Marginal Costs and Prices in the Electricity Industry

by
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1. Introduction and Summary

One of the major efficiency gains associated with the new market-oriented electricity supply industry arrangements results from the fact that consumers can now be charged prices that are more indicative of the costs of supply. Another advantage of relying more on decentralised markets to co-ordinate the supply and demand decisions of many independent agents is that the evolution of the industry can reflect the wisdom of many more decision-makers. Entrepreneurs do not have to convince bureaucratic planners of the virtues of new technologies, products or market arrangements in order to discover if those alternatives might improve upon the entrenched ways of doing things.

Many commentators have questioned, however, whether the new market-oriented arrangements send the appropriate signals to suppliers and demanders of electricity. In particular, a common question that arises is whether what appears to be a very short-run process is capable of inducing appropriate decisions about the long run supply of new generating capacity. Auction markets set prices on an almost continuous basis to equilibrate supply and demand. It would appear to be obvious that the prices so established would reflect the short run marginal costs of supply (holding current capacity fixed) and not the longer run costs associated with ensuring a continuing supply of capital to the industry.

We shall argue on the contrary that market prices send appropriate signals not only about the short run costs and benefits of altering industry output but also the longer run costs. Though prices can fall to the level of marginal costs – and even less for short periods – in the long term they must cover all costs. Failure of this to occur means the market is signalling that there is excessive supply and some capacity will exit or new capacity will be deferred until market growth exhausts the over-capacity. The fact that price is higher than marginal costs no more indicates that suppliers in the electricity industry have market power than it does in other capital intensive industries like air transport and offices.

As well as inducing appropriate decisions about the time profile of additions to capacity, an efficient set of prices leads to the lowest cost mix of generating plant to satisfy a given time profile of demands. Most industry observers or participants are familiar with the idea that different types of generating capacity are best suited to satisfying different parts of the industry demand load. The way that market prices induce a supply of different types of generating plant is closely related to the way markets encourage appropriate long run decisions about the overall supply of generating capacity.

2. Prices and Marginal Costs in the Victorian Electricity Supply Industry

Compared with their expected levels, prices in Victoria (and New South Wales) have been low since electricity markets commenced in 1995 and average prices were pushed lower once New South Wales and Victoria were joined in the National Electricity Market.

Compared to price expectations that were reflected in the vesting contracts ($38-40 per MWh) average prices have been about $25 per MWh. To a considerable degree the lower prices reflect the *de facto* increase in capacity since corporatisation/privatisation that has stemmed from the greater efficiency in the industry. Figure 1 illustrates the prices since the commencement of the national market.

