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Market-oriented reform in the Australian electricity industry

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Abstract

In this paper, the costs and benefits of reform of the electricity industry in Australia are assessed. Issues addressed include the National Grid and the National Electricity Market, corporatisation, competitive restructuring, regulation, and privatisation.

Keywords

electricity spot markets privatisation corporatisation Australia microeconomic reform

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Introduction

From World War II until the early 1980s, electricity in Australia was provided by public monopolies owned primarily by state governments, and operated as statutory authorities. Although the arrangements differed in their details, the electricity industry in each state was characterised by a high degree of vertical and horizontal integration and, except in crises such as the widespread blackouts in New South Wales during the late 1970s, a substantial degree of autonomy. The major authorities were controlled primarily by engineers, and pursued objectives defined in terms of meeting the needs of households and business for a reliable supply of electricity, with prices being set to cover average costs.

The reforms[1] of the 1980s and 1990s were designed to change almost every aspect of the pre-reform institutional framework. The integrated, state-owned and bureaucratically run electricity monopolies would be replaced by a profit-oriented, privately-owned industry, operating in a competitive national market characterised by a clear separation between the activities of generation, transmission and distribution, and retailing. Consumers would be able to choose their supplier in a competitive retail market. With the partial exception of privatisation, which was rejected in several states, these reforms were nearing completion by 2000.

The reform program in the electricity industry consists of a number of elements,

[1] The term 'microeconomic reform' is generally accepted as referring to a wide range of market-oriented policy initiatives of the 1980s and 1990s, including those affecting the electricity industry. Some of these policy initiatives have increased welfare and others have not. In using the term 'reform', it is necessary to focus attention on the literal meaning 'change in form', without necessarily adopting the connotation 'change for the better'.

which are logically independent, but mutually supportive. First, there is the creation of the National Grid and the National Electricity Market. Second there is the process of corporatising government business enterprises engaged in electricity supply. Third is the restructuring of the industry and the separation of generation, distribution and retail functions. Fourth is the regulation of natural monopoly activities such as electricity transmission and distribution. Finally, the reform process is regarded as complete when the industry is fully privatised.

Most commentators on the reforms have concluded that they have been highly successful in increasing efficiency and reducing electricity prices. By contrast, discussion of similar reforms in the United States and the United Kingdom has been considerably more critical, in part because, in some instances, electricity prices have increased substantially. In this paper, the costs and benefits of reform of the electricity industry are assessed. Following a brief discussion of international experience, each of the five components of the reform program discussed above is analysed in turn and the outlook for the future is considered.

International Experience

Although a variety of pooling arrangements have been adopted in many jurisdictions, the recent upsurge in the creation of electricity markets may be traced to the national market established in the United Kingdom by the Thatcher government following the privatisation of the British electricity industry.

As with the Australian case, discussed in detail below, the British system allowed for electricity to be sold both through long-term contracts and through a spot market or 'Pool'. Although most evaluations of the electricity reforms in the United Kingdom have been, on balance, positive, serious problems emerged. To maintain high sale prices, the generating component of the former public monopoly was divided into only two main firms. In combination with design features of the Pool, this gave rise to opportunities for

the two main suppliers to extract monopoly rent through strategic bidding (Green and Newbery 1992). In 1998, the Pool was abolished. Opinion remains divided as to whether this decision was an appropriate response, or whether design changes to the Pool could have yielded superior outcomes, as argued by Newbery (1997).

Apart from the the United Kingdom model on which the design of the Australian electricity market was based, most Australian discussion of electricity markets overseas has focused on experience in the United States, and, in particular, on the failure of the Californian electricity market. The Californian market was established at a time of excess supply of electricity, and took the opposite approach to that embodied in the 1998 reforms in the United Kingdom. Long-term contracts were prohibited and all sales were required to go through the spot market. Moreover, retail prices for most consumers remained fixed.

Problems with the Californian system did not become evident until the (northern) summer of 2000, when the system was barely able to meet peak demands. By the end of 2000, the market price of electricity had risen from $50/MWh to $500/MWh. The main distributors, Pacific Gas and Electric and Southern California Edison, who were required to buy electricity at market prices and sell it at fixed retail prices, faced bankruptcy. On January 8, 2001, the state Governor announced that the deregulation scheme, which he called a ‘ colossal and dangerous failure’, would be abandoned (Davis 2001).

Supporters of the Australian electricity reforms have generally sought to play down the difficulties experienced in the United Kingdom and to argue that the failure of the Californian system was due to incomplete deregulation and, in particular, the cap on retail prices and the prohibition of long-term contracts. The latter claim has some validity, but is subject to important qualifications.

First, as will be argued below, any system of electricity markets faces a tension between the short-term function of electricity prices in allocating a scarce and nonstorable resource and the long-term function of providing appropriate investment signals. Neither

in the United Kingdom nor in California have these roles been properly reconciled.

Second, many Australian advocates of electricity reform have relied on short-term experience of declining prices to argue that the reforms have been beneficial. As the Californian experience shows, an excessive focus on reducing prices in periods of excess supply can contribute to system failure in periods of excess demand.

Finally, it is always possible, *ex post*, to explain the failure of a system in terms of inappropriate implementation. A crucial feature of system design is that systems should be robust to minor errors and unexpected shocks. Repeated failures, no matter how easily explicable in retrospect, are evidence that the system as a whole is flawed. It is necessary to consider the extent to which the Australian system has the robustness required for a system in which even brief failures are extremely costly.

