given by the cost of that input divided by its input price. The weight assigned to each input class depends on the index form that is chosen to aggregate inputs. In both the Tornqvist and Fisher Ideal forms, these weights depend on the average share of that input in total cost. Cost-share weighting reflects differences in the prices paid for inputs as well as differences in their volumes.

One implication of this is that changes in the opportunity cost of capital tend to have offsetting effects on estimated TFP growth. For example, a lower cost of capital will be reflected in lower capital costs. All else equal, this implies less rapid input quantity growth and more rapid TFP growth. On the other hand, the weights applied to individual input quantities reflect their share of costs. Lower capital costs tend to reduce capital's cost share and therefore the weight applied to capital inputs. Placing less weight on slow-growing capital inputs has an offsetting effect on the input quantity index and TFP index. This is another reason that TFP trend measures are less sensitive than revenue requirements to differences in opportunity cost of capital measures.

3.6 Output Quantity Variables

The output quantity index is computed by aggregating individual output quantities into a comprehensive output quantity measure. The main outputs to be included depend on the services provided by the industry. For example, gas and power distributors have networks that are designed to serve retail customers in their service territories. The total number of customers served is therefore an important output for energy distributors. However, total customer numbers is not an important output for gas and power transmission companies, whose primary (and sometimes only) customers are a small number of gas and power distributors, respectively. The appropriate outputs will therefore vary by industry. However, as we detailed in our Response to the Discussion Paper, CitiPower believes that most power distribution outputs can be identified fairly easily.

The weights applied to each individual output quantity depend on the index form. For both the Tornqvist and Fisher Ideal forms these weights depend on the average shares of each output in regulated revenue. For example, for a power distributor, the weight applied to customer numbers would be equal to the share of revenue collected from customer charges in total regulated revenue. The weight applied to kWh would be the share of revenue stemming from volumetric charges. These revenue figures are often known. If they are not, an alternative is to use weights that reflect the relative shares of cost elasticities, as estimated from an econometric cost function. Weighting by relative cost elasticity shares is an appropriate basis for aggregating outputs since an elasticity reflects the marginal cost of providing an output. This proxy has also been accepted in regulatory proceedings in North America.

3.7 Total Factor Productivity Indexes

A TFP index is just the ratio of an output quantity index divided by an input quantity index. Hence, an industry TFP index would be computed by calculating indexes of total output quantity and total input quantity for a sample of firms in the industry. The growth in such an index over a multi-year period would equal the industry trend in TFP.

Two points are relevant regarding the period used to estimate industry TFP trends. First, it must be long enough to smooth out year-to-year fluctuations in TFP. Many U.S. energy utility plans have accepted 10 years as a sufficiently long period for estimating TFP trends. Second, because one factor that can lead to TFP fluctuations is demand growth, it is desirable to have the beginning and ending dates of a TFP study take place at comparable points of the business cycle.

3.8 Data Issues

A detailed discussion of data sources and requirements for TFP measurement is beyond the scope of this report. Nevertheless, it is worthwhile to make a general points regarding data issues.

First, the data requirements for TFP measurement are not onerous. This is apparent in the fact that the TFP of CitiPower and other Victorian DBs has previously been measured. These studies relied heavily on each DB’s current regulatory reporting for most of the needed cost and output data. Many of the remaining information needs (e.g. costs of constructing utility plant) were obtained from standard, well-respected sources such as the Australian Bureau of Statistics.[13] CitiPower therefore believes that the data needed for TFP measurement are readily available and, at least in Victoria, are well-known to regulators.

Second, it is not necessary for all data series to be comparable across companies to measure TFP. For example, DBs sometimes have different allocations of administrative and general costs across their distribution and retailing operations. This does not distort TFP measures provided that the total amount of these costs is known. The researcher can then allocate these costs in a standardized fashion across companies. Of course, we are not suggesting that there is no value in having comparable data across Australian utilities. CitiPower supports moves to standardize data reporting, since this will create greater transparency and reduce confusion. In light of the fact that Victoria’s regulatory reporting is generally suitable for TFP measurement, we believe it may be valuable for the Forum to examine this as a possible model for Australia’s DBs.