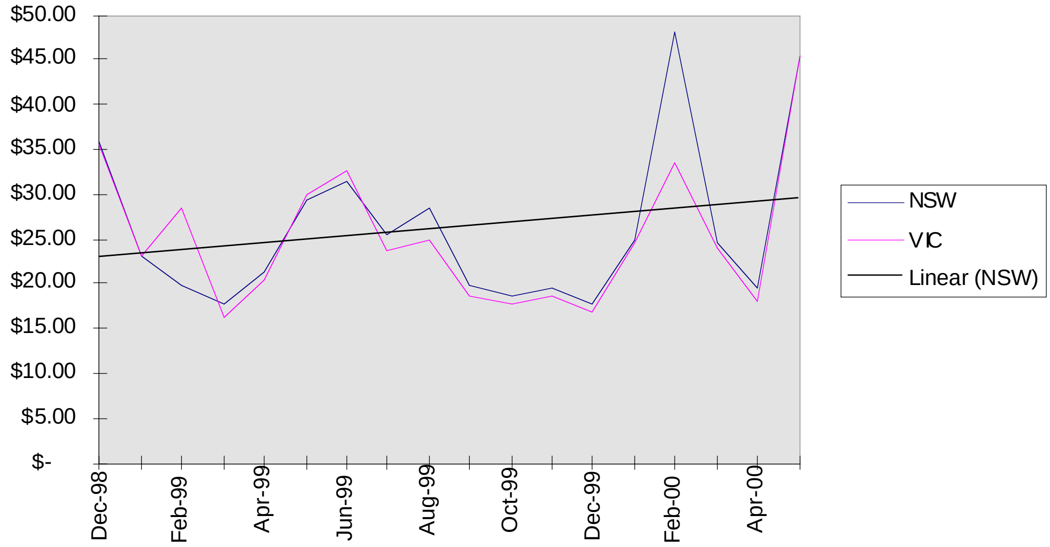

Figure 1 Prices in NSW and Victoria

Figure 2 illustrates the marginal costs of the different plant in Victoria compared with the average level of demand experienced. It can be readily seen that the average price as in Figure 1, low though it has been, was in excess of the marginal costs of almost all the plant listed. Between the commencement of the NEM and June 2000, there were however only just over a hundred half hour periods in which the Victorian price exceeded $100.