The National Grid and the National Electricity Market

This section describes the process leading up to the creation of the National Grid and the National Electricity Market. More detailed chronologies are given by the Industry Commission (1995a) and Rann (1998).

The National Grid

As was economically rational in the light of Australia's geography, separate electricity supply industries were initially established in each state.[2] Limited connections between Victoria and New South Wales were established as part of the Snowy Mountains Hydro-electric Scheme, which also created a new generator, the Snowy Mountains Hydro-electric Corporation. A link between Victoria and South Australia was added subsequently. Moves towards a National Grid encompassing all states and territories except Western Australia and the Northern Territory began with the establishment of the National Grid Management

2 The example of the railways suggests that this would have happened even if it was not economically rational.

Committee in 1991.

In physical terms the National Grid involved the expansion of existing interstate links and the creation of a range of new links including Riverlink (between New South Wales and South Australia), Basslink (between Victoria and Tasmania) and Eastlink (between New South Wales and Queensland). The plans for the National Grid also allowed scope for private initiatives to construct additional links. In practice, most of the additional links ran into political and environmental difficulties. Riverlink was rejected by the South Australian government when it appeared likely to reduce the sale price that could be realised in the privatisation of ETSA, the state electricity enterprise. Basslink was the subject of extensive debate, and a decision to support its construction by a private consortium was only announced by the Tasmanian government in February 2000. Eastlink was abandoned in favour of an alternative route (Westlink) with completion expected in 2001. As a result of these delays, the national electricity market is still only partially integrated, with different prices prevailing in different states. The creation of a fully operational National Grid is still some years away.

The creation of a National Grid is a necessary condition for the creation of a National Market, but it does not necessarily imply the creation of such a market. In a different policy environment, the decision to build a National Grid could have been the precursor to the establishment of a unified national electricity supplier comparable to Telecom Australia. More realistically, the existing arrangements for trade between the states could have formed the basis for the more frequent and extensive trading made possible by the National Grid.

The National Market

Following the agreement to construct a National Grid in 1991, attention turned to the design of a National Electricity Market, modelled primarily on that of the United Kingdom. Although it was already evident that the British model had serious flaws, it was

hoped that Australia could learn from the British experience. The process of designing and implementing the National Electricity Market was undertaken jointly by the National Grid Management Committee and the Council of Australian Governments (COAG).

The core of the Market was the creation of a continuous-time auction market, in which generators and users enter bids on a half-hourly basis. Each bid takes the form of a supply or demand schedule indicating willingness to supply or demand electricity. These bids are combined to form aggregate demand and supply schedules.

Because available capacity and consumption can fluctuate, market clearing is undertaken at five-minute intervals. The intersection of the aggregate demand and supply schedules determines the dispatch price required to equate demand and supply for the given five-minute period. All generators with bids less than or equal to the dispatch price have their bids accepted, and, conversely, all users with bids greater than or equal to the dispatch price have their demand met. These prices are averaged over a half-hour period to determined a spot price, which is the price received by generators and paid by purchasers. In addition to spot purchases, participants in the market may enter into long-term bilateral contracts or trade in a forward market. The Australian spot and forward markets are operated by a private limited-liability company — the National Electricity Market Management Company (NEMMCO).

Competition and prices

Much discussion of electricity reform in Australia is based on the assumption that 'competition reduces prices'. Hence, the decline in the cost of electricity, at least for contestable users, that has occurred since the introduction of the National Electricity Market, is seen as evidence that the reforms are working well.

Such an interpretation is simplistic. Assuming that pre-reform prices included an element of monopoly rent, the average price should be reduced by the introduction of a competitive market. Under competition, the long-run average price should be driven

down to equal the long-run average cost of a technically and allocatively efficient producer. The Industry Commission (1995b) estimated that the achievement of world best practice would reduce the cost of electricity generation, transmission and distribution by around 20 per cent, though this estimate was criticised by Quiggin (1996).

In the short term, however, the reduction in costs resulting from competitive long-run average pricing will generally be small in relation to the greater variability in prices associated with the operation of the spot market. The dominant effect of the introduction of a competitive spot market will be to push prices below long-run average cost in periods of excess capacity and to raise prices above long-run average cost in periods of excess demand. As will be shown below, this variation in prices is crucial if the electricity market is to perform its allocative function and provide appropriate investment signals.

Planning and prices

Before the introduction of the National Electricity Market, the electricity supply industry operated on the basis of central planning. New generating capacity was constructed on the basis of estimates of future 'needs', sometimes subject to constraints on the availability of capital. Short-run operation of the system relied on the concept of an 'order of merit' that determined which units of generating capacity would be used to supply demand. Broadly speaking, low-cost 'baseload' stations were designed to operate continuously, supplemented by higher-cost peakload capacity in periods of higher demand.

In an electricity market, the central planner is replaced by price signals. In the short run, generators submit bids specifying their willingness to supply electricity at particular prices. These bids are matched with demand from purchasers of electricity to determine the spot price. The spot price not only equilibrates the market in the short term, but also provides firms with information on the likely profitability of investments in new generating capacity

As would be expected, under standard assumptions, a perfectly operating electricity

market will produce exactly the same outcomes that would be chosen by a central planner seeking to maximise aggregate producer and consumer surplus. This point may be illustrated by considering a radically simplified model of the electricity market.