Third, fewer data are needed for TFP measurement than for credible benchmarking studies. Benchmarking attempts to evaluate utility performance given various factors or business conditions that are beyond company control. This naturally requires that data be available on the relevant business conditions. TFP controls for some important business

13 The particular studies commissioned by the Victorian DBs also compared their TFP levels to those of US power distributors. This required additional information to ‘link’ various cost measures and input prices between the US and Victoria. However, suitable data for this purpose were also discovered and used for the study. These data sources are explained in *CitiPower Performance: Results from International Benchmarking.*

conditions that differ between companies, such as input prices and the scale of output, but it does not control for other factors. For example, TFP indexes typically do not adjust for differences in geographic and topographical conditions between companies and these conditions can affect the cost of providing service. For this reason, it is widely acknowledged that TFP is less appropriate than other techniques for evaluating differences in the *level* of firm performance at a given point in time.

However, this is not problematic when TFP is used appropriately in regulatory applications. As we have discussed, the long-run *trend* in industry TFP is the appropriate measure for calibrating X-factors under external regulation. Differences in geographical and related factors will be reflected in the *level* of prices that apply to a company at the outset of a CPI-X plan. Such factors are generally permanent features of a utility's service territory, so they are unlikely to vary much during a price control period. Therefore, provided that initial prices are set appropriately, subsequent price adjustments based on industry TFP trends will not be problematic.[14]

In essence, TFP has fewer data requirements information than most benchmarking methods because it requires information on input and output quantities only. Benchmarking requires these data and more to make reliable comparisons of performance levels. We therefore believe that regulators should not reject TFP on the basis of its data requirements. Indeed, since many regulators already use benchmarking in their reviews of utility costs, TFP can reduce the information burdens that are emerging in Australian CPI-X regulation.

14 Because business conditions can lead to differences in cost levels among utilities, CitiPower has always supported cost of service/rate of return rate cases at the beginning of an *initial* CPI-X plan. Such cost reviews can be important for setting appropriate initial prices. However, once those prices are set, we maintain that it is not necessary to have additional cost of service reviews, e.g. to ensure that customers benefit. Indeed, external regulation will ultimately create more benefits for customers.

4. Some Practical Experience with Using TFP in Utility Regulation

TFP research has played an important role in CPI-X regulation in North America. We will not review this entire experience here, but we thought it would be valuable to discuss a few regulatory case studies from North America and some of the key issues surrounding TFP in these proceedings.

4.1 U.S. Railroads

One of the most interesting case studies comes from U.S. railroads. As early as 1980, the Interstate Commerce Commission (ICC) proposed to determine allowable increases in U.S. rail freight rates using the average increase in rail carrier costs.[15] The Staggers Rail Act of 1980 required index-based regulation for the services of larger railroads to captive customers. The law established a Zone of Rate freedom for certain rail services. Under Section 203 of the Act, the boundary of this zone is to be adjusted each quarter by an "Index of Railroad Cost compiled or verified by the Commission with appropriate adjustments to reflect the changing composition of railroad cost, including the quality and mix of material and labor". The index used to adjust the maximum rail rates was known as the Rail Cost Adjustment Factor (RCAF).

There was vigourous and protracted debate before the ICC regarding the appropriate form of the RCAF. The most fundamental issue was whether the rail cost index should reflect the trend in the TFP of the industry as well as the input price trend. In 1981, the ICC rejected a productivity factor as part of the original RCAF formula. The primary reason was "the tenuous level of earnings in the industry". At the time of the Staggers Act, railroad finances had become perilous because the operating restrictions of cost of service regulation were untenable in the increasingly competitive markets for surface freight and passenger traffic. In addition to the concern with earnings, the ICC thought that an inappropriate productivity factor might diminish incentives and it was skeptical that a workable measure of TFP could be computed for the railroad industry.

To investigate the issue further, in 1982 the ICC began a proceeding to examine whether a workable measure of productivity could be established and used as the basis of an X-factor in the RCAF formula. This proceeding involved some eminent economists. For example, William Baumol testified on behalf of the American Association of Railroads (AAR). He argued against a productivity factor, citing the possible diminution of incentives and the difficulties in measuring TFP accurately.

The Western Coal Traffic League, an association coal shippers that included many electric utilities, opposed this position. They argued in a series of filings beginning in 1982 that an RCAF tracking the unit cost of the railroad industry was consistent with both the Staggers

15 ICC, Advanced Notice of Proposed Rulemaking, 'Railroad Cost Recovery Procedures', Ex Parte No. 290 (Sub-No. 2), April 28, 1980.

Act and the workings of competitive markets. They proposed a workable TFP index based on rigorous productivity research. They also recommended that the X-factor be based on a moving average of the growth rates in industry TFP. One reason was that a moving average would smooth year-to-year fluctuations in TFP growth. Because the X-factor was based on industry TFP trends, there were also strong performance incentives for individual firms. They also argued that a moving average of industry TFP growth passed through productivity growth in the same manner as a competitive market.

After seven years of debate, the ICC reversed its earlier decision and in 1989 added an X-factor to the railroad PCI. One reason for this change was that the railroad industry was beyond "the early, financially uncertain post-Staggers years".[16] But even more fundamentally, the ICC was convinced that workable definitions of TFP could be computed for the railroad industry and that the inclusion of a productivity factor was consistent with a fair and reasonable price standard.

The X-factor adopted by the ICC was a five moving average of the growth rate in an index of railroad industry TFP. This index was applied only to future index-based rate adjustments and earlier RCAF-based adjustments were not modified, as some intervenors advocated. The index is now computed and updated by the staff of the Surface Transportation Board, successor to the ICC. There is a two-year lag between the most recently available TFP data and the annual X-factor updates.

In adding an X-factor to the RCAF, the ICC strongly affirmed that industry-wide rather than individual company TFP trends were the proper basis for the X-factor. The main reason is that when prices reflect industry-wide productivity trends, returns for individual railroads are a direct reflection of their TFP performance relative to the industry average. All firms have both an opportunity and incentive to earn above-normal returns. Indeed, the ICC reasoned that "once we decide to reflect actual productivity in the (price cap) index, the industry average is the only reasonable target".[17]

It is also important to recognize that the railroad plan utilizes a *rolling* X-factor that is updated automatically on the basis of new TFP information. This updating occurs each year and substitutes for periodic regulatory reviews of the X-factor. The rolling X-factor in this plan therefore represents an extremely light-handed regulatory approach. The regulator does not review the performance or earnings of individual railroads and the PCI is updated automatically for relevant changes in the industry's unit cost.

CitiPower believes that this experience has some important lessons for Australia. First, a detailed review process that involved all interested parties ultimately convinced regulators that TFP measurement was both feasible and desirable. Indeed, in its Order approving a TFP-based X-factor, the ICC embraced the concept and touted its virtues. This is notable since the ICC was initially skeptical and rejected the idea as unworkable. This conclusion also came despite the opposition of some eminent economists working for the railroads.

16 According to a study by the U.S. government, the return on equity in the railroad industry rose from 2.3% in the 1970s to 9.0% in the 1980s; see *Railroad Regulation: Economic and Financial Impacts of the Staggers Rail Act of 1980,* General Accounting Office/RCED-90-80, May 1990, pp. 34-36.

17 Interstate Commerce Commission, *Railroad Cost Recovery Proceedings,* Ex Parte No. 290 (Sub-No. 4), March 22, 1989, p. 16.

Second, the ICC adopted an *industry* TFP standard as the basis for the X-factor. Some parties argued that any use of TFP must be company-specific, both to pass through that company's TFP gains and to reflect its particular circumstances. The ICC rejected this approach because of its relatively poor incentive properties. They explicitly adopted a competitive market paradigm and noted that an industry TFP standard creates the right opportunities and incentives for all firms to benefit from TFP growth.

Third, this decision shows that implementing TFP can be extremely light-handed. In this plan, it is actually the regulator itself that is responsible for computing TFP and updating the X-factor annually. This occurs on the basis of an agreed productivity measurement formula. There are no regular reviews of industry costs or earnings and the X-factor is updated automatically based on industry trends. While this is an extremely light-handed approach that is not the norm in most applications, it does show the extent to which external regulation can substitute for contentious review processes that often leave all parties unsatisfied.

4.2 North American Telecom Plans

The Federal Communications Commission (FCC) has issued landmark decisions on designing CPI-X regulation that are broadly consistent with the principles established in the railroad case. The first U.S. telecommunications price cap plan was approved for AT&T in 1989.[18] Inflation measures and industry TFP trends were discussed extensively in the proceeding. The X-factor reflected a productivity differential and a 0.5% 'consumer productivity dividend'. There was no input price differential since the Commission did not find evidence of a difference between the industry and economy input price trends.