Suppose there are two possible states of demand, normal and peak, with associated demand curves $D^n(p)$ and $D^p(p)$. In a given year, the state of demand is normal with frequency θ and peak with frequency $(1-\theta)$. Suppose also that there are two fixed-proportions generating technologies, baseload and peak, and confine attention to solutions in which both technologies are used. The baseline technology has an annualised capital cost of K^b per unit of generating capacity, and an operating cost of c^b per unit of electricity supplied. The peak technology has capital cost $K^p<K^b$ and operating cost of $c^p>c^{p\cdot}$. Then the market equilibrium will have normal and peak prices p^n and p^p such that

$$p^p = c^p + K^p/\theta$$

$$\theta p^n + (1-\theta)p^p = K^b + c^b$$

and that the corresponding levels of generating capacity are those that would be chosen by a perfectly informed planner. In this case, the order-of-merit rule is to operate baseload capacity continuously and peak capacity in peak periods only, the same solution as in the market equilibrium.

As in the planning debate between Hayek (1937) and advocates of market socialism such as Lange and Taylor (1948) and Lerner (1944), advocates of the electricity market argue that a smoothly functioning market will achieve automatically the outcomes that would be chosen by a perfectly informed planner pursuing an efficiency objective. Since, in practice, planners are not perfectly informed and are likely to pursue private objectives, the market is to be preferred.

Welfare analysis

The welfare effects of changes in prices can be analysed, under the standard assumption

of a representative consumer, using the theory of price indexes. In the simple example, set out above, consider a move from some uniform price p_0 to the price pair p_1^n and p_1^p. Let

$$q_0^n = D^n(p_0),\ q_0^p = D^p(p),\ q_1^n = D^n(p_1^n),\ q_1^p = D^p(p_1^p).$$

The change in the welfare of the representative consumer is bounded below by $p_0(q_0^n+q_0^p)-(p_1^n q_0^n + p_1^p q_0^n)$, the reduction in the cost of the original consumption bundle, and bounded above by $p_0(q_1^n+q_1^p)-(p_1^n q_1^n + p_1^p q_1^n)$, the extra cost of purchasing the final consumption bundle at the original price. In particular, assuming $p_1^n < p_0 < p_1^p$, so that $q_0^n < q_1^n$, $q_0^p > q_1^p$, this implies that the change in consumer welfare is overstated by considering the reduction in the quantity-weighted price of electricity, but understated by considering the change in the average daily or hourly price.

For a complete evaluation it is also necessary to take account of changes in producer surplus, tax revenues and external effects. It is clear that producer surplus has declined, but measurement of the decline is complicated by the structural changes in the industry. Similarly, the study of tax revenue is complicated by the imposition and removal of various special levies during the reform process. Environmental externalities are discussed below.

Weaknesses of the price mechanism

The crucial feature that distinguishes the spot electricity market from most other markets for goods and services is the variability of prices. Even in the most variable commodity markets, it is rare for prices to vary by more than a factor of ten in the course of a single year. By contrast, in the National Electricity Market prices routinely vary by a factor of 500 from one day to the next. Whereas prices in periods of excess capacity usually vary between $20/MWh and $40/MWh, the price in periods of excess demand frequently reaches the maximum of $10 000/MWh. Although periods of excess demand are rare, they account for a significant proportion of the annual revenue accruing to

generators. For example, if the price is normally $20/MWh, but reaches the peak price of $10 000/MWh for four hours during each of four days per year, these four days will account for approximately half of the annual revenue accruing to generators.

A number of difficulties arise here. First, there is the regulatory limit of $10 000/MWh. The theory underlying the spot market is based on the absence of any such regulatory constraints. There is no clear justification for the choice of an upper limit of $10 000 as opposed to say $5000 or $20 000, yet these alternative choices lead to large differences in the annaul revenue accruing to generators. This in turn implies that investment signals will be significantly distorted by the choice of an inappropriate upper limit.

A second set of difficulties, at least in the short term arises from the fact that most final consumers are not connected to meters sufficiently sophisticated to respond to price variations (or even, in many cases, time-of-day variations). Hence, the demand side of the price signalling mechanism is ineffective. Moreover, the mismatch between highly variable producer prices and fixed consumer prices requires wholesalers to absorb variation in their margins or to seek insurance against price variations.

The third problem arises when suppliers possess market power. Because short-run demand is highly inelastic, even modest market power can yield large monopoly rents (London Economics 1995; Industry Commission 1995a). These issues, and the effectiveness of competitive restructuring as a response, are discussed below.

The market and the environment

Electricity production gives rise to a number of environmental externalities of which the most important is the emission of carbon dioxide as a result of the combustion of carbon-based fossil fuels. Carbon dioxide is the most important of the 'greenhouse gases' which contribute to global warming (Intergovernmental Panel on Climate Change 1995).[3]

[3] As a referee points out, separate issues arise with hydroelectricity. In the construction phase, flooding of valleys can give rise to methane emissions. However, as no new hydroelectric projects are under serious consideration in Australia, any costs associated with methane emissions may

A standard externality analysis implies that the environmental damage should be offset by a Pigovian tax, set equal to the marginal damage associated with carbon dioxide emissions. In the case of global warming, the relevant variable is the amount of carbon consumed, so that the proposed Pigovian tax is commonly referred to as a carbon tax. Alternatively, users of carbon-based fuels could be required to hold tradeable emissions permits set at a level such that the market price of permits is equal to marginal environmental damage.

The short-run impact of the National Electricity Market has been to reduce prices in periods of low demand to levels approximately equal to the market cost of the fuel consumed in generation. This reduction in prices has contributed to an increase in total greenhouse gas emissions from electricity generation, which rose from 129.1 million tonnes in 1990 to 168.6 million tonnes in 1998 (Australian Greenhouse Office 2000, table 1-5).