Price cap regulation was approved by the FCC for the interstate services of Local Exchange Carriers (LECs) in 1991 and has continued to the present day. The need to calibrate the CPI-X formula to the industry unit cost standard is now explicitly recognized. For example, in a 1995 order dealing with the PCI for LECs, the FCC states that "the indexes are adjusted each year in accordance with a formula that accounts for industry-wide changes in unit costs".[19] Since GDPPI is the inflation factor, productivity and inflation differentials have been carefully examined in plan reviews.

Another important telecommunications price cap precedent applies to the Stentor companies in Canada. Stentor is an umbrella group that represents nearly every telecom carrier in Canada, including Bell Canada and BCTel. A price cap plan was approved for the Stentor companies by the Canadian Radio-Television and Telecommunications Commission (CRTC) in May 1997. In approving this plan, the CRTC made explicit reference to the competitive market paradigm employed in the FCC and ICC decisions. The CRTC stated that "the price cap formula is composed of three basic components

18 In 1996, competition in the markets served by AT&T led to the termination of this plan and the affected rates of AT&T were subsequently decontrolled.

19 Federal Communications Commission, *First Report and Order in the Matter of Price Cap Performance for Local Exchange Carriers*, cc Docket 94-1, April 7, 1995.

which, in total, reflect changes in the industry's long-run unit costs... These are (the) inflation index, productivity offset and exogenous factors".[20] Furthermore,

> "an X-factor should be based on data that are independent of the actions of any one individual company. As noted by Stentor, the use of an industry-wide X-factor has major benefits to consumers and the general economy as it will enhance companies' incentives to increase their efficiency. Further, the Commission notes that the use of an industry-wide X-factor rewards those companies that have achieved above-average productivity gains in the past and provides an appropriate incentive to those companies that have had below-average productivity in the past."[21]

In addition to the setting of X-factors, there is also an interesting history regarding the use of earnings-sharing mechanisms (ESMs) in CPI-X regulation for North American telecom companies. Many of the earliest such plans also included ESMs. For example, the CPI-X plan approved in 1991 by FCC for the LECs included a symmetric ESM (both gains and losses relative to allowed ROE were shared). One reason for this ESM is that the plan applied to eight different companies with service territories as diverse as New England and the Pacific Northwest. The FCC was concerned that regional economic growth and other conditions could vary across the companies and thereby influence the potential for productivity growth. The ESM was viewed in large part as a 'backstop' which would reduce this risk.

At around the same time, several state commissions approved price cap plans for telcom utilities that included ESMs. Examples included California (Pacific Bell and GTE-California in 1990), New York (Rochester Telephone in 1991), Rhode Island (1992) and New Jersey (1993). In these cases, ESMs were viewed primarily as earnings-sharing devices rather than risk-reducing 'backstops'.

Earnings-sharing mechanisms became rare in the North American telecom industry as price caps became the standard method of regulating telecom services. For example, the updated plan for the LECs subject to FCC jurisdiction did not include an ESM. ESMs have also become rare on the state level. Of the more than 25 states that currently use indexed price caps to regulate the dominant LEC, only one (Florida) includes an ESM. In place of ESMs, regulators have chosen to share benefits with customers through consumer dividends that are incorporated in X-factors.

CitiPower believes this experience also contains lessons for Australia. First, it shows that external regulation helps to facilitate more competitive markets. External regulation of telecom utilities was motivated in large part by its compatibility with competitive environments. Regulators believed that cost of service methods were too unwieldy and cumbersome in the fast-moving markets in which telecom companies operated. CitiPower has long emphasized the importance of promoting competition and having a regulatory framework that is compatible with this goal. Australian regulators recognize the importance of fostering competition, but most have not appreciated the link between regulatory methods and effective competition in contestable markets. This link has been acknowledged in North American telecom regulation and has played a significant role in enhancing the role of TFP relative to building block/cost of service methods.

---

20 *Price Cap Regulation and Related Issues,* Telecom Decision CRTC 97-9, May 1, 1997, paragraph 29.
21 CRTC, op cit, paragraph 48.

This experience also supports the view that ESMs can be useful for transitioning to a more delinked, external regulatory approach. In North America, some regulators initially had concerns with relying entirely on external measures to set CPI-X formulas, and ESMs were viewed as a backstop against completely delinking cost and price adjustments. Over time, more regulators grew comfortable with the concept, and ESMs became very uncommon in telecom CPI-X plans. CitiPower realizes that some Australian regulators will not be immediately comfortable with external regulation. For example, some regulators may believe they have an obligation to examine company costs, particularly if there has never been a detailed cost review. We believe that ESMs may help to allay regulators' concerns and increase their comfort in transitioning to more delinked approaches. CitiPower therefore believes that ESMs deserve serious consideration in the present environment.

4.3 Energy Distribution

CPI-X regulation is less common for North American energy utilities. However, there are several comprehensive CPI-X indexing plans for North American energy distributors. Below we briefly describe important TFP-related issues that have arisen in some of these proceedings.

Southern California Edison. The first CPI-X regulation plan approved for a North American power distributor was for Southern California Edison (SCE). This plan took effect in 1997 and will continue until the end of 2001. The X-factor in this plan rises from 1.2% in 1997 to 1.4% in 1998 and 1.6% in 1999-2001.

This X-factor was based on a TFP study that the company conducted of its TFP growth. This study showed that SCE's long-term TFP growth trend was 0.9% per annum. The Commission accepted this estimate. The overall X-factor therefore reflects this TFP trend plus consumer dividends that rise from 0.3% to 0.7% over the plan, with an average value of 0.56%.

In approving this plan, the California Public Utilities Commission (CPUC) said it would have preferred to use industry TFP measures as the basis for the X-factor. However, no party in SCE's proceeding presented evidence on industry TFP. The CPUC espoused a competitive market standard as the rationale for its preferred approach. It wrote:

> "The price and productivity values should come from national or industry measures and not from the utility itself. The independence of the update rule from the utility's own costs allows PBR regulation to resemble the unregulated market where the firm faces market prices which develop independently of its own cost and productivity. The productivity measure should come from a forecast of industry specific productivity."[22]

To comply with this standard, the CPUC has ordered SCE to provide evidence on industry TFP growth when its plan is updated.

Southern California Gas. The plan approved for Southern California Gas (SCG) represents the first approved for a Californian energy utility that used industry TFP research.

22 Application of Southern California Edison to adopt a Performance Based Rate Making Mechanism Effective January 1, 1995, Alternate Order of Commissioners Fessler and Duque, July 21, 1996.

SCG commissioned a study that showed a TFP trend for the U.S. gas distribution industry of 0.5% per annum. In reviewing this study, the CPUC staff were interested in developing their own TFP estimate and asked for the data used in the study. These data were compiled from publicly-available sources, but they were collected by the researchers themselves and are not available from a centralized source.[23] The data were provided to the CPUC staff subject to a confidentiality agreement and the staff proceeded to conduct their own TFP study. The staff's estimated TFP trend for the industry was identical to the 0.5% proposed by SCG. In light of this experience, the CPUC approved a 0.5% figure for industry TFP growth and ruled that this figure "elicited little criticism from the parties".[24]

Boston Gas. The X-factor approved for Boston Gas (BoGas) had four components: a TFP differential (i.e., the difference between industry and economy-wide TFP trends), an input price differential (i.e., the difference between economy-wide and industry input prices), a stretch factor and an accumulated inefficiencies factor. The first two of these components reflect the indexing logic presented in Chapter 2 when an economy-wide inflation measure is employed as the inflation factor. This was the case for Boston Gas, whose proposed inflation factor was the gross domestic product price index (GDP-PI), the official measure of GDP price inflation. By contrast, the SCG plan had an industry-specific measure of input price inflation, so only industry TFP trends were examined.

The Massachusetts Department of Public Utilities (DPU) approved an overall X-factor of 1.5%. The approved TFP trend for the gas distribution industry was 0.4%, which was the trend computed for the U.S. industry in a study commissioned by the company. However, the economy-wide TFP trend was 0.3%, so the TFP differential was 0.1%. The input price differential was measured to be -0.1%. Input prices in the industry were therefore shown to be growing 0.1% less rapidly than economy-wide input prices.