Since the market price of fuel does not incorporate any implicit or explicit externality charge, it is reasonable to conclude that the price of fuel (and therefore the price of electricity) is below the socially optimal level, and therefore that the operation of the National Electricity Market has contributed to excessive consumption of electricity and fossil fuels.

The adverse environmental effects of the National Electricity Market are likely to be reduced in the long run, as excess capacity is reduced by the retirement of older coal-fired plants, and as carbon taxes or similar market-based policies to reduce emissions are introduced. However, as Keynes appositely observed, in the long run we are all dead.

Corporatisation

Until the 1980s, most organisations in the electricity supply industry were statutory authorities. Statutory authorities were themselves an organisational innovation arising

be regarded as 'sunk'

from the recognition that the organisational structure of a government department was not appropriate for an organisation primarily involved in the production of marketed goods and services.

The organisation of a government department is based on the principle of ministerial responsibility. The department is directly accountable to the minister on a day-to-day basis. Conversely, in the pure Westminster theory, the minister is personally responsible, and accountable to Parliament, for all actions of the department.

The idea of the statutory authority was to provide organisations with substantial operational independence, while requiring them to pursue the policy objectives set by the government. Since these objectives typically involved trade-offs between the interests of taxpayers, employees, consumers and public interest groups, statutory authorities were commonly managed by boards made up of representatives of these groups.

Critics of the statutory authority model of service provision argued that government policies should be directed to the achievement of specific, sharply–defined objectives (the term 'transparent' was commonly used), rather than being justified in terms of a broadly-defined notion of the public good. Critics sought to clarify the objectives of government agencies, and to require that, if policies were justified in the name of particular objectives, they should be funded out of the relevant budget. The idea of transparency was used to justify the replacement of statutory authorities, whose managers had a general objective of promoting the public interest, with corporatised enterprises, which were directed to maximise profits subject to the satisfaction of specific 'Community Service Obligations' (CSOs).

In form, corporatisation normally involves the replacement of government agencies or statutory authorities with a corporation operating under the company laws applicable to private corporations but with all the shares (at least initially) owned by the government. In some cases, government-owned corporations may be set up under special legislation differing in some respects from that applicable to private corporations.

The main substantive change associated with corporatisation is the abandonment of the idea that government business enterprises should pursue a social welfare objective. Like private sector managers, the managers of a corporatised public enterprise have a fiduciary obligation to maximise profits, subject to regulatory or other external constraints.

Governments may, if they choose, impose a community service obligation under which some users pay less than the costs of the services that they consume. The cost of the community service obligation is then included as a payment from the budget to the enterprise. Community service obligations have been relatively unimportant in the electricity sector — the most important have been the provision of subsidised access in some rural areas and limited discounts for pensioners.

Corporatisation was highly successful in the goal of increasing the profitability of the publicly owned electricity industry. The case of South Australia is typical. From 1946 until 1 July 1995 the generation, transmission and distribution of electricity in South Australia was undertaken by a state government instrumentality, the Electricity Trust of South Australia. The Trust was corporatised under the name ETSA in 1995, after several years of organisational changes that had already created a commercial orientation. From 1992-93 to 1998-99, earnings before interest and tax rose from $232 million to $433 million. Reductions in employment contributed substantially to growth in profitability. From 1992-93 to 1998-99, the number of employees fell from 4200 to 2300

Efficiency gains and transfers

The improvements in the profitability of electricity enterprises following corporatisation may be traced to two main sources. First, as noted above, there were large reductions in employment, although these were partly offset by increased use of contractors. Reductions in employment were feasible for a number of reasons. First, because labour costs were a relatively small proportion of total costs (between 30 and 40 per cent in most cases), and because the costs of disruptions to electricity supply were high, unions were in a strong

bargaining position in the pre-reform period. Hence, unions were able to impose a range of work practices, pejoratively referred to as 'featherbedding', which reduced the effort required from employees. Union power was eroded by the high unemployment and institutional changes of the 1980s, and this permitted employers to impose work practices which required higher levels of effort. Second, the statutory authorities were largely managed by engineers, who placed a high weight on the reliability of electricity supply, and therefore favoured high expenditure on maintenance. Corporatisation resulted in a transfer of power to financially-oriented managers, who sought to reduce apparently unnecessary maintenance costs.

In the short run, increases in work effort are primarily a transfer from employees to employers. Some workers are made redundant and therefore suffer a reduction in wage income, while the employer benefits from the corresponding reduction in costs. The workers who remain must supply more effort for the same wages, and therefore receive a lower wage per unit of effort.

Assuming that the original situation of low work effort represents a suboptimal contract, in that workers would prefer to work harder in return for a commensurate increase in wages, and that workers made redundant in the electricity industry ultimately find employment elsewhere in the economy, the elimination of 'featherbedding' will produce a net welfare gain in the medium term. However, since workers will still be worse off, the increase in profitability overstates the net efficiency gain for the economy.

The second major source of improved profitability has been a reduction in excess capacity. In part, this was simply a recovery from over-optimistic investments during the late 1970s and early 1980s, and should not be attributed to reform. Similarly over-investment and overcapacity is regularly observed in capital-intensive private sector activities, such as the office construction market in the late 1980s. Reductions in excess capacity also arose because the managers of corporatised electricity enterprises were generally willing to operate with less reserve capacity than the engineering-oriented managers of the former

statutory authorities. The implications for security of supply are discussed below.