The approved stretch factor was 0.5%. The accumulated inefficiencies factor was equal to 1.0%. This factor is unique to Massachusetts and it is designed to reflect the accumulated inefficiencies of operating under cost of service regulation, which purportedly encouraged inefficient practices. The DPU first approved an accumulated inefficiencies factor of 1% in the indexing plan for NYNEX-Massachusetts. BoGas subsequently appealed the accumulated inefficiencies factor to the courts, which agreed that it had no evidentiary basis and ordered it to be eliminated.

San Diego Gas and Electric. San Diego Gas and Electric (SDG&E) was the first indexing plan approved for both the gas and power distribution operations of a combination utility. The company commissioned studies on industry TFP trends in both power distribution and gas distribution. The estimated TFP trends were 0.68% and 0.92% per annum for gas and power distribution, respectively. Although there was invariably criticism of these

---

23 These individuals are now employed with Pacific Economics Group (PEG).

24 Decision 97-07-054, *In the Matter of the Application of Southern California Gas Company to Adopt Performance Based Regulation for Base Rates*, July 16, 1997. It should be noted, however, that there was less agreement on other elements of the X-factor. SCG proposed a 0.5% consumer dividend, but the CPUC approved dividends that rose from 0.6% to 1.0% throughout the plan. The CPUC also added a 1.0% increment because SCG's capital stock was projected to decline during the plan. This is a fairly unique situation, and it is the only such instance of a North American CPI-X plan including an increment for a declining rate base.

studies from other parties, the CPUC accepted this evidence and added an average consumer dividend of 0.55% per annum. The average X-factors for gas and power distribution were therefore 1.23% and 1.47%, respectively.

Ontario power distributors. The Ontario Energy Board (OEB) has approved a CPI-X plan for power distributors in the Canadian province of Ontario. The OEB adopted a competitive market paradigm when setting the terms of the CPI-X formula. It wrote "PBR (performance-based regulation) is not just light-handed cost of service regulation. For the electricity distribution utilities in Ontario, PBR represents a fundamental shift from the historical cost of service regulation. It provides the utilities with incentive for behaviour which more closely resembles that of competitive, cost-minimizing, profit-maximizing companies".[25]

The X-factor was based on the TFP trend for the Ontario power distribution industry. These TFP studies were done for the OEB. The OEB examined both the five-year and 10-year trend when deciding on an industry TFP measure. It believed more weight should be placed on the longer-term trend but some weight should also be applied to more recent experience. It applied a two-thirds weight to the 10-year trend and a one-third weight to the five-year trend. This led to an industry TFP growth rate of 1.25%. A 0.25% stretch factor was added to this to arrive at an overall X-factor of 1.5%.

CitiPower believes that this experience is also valuable for Australia. TFP has clearly played an important role in CPI-X plans that have been approved for North American power and gas distributors. Regulators have also shown a decided preference for using industry TFP trends. In every case above but one, the industry TFP trend was the calibration point for the X-factor. The one exception is for SCE and in this instance the Commission used company TFP trends only because industry measures were not available. We believe this experience shows that the competitive market paradigm is widely used to calibrate the terms of CPI-X formulas for energy utilities.

Second, this experience shows a high degree of acceptance of the TFP studies sponsored by utilities. In spite of the antagonistic nature of North American regulatory proceedings, in nearly every instance the final TFP figure approved by the Commission was identical or nearly identical to the industry TFP trend proposed by the company.[26] One notable example is the TFP research for Southern California Gas. Here, the Commission staff was provided the same data used in the company's study and was given carte blanche to develop its own TFP estimate. The trend it estimated was identical to that proposed by

25 Ontario Energy Board, *Decision With Reasons*, RP-1999-0034, January 18, 2000, p. 13.

26 To our knowledge there is only one significant counter-example. The plan recently approved for the power distribution operations of Central Maine Power (CMP) also featured TFP studies that were performed by outside parties. However, the firm performing the study for CMP changed their techniques and TFP estimates at various points during the proceeding. The final terms of CMP's CPI-X plan were reached in a stipulation agreement between most interested parties. The Maine Public Utilities Commission only had to decide whether or not to approve this stipulation and did not have to make a specific finding on the industry TFP trend. However, the approved X-factors, ranging from 2% to 2.9% over the course of the plan, were nearly identical to those proposed by the Office of the Public Advocate and were substantially different from those supported by CMP. This does not discredit the notion of TFP but only shows that, in the words on one witness, "repeated revisions have undermined the credibility" of the company's TFP evidence (Surrebuttal testimony Neil Talbot and Ron Norton on Behalf of the Office of the Public Advocate, p. 15).

the company. CitiPower believes that this experience compares favourably with most building block and cost of service proceedings, which are often characterised by a high degree of mutual suspicion and mistrust by companies and regulators.

Third, there has also been a very high degree of consistency in the magnitudes of industry TFP trends and stretch factors approved in these plans. This is evident in the table below.

	Power Distribution		**Gas Distribution**	
	Industry TFP	Consumer Dividend	Industry TFP	Consumer Dividend
SCE	0.90%	0.56% (average)		
Ontario	1.25%	0.25%		
SDG&E	0.92%	0.55% (average)	0.68%	0.55% (average)
SoCalGas			0.50%	0.80% (average)
BoGas			0.40%	0.50%

While this is a small sample, it does represent the lion's share of currently approved CPI-X plans for North American energy utilities. It clearly shows a high degree of convergence among the estimated TFP trends for both industries, although power distribution TFP is growing somewhat more rapidly than gas distribution TFP.[27] Perhaps even more surprising is the similarity in approved consumer dividends. All consumer dividends average between 0.25% and 0.80% per annum and most are only slightly greater than 0.5%.

Overall, we believe this experience is positive. It suggests that TFP is a well-founded technique that tends to produce stable results in repeated applications. These TFP studies also compare favourably with either building block CPI-X regulation or 'classic' rate of return regulation in terms of stability and predictability. Many Australian regulators have expressed a desire to create stable and predictable regulatory arrangements, which are rightly seen as critical for attracting investment to infrastructure industries without having to offer large risk premiums to investors. CitiPower believes that the experience presented in this chapter suggests that external regulation and the use of industry TFP to set the terms of CPI-X formulas can help to achieve these goals.

27 This consistency is even more remarkable since it comes from different time periods and different countries (i.e., Canada and the United States).

5. Conclusions and Directions for Australia

CitiPower offers this Paper to the Utility Regulators Forum in the hope of furthering the debate on external regulation in Australia. The Forum commissioned a Discussion Paper that questioned the practicality of using external benchmarks, particularly TFP, in utility regulation. We have already stated that we believe these difficulties are overstated. We believe that the evidence presented here further supports our view and shows that, far from being controversial and impractical, external regulation compares favourably compared with the building block approach to CPI-X regulation.

CitiPower also hopes that this Paper serves as a springboard for TFP research for Australian energy utilities. This report has provided an introduction and a framework for TFP measurement. It has also shown that TFP practitioners have developed rigorous and tested methods for dealing with implementation issues that, according to some Australian observers, are difficult to resolve (e.g. aggregating inputs and outputs, 'lumpy' capital investment, etc.). Computing TFP for utility industries is therefore a feasible and practical exercise, but this can only be demonstrated in an Australian context by beginning real work on TFP measurement.

CitiPower understands that implementing external regulation in Australia is likely to present certain challenges. For example, demand growth is largely beyond utility control and can influence TFP growth (e.g. through the realisation of economies of scale). One way of dealing with this may be an econometric decomposition of TFP growth into different components, including a portion related to the realisation of scale economies. Under this approach, the portion of TFP growth that is related to demand growth can vary depending on differences in local demand. This approach has been discussed in the academic literature and, while it has not been applied to our knowledge, it is straightforward in principle and can be implemented easily.[28] Other, related issues can be addressed using methods that are well developed overseas but less common in Australia. For example, earnings-sharing mechanisms can help to control 'windfall' gains (or losses). This can help to keep returns in a politically acceptable range without actually involving regulators in the detailed examinations of company costs that are characteristic of the building block approach. CitiPower believes that a full and open investigation into using TFP in regulation can help to resolve these issues. We believe the time has come for innovative thinking and moving forward on external regulation, especially given its potential benefits to all Australian stakeholders.

28 For a discussion of this concept, see F. Kiss, 'Constant and Variable Productivity Adjustments for Price Cap Regulation', in *Price Caps and Incentive Mechanisms in Telecommunications*, Norwell, MA, Kluwer Academic Publishers, 1990. In terms of its practicality, econometric decompositions of TFP growth have been presented in some North American proceedings (e.g. for SDG&E).

Capstone MicroTurbine™

Photos courtesy of Capstone Turbine Corporation
www.capstoneturbine.com