Competitive restructuring

Before the reforms, the Australian electricity industry displayed a high degree of vertical and horizontal integration (at least within any given state). The archetypal form of industry organisation was that of an integrated state-owned monopoly which provided all electricity services, from generation, transmission and distribution to metering and billing, for the entire state. Integration was less complete in some states. In New South Wales, distribution was undertaken by county councils and in Queensland by regional electricity boards. On the other hand, vertical integration sometimes extended beyond the electricity industry (as normally defined) to include coal mining at one end of the production chain[4] and the sale and repair of electrical appliances at the other.

A crucial element of the reforms was vertical and horizontal disintegration of the industry. Vertical disintegration was undertaken by separating the industry into separate components of generation, transmission, distribution and retailing. Each of these components was horizontally disaggregated into separate firms to encourage competition.

An aggressive approach to horizontal disaggregation was consistent with the policy atmosphere of the early 1990s, which saw, for example, the construction of parallel optical fibre telecommunications networks in several Australian cities. It was also encouraged by a critical evaluation of the British electricity market. The general practice in British privatisations was to sell monopoly enterprises such as British Telecom and the London Airports Authority intact in order to maximise the sale price. This practice was criticised by commentators such as Domberger and Piggott (1986) because opportunities to make markets more competitive were foregone. In the case of electricity, the main generation component of the former Central Electricity Generating Board was broken

[4] Vertical integration between coal-mining and electricity generation in the United States is analysed by Joskow (1985).

into two private firms, National Power and PowerGen. (The unprofitable nuclear electricity plants were retained in public ownership.)

Green and Newbery (1992) examined the British market design, and concluded that the market structure would allow for the extraction of substantial monopoly rents. A crucial analytical issue arises from the fact that the market design requires the submission of price schedules rather than prices (leading to Bertrand competition) or fixed quantities (leading to Cournot competition). Klemperer and Meyer (1989) show that duopoly competition in supply schedules produces an indeterminate outcome. Any price–quantity pair from the joint-profit-maximising monopoly price and aggregate supply to the perfectly competitive Bertrand outcome may be supported as a Nash equilibrium. Within this range, producers prefer higher prices and lower quantities. Klemperer and Meyer (1989) present an alternative equilibrium concept. Grant and Quiggin (1994) show how this concept may be applied to yield a markup-pricing equilibrium intermediate between the Cournot and Nash cases.

Economies of scale and scope

The designers of the Australian National Electricity Market sought to avoid the anticompetitive features of the British market, and therefore encouraged the breakup of state electricity generation enterprises on horizontal as well as vertical lines. Electricity suppliers were browen into separate generation, transmission and distribution and retail enterprises. In addition, integrated electricity generators were broken into a number of competing firms, while distributors were broken up into separate firms, each with a monopoly in a given region.

The restructuring of the electricity industry was based on the presumption that economies of scale and scope are relatively unimportant. The vertical separation of generation, transmission and distribution eliminates any economies of scope that might have arisen with an integrated supplier. Moreover, the creation of a number of small

generators implies the loss of economies of scale that might be achieved by larger firms.

Empirical evidence on this issue is mixed. Christensen and Greene (1976) estimated that in 1970, the flat component of the cost curve ranged from about 20 to 67 terawatt-hours per year, corresponding to generating capacity of between 5 and 12 gigawatts of generation capacity, with an optimum of 33 terawatt-hours per year (8 gigawatts of capacity). By contrast, the Industry Commission (1995a) cited the conclusion of London Economics (1995) that the optimal aggregate capacity for a generating enterprise is 3 gigawatts and that diseconomies of scale may be observed when capacity exceeds 6 gigawatts.

For comparison, ABARE (1995) estimated total electricity consumption in the four states currently linked to the National Grid at 140 terawatt-hours per year (25 gigawatts of capacity) for 1993-94. On the Christensen–Greene estimates, ignoring interconnection problems, this demand could be met most efficiently by an industry with four generation enterprises. Taking account of interconnection limits, the technical optimum would have three generators operating in the New South Wales–Victoria market, and one each in Queensland and South Australia. This is exactly the configuration that prevailed prior to restructuring. By contrast, the London Economics estimates imply that the optimal organisation would have at eight generators, and that substantially larger numbers of firms are consistent with efficient production.

The Industry Commission (1995a) argues that the optimal scale of operation has declined over time, primarily because of increased reliance on gas-fired plants which have a lower minimum efficient scale, and because markets provide alternatives to coordination activities undertaken within firms. On the other hand, Christensen and Greene (1976) concluded that the minimum efficient scale doubled between 1955 and 1970 and that the optimal scale rose by 60 per cent. It seems likely that, for a given fuel mix and market structure, the optimal scale of operation is increasing over time. This conclusion is consistent with the observation of large-scale mergers between private electricity enterprises.

An alternative interpretation of the restructuring process is that the breakup of state electricity monopolies is a prelude to reintegration of the industry through mergers between companies operating in different states, most of which, in turn, would be subsidiaries of multinational electricity enterprises. On this view, economies of scale and scope may be captured by a 'multi-plant' enterprise operating in widely disparate locations.

Retailing, wholesaling and distribution

Other unresolved issues in relation to vertical disintegration relate to the retailing function. The separation of retailing and distribution is based partly on the belief that consumers will benefit from a choice between completing packages of electricity pricing and billing, and partly out of concern to limit, as far as possible, the natural monopoly component of the industry. However, for most households, and particularly in the absence of sophisticated metering, electricity is a fairly simple commodity. Assuming prices are set at an appropriate level, it may be that most householders will prefer to continue buying their electricity from the distributor as they have done in the past.

The object of policy should be to permit the natural market outcome to emerge, without allowing unfair exploitation of upstream monopoly power by distributors. The various state electricity codes contain structural separation provisions designed to achieve this end, but their performance has yet to be fully tested.

Because most consumers have little experience of choosing between electricity suppliers, special consumer protection regulations have been introduced to ensure that competing retailers adhere to appropriate codes of conduct. The experience of the tele-communications industry, where a range of dubious marketing practices had been observed, was important in guiding policy in this respect. However, it is reasonable to expect that, over time, industry-specific consumer-protection regulations will be replaced by reliance on general consumer law, possibly extended to cover the special characteristics of infra-structure services.

The organisation of the National Electricity Market and the retail electricity market also implied the creation of a wholesaling function in electricity. Since electricity is purchased in five-minute blocks in the market, while retail consumers face constant prices over periods of a month or a quarter, it is necessary that some market participant should undertake the function of buying electricity at the spot price and supplying it in wholesale quantities at a stable wholesale price. This function is conceptually distinct from the retail activity of providing metering and billing services in return for a markup on the wholesale price. In much discussion of the electricity market it seems to be assumed that wholesaling will be integrated with retailing. However, the wholesaling function must be primarily concerned with risk management, while the retailing function is concerned with customer service. It seems unlikely that joint provision of wholesale and retail services will yield positive economies of scope.

Regulation

Before reform,the statutory authorities responsible for the supply of electricity were largely self-regulating.The authorities were accountable to ministers and therefore ultimately to Parliament but, in normal circumstances, were left to manage their own affairs. Although enterprises were normally expected to cover their costs, and often to generate a surplus sufficient to fund capital expenditure, they were not expected to act as profit-maximising firms. Rather, it was assumed that they would act in the public interest.

When statutory authorities were corporatised and privatised, it was hoped that price signals from competitive markets would lead them to act in a socially optimal ways. This assumption clearly did not apply to the natural monopoly components of the industry (transmission and distribution). Thus, some form of regulation was needed to prevent the exploitation of monopoly power.

The crucial regulatory issues relate to the pricing and access policies of enterprises engaged in electricity transmission and distribution. The issues are simplest in the case of

a ‘stand-alone’ enterprise supplying a homogeneous service such as transmission of electricity. In the absence of regulation, such an enterprise would charge the monopoly price, capturing rent and distorting the prices faced by consumers.

Australian regulators have faced issues of this kind in a number of different industries as a result of microeconomic reform. Although the policies adopted have varied as the results of differences in the regulatory stance of regulators in the various jurisdictions and of differences in the circumstances of particular enterprises, a standard approach to the setting of prices for monopoly operators has emerged. This approach has five main elements:

(i) the estimation of current efficient operating costs;

(ii) choice between a revenue cap and a price cap;

(iii) the use of a CPI-X mechanism to encourage efficiency improvements over time;

(iv) determination of an optimised capital base; and

(v) calculation of a market-equivalent rate of return;

These elements may be considered in turn. The estimation of current efficient operating costs is conceptually straightforward, although in some cases, it may be technically complex.

A typical revenue cap rule is

$$R_t = e^{-xt} C_o + \rho K_t,$$

where

R_t is real revenue in period t;

C_o is the estimate of current efficient operating cost;

x is the required rate of real efficiency improvement;

ρ is the market rate of return for assets with comparable risk characteristics; and

K_t is the optimised capital base for period t.

A typical price cap rule is

$$R_t = (e^{-xt}C_o(Q_t)+\rho K_t)/Q_t,$$

where Q_t is an estimate of the volume of output in period t and cost $C_o(Q_t)$ incorporates an element of variable cost. Relative to a revenue cap, the price cap transfers quantity risk from consumers to the regulated firm.

The idea of a CPI-X mechanism was originally introduced by Beesley and Littlechild (1983), who presented it as a once-off transitional rule in the period between the privatisation of an industry and the arrival of a fully competitive market. However, in the natural monopoly case, which includes most of the privatisations advocated by Beesley and Littlechild, the regulated firm retains its monopoly position indefinitely, and the level of efficient costs must be reassessed at regular intervals. Hence, the CPI-X mechanism is part of a more sophisticated form of cost-based regulation, rather than an alternative to such regulation.

The capital base is most commonly estimated using a depreciated optimised replacement cost (DORC) method. Variations such as deprival value have also been used. The most problematic issue concerns 'stranded' capital assets which arise as the result of investments that are, at least *ex post*, unnecessary to supply the service in question. The difficulty is to avoid rewarding mistaken investment decisions while allowing for *ex ante* uncertainty about future demand.

Finally, the capital asset pricing model (CAPM) has generally been used to determine rates of return. Other possibilities such as the use of arbitrage pricing theory have been considered. Application of CAPM allows a wide range of variation with regard to the treatment of corporate and personal taxation, estimates of the market risk premium and so on.

The problem for a regulator is to set a price low enough to avoid distorting the final price faced by consumers but high enough to provide appropriate incentives for new

investment. Decisions of the Victorian Office of the Regulator General have created particular controversy. The private owners of Victorian electricity distribution businesses have protested against recent reductions in allowable rates of return, claiming that they were promised higher rates when they entered the industry, and that lower rates will discourage investment.

The difficulties of balancing the interests of consumers and the owners of electricity distribution assets are particularly acute in the case of privatised enterprises, and even more so when the buyers are foreign-owned utility enterprises, as has generally been the case in Australia. Any decision to set prices too high results in a permanent loss to the community, whereas under public ownership, the costs imposed on consumers are offset by corresponding benefits to taxpayers. For most households, these effects will approximately cancel out.

A final regulatory issue, which has, as yet, received inadequate attention is that of reliability of supply. A series of spectacular infrastructure failures including the failure of the electricity distribution network in Auckland, the Longford gas explosion in Victoria, concern over possible contamination of the Sydney water supply and the 'Big Pong' breakdown of the sewage treatment works in Adelaide, has contributed to a public perception that microeconomic reform is associated with reduced reliability.

Public perceptions are not necessarily accurate. There are, however, reasons for concern about the impact of microeconomic reform on the reliability of supply. Reductions in employment of maintenance workers have been an important source of cost reductions arising from microeconomic reform. *Ceteris paribus* it would be expected that reduced maintenance would be associated with reduced reliability. It seems likely that the effects of reduced maintenance have been offset by technological improvements that have enhanced the reliability of most types of plant and equipment. However, the same technological improvements have also enhanced the importance of reliable electricity supplies. Even momentary interruptions in power can be costly for computer-based systems. Although

advocates of microeconomic reform have frequently criticised the ‘gold-plating’ (excessively high technological standards) said to characterise the pre-reform system, no cost–benefit analysis has been undertaken to determine optimal levels of reliability. For all that we know, ‘gold-plating’ may be a socially optimal policy.

A further difficulty arises from the policy of vertical disintegration. In the reformed system, no single entity is responsible for the reliability of the system as a whole, or of services to any individual consumer. State governments have traditionally been regarded as being ultimately responsible for infrastructure services, but their capacity to intervene in the day-to-day workings of a national market is now limited. NEMMCO maintains some generating capacity, including backup generators that are maintained to ensure that the power system can be restarted after a widespread blackout, and 'reactive power' which is produced in order to control the power system voltage. State regulators can impose performance requirements on distributors, and retailers may be subject to conditions imposed to protect consumers.

On the other hand, some aspects of microeconomic reform in infrastructure industries seem likely to improve incentives to achieve appropriate levels of supply reliability. The majority of interruptions to supply arise because of breakdowns in the distribution network. Before reform, the suppliers of distribution services were elements of a self-regulating monopoly enterprise. After reform, they retain their monopoly status but must satisfy performance criteria imposed by external regulators. The separation of the roles of regulator and service supplier should generate a better match between the social goal of reliable supply and the incentives facing market participants.

No such external regulation applies to electricity generators. Their incentives for supply reliability are assumed to arise from the high opportunity cost of breakdowns in periods of peak demand. However, as noted above, the low and variable frequency of demand peaks implies that the market mechanism is highly sensitive to modest violations of the assumption of a perfectly competitive market. The collective benefits to generators

arising from high prices imply that there is a strong incentive to collude, implicitly or explicitly, in practices leading to suboptimal reliability of supply.

Privatisation

For most, though not all, advocates of reform, corporatisation and competitive re-structuring were seen as steps towards an ultimate goal of privatisation. This goal represented a reversal of the policy trends observed in the first half of the 20th century, when a number of private electricity suppliers were nationalised. Private businesses were seen as unwilling to take the necessary risks to develop public infrastructure and as demanding excessive returns when they did so. This perception was reflected in the key finding of the Royal Commission set up in 1948 by the conservative Playford government in South Australia to examine the performance of the privately-owned Adelaide Electric Supply Company. The Royal Commission observed:

> Over the period of the last 24 years [to 1948], the Company has paid in dividends and interest nearly 2 million pounds more than if the Treasury rate had been paid. Future capital costs at Treasury rates would result in reduced capital costs and lower charges
>
> (quoted by Linn 1996, p. 47)

On the basis of this and other findings of inadequate performance, Playford nationalised the industry. The point made by the Royal Commission about the relative costs of private and public capital remains at the core of the privatisation debate today, though this is often obscured in the presentation of the issues. A number of other issues remain unresolved.

The first issue relates to the assessment of the evidence on the relative performance of publicly-owned and privately-owned enterprises. On balance, the majority of studies find that privately-owned firms have lower costs. However, in some sectors, such as

water supply the opposite is true. Moreover, the differences are relatively small if attention is focused on corporatised public enterprises operating in competitive markets. Some analysts, such as Domberger and Piggott (1986) conclude that market structure is more important than ownership. In contrast, Quiggin (1996) argues that corporatisation eliminates most operational differences between public and private enterprises. Beesley and Littlechild (1983) reject both views, arguing that ownership *per se* makes a substantial difference.

A second set of issues relate to the role of regulation. King and Pitchford (1998) argue that where an enterprise generates externalities requiring regulation, and complete contracts cannot be written *ex ante*, regulation may be less costly under public ownership than under private ownership. The excess cost of regulating private monopolies will be reflected in a reduction in the price private buyers are willing to pay for a publicly-owned asset.

Finally, there are disputes over the cost of capital for publicly-owned enterprises, and public investments more general. These disputes began in the early 1970s when Arrow and Lind (1970) argued that, in general, it was not appropriate to impose a risk premium in calculating the discount rate for public enterprises. Numerous critics of Arrow and Lind argued that, in the absence of demonstrable market failure, the government should use the same discount rate as the private sector.

The cost-of-capital debate has been revived in the context of privatisation. Walker (1994) and Quiggin (1995) argued that, when the prices at which public assets are sold is compared to the flow of earnings foregone, discounted at the real government bond rate, most Australian privatisations have reduced the net worth of the public sector.

A theoretical basis for this argument was presented by Grant and Quiggin (1998), based on the 'equity premium puzzle', that is, the fact that the market risk premium is much larger than would be expected on the basis of a standard life-cycle consumption model incorporating perfectly efficient capital markets. Grant and Quiggin show that the observed equity premium is consistent with the existence of undiversifiable background

risk, as suggested by Mankiw (1986), and that, when such risk is present, the optimal discount rate for public investments is close to the real bond rate.

Supporters of privatisation, such as Domberger (1995), Hathaway (1997) and Officer (1999) have reiterated the view that the government should use the same discount rate as the private sector. They have also argued that, if the public sector did face a lower rate of discount, the optimal policy would be for public ownership of all enterprises. As Quiggin (1997) observes, this r*eductio ad absurdam* would be correct if there were no differences between privately-owned and publicly-owned firms other than those arising from the cost of capital. Quite small differences in operating efficiency can offset the difference in the cost of capital associated with the equity premium. Where such differences favour the private sector, privatisation will pass the present-value test.

Quiggin (1995) discusses characteristics that make an enterprise more or less suitable for privatisation. Small enterprises with modest capital requirements, operating in competitive markets with little need for regulation are most suitable for privatisations. Large capital-intensive enterprises operating in highly regulated markets with considerable monopoly power are least suitable.

In the context of the National Electricity Market, the breakup of integrated monopoly suppliers has produced enterprises with radically different characteristics. Electricity retailers and wholesalers appear very well suited for privatisation, except to the extent that distributors retain a retail function. On the other hand, transmission and distribution activities are natural monopolies requiring continuing regulation. Generation has intermediate characteristics, suggesting the possibility of a mixture of public and private operators.

In practice, however, distinctions of this kind have not been drawn in Australian policy debates. A major source of difficulty is the fact that transmission and distribution assets account for the majority of the capital value of the industry, while the market value of publicly-owned retail assets is negligible. Hence, a proposal to privatise retail assets alone, or even retail and generation assets, has little appeal to governments concerned

with the cosmetic effects of asset sales on budget balances and levels of public debt. Hence, privatisation proposals have normally involved the sale of the entire industry.

On the other hand, politicians opposed to privatisation have generally found it easier to maintain a stance of unqualified support for the *status quo*. See however Quiggin et al (1988) for a proposal to divest the retail activities of the Australian Capital Territory's publicly owned electricity and water supplier ACTEW.

Proposals for privatisation of state-owned electricity enterprises have been put forward in most Australian jurisdictions, but so far, privatisation has taken place only in Victoria and South Australia. The Liberal government of Tasmania was defeated in 1998 in an election fought primarily on the issue of electricity privatisation, and the NSW Liberal Opposition suffered a similar fate in 1999, even though it was well known that the leading members of the Labor government favored privatisation of the state's electricity assets, as proposed by the Opposition.

The Victorian electricity privatisations appear to have been among Australia's most successful in terms of their effect on the net worth of the public sector. Unfortunately, it is difficult to obtain sufficient information on the conditions of the sale and on performance prior to privatisation to undertake a complete evaluation. Nevertheless, the sale price of nearly $20 billion implies annual interest savings of $1.2–1.4 billion per year, which may be higher than the sustainable flow of earnings in public ownership.

Returns from the Victorian privatisations were boosted by a number of factors. First, Commonwealth tax concessions effectively subsidised the purchasers. Second, the sale took place at a time when regulatory changes in the United States had encouraged US utilities to undertake overseas investments. Third, the pro-business and deal-oriented nature of the Kennett Liberal government, which led investors in transmission and distribution assets to expect favourable regulatory treatment. Particularly since the unexpected defeat of the Kennett government in 1999, regulators have set rates of return lower than those expected by investors. Finally, the decline in returns to generators arising from the

introduction of the National Electricity Market was not fully anticipated.

Even allowing for the impact of tax concessions, it is clear that the purchasers of Victorian electricity assets paid more than the private value of the assets. Some assets have subsequently been resold at significantly lower prices. For example, the electricity transmission business Powernet was sold at a discount of 17 per cent to its original price (Moran 2000).

The privatisation of the South Australian electricity industry has reduced the net worth of the public sector. South Australia is an electricity importer, so the bulk of the sale price (more than $4 billion out of a total of $5 billion) was realised through the sale of transmission and distribution assets. In the final year of public ownership, earnings before interest and tax were $368 million, of which the distribution and transmission assets contributed $300 million. In the absence of regulatory decisions that reduce the nominal return to these assets, the interest savings on the sale price will fall consistently short of the earnings foregone through privatisation. This is consistent with most Australian experience of privatisation.

Concluding comments

The National Electricity Market is still developing. Some problems that have emerged in the early stages such as the disparity between the substantial price reductions for large customers and the largely unchanged prices paid by households will fade away as the market matures. Other issues such as the structure of the industry and the degree of horizontal and vertical integration will be resolved by a mixture of market processes and regulatory interventions.

Some problems, however, are likely to become more rather than less acute. The Australian National Electricity Market commenced operation in a period of oversupply so that problems of market power and excessive prices have not emerged until recently. It remains unclear whether an electricity auction market can produce adequate incentives

for investment while generating appropriate prices for consumers. Similar problems are emerging in relation to the regulated monopoly component of the industry, the transmission and distribution sector. Regulators must set prices that do not reward inefficiency or allow monopoly profits, but nevertheless provide appropriate incentives for new investment. This is a delicate balance.

In the longer term, the problem of the environmental impact of an industry relying predominantly on carbon-based fuels remains to be addressed. A market solution would involve the creation of emissions credits that could be traded along with electricity in national markets. Although limited steps have been taken in this direction, much remains to be done.

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