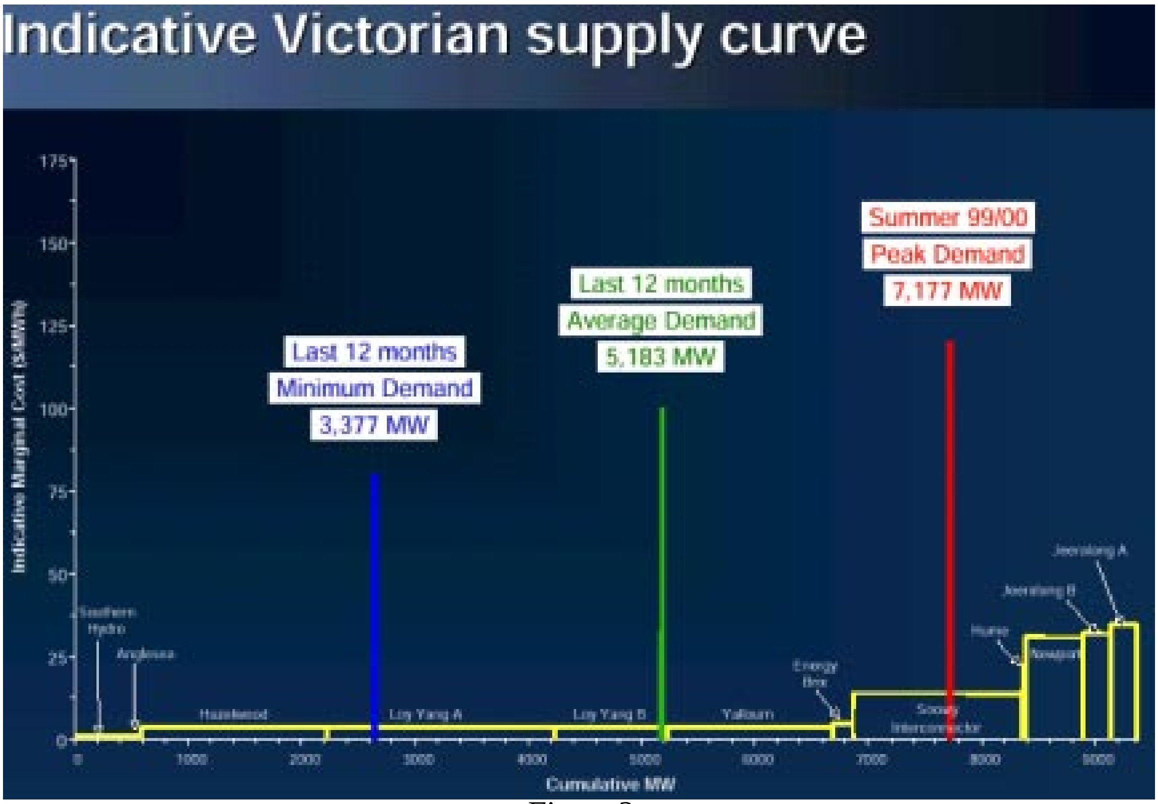

Figure 2

Source: E.Kee *Victorian Power: New Market Investment,* Melbourne, 13 June 2000

3. Marginal Costs in a Mixed Plant Supply System

3.1 Short run Price setting

A competitive auction market without any rules restricting bidding behaviour will always set prices so that the market clears, with both demand and supply adjusting. In electricity markets, demand has a very low price elasticity. In consequence, almost all the adjustment in the short run[1] is on the supply side. Prices therefore call forth or deter the offering of supply from existing plant. By contrast, when prices are not allowed to determine supply, demand is rationed either by very high price levels (which, however, are not paid to suppliers) or by more direct and arbitrary regulatory allocation. This is needed to ensure the load on the network does not exceed the amount of energy supplied to it.

As illustrated in Figure 3, the relationship between prices and production costs in an auction market will depend on the level of demand and the way costs vary with output. Suppose, to begin with, that current demand (D_1 in Figure 3) is less than the available generating capacity. If

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[1] One of the few loads adjustable in the shorter term are domestic water heating where this has ripple controls that permit demand shifting. Some industrial users also have negotiated interruptible load contracts.

generators can earn sufficient income to cover their marginal operating costs (the fuel and labour costs of producing one more unit of electricity) they will be willing to expand output. Although supplying output at that price makes little contribution to the overhead costs (particularly the capital costs), if the capital is already in place any contribution is worthwhile. On the other hand, if total demand equals current generating capacity (D_2 in Figure 3), the price needed to ration demand to the available capacity will exceed marginal costs.

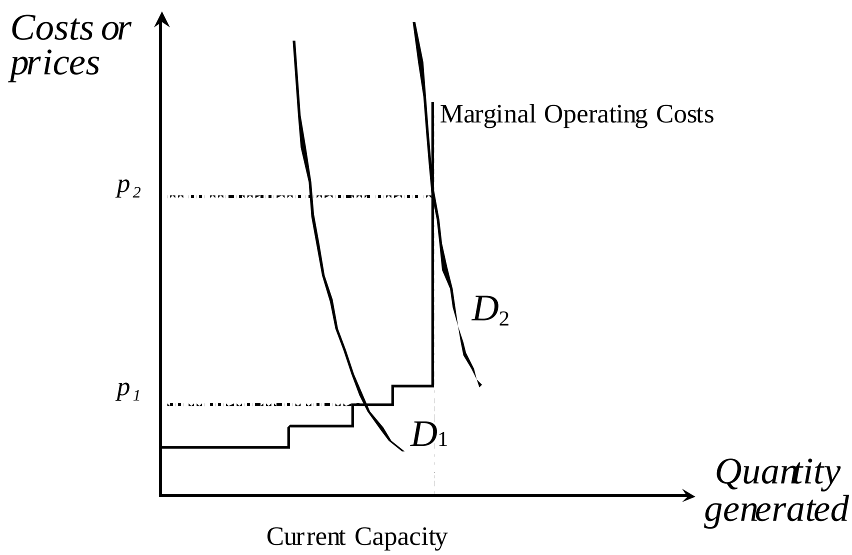

Figure 3: Prices set in a competitive electricity auction market

The behaviour of average costs as output expands has a critical influence on whether electricity prices in an auction market are likely to be sufficient to cover the costs of production. This is because the relationship between average and marginal costs depends on whether or not the firm displays economies of scale. If there are increasing returns to expanding output, average costs will fall as output expands and marginal costs will be smaller than average costs.[2] Conversely, if there are decreasing returns to scale, average costs will rise as output expands and marginal costs will exceed average costs.

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[2] This follows mathematically from the fact that total costs equal average costs multiplied by the level of output whereas marginal costs equal the derivative of total costs with respect to output. Hence

$$MC = \frac{dC}{dQ} = \frac{d}{dQ}(Q.AC) = AC + Q\frac{dAC}{dQ}$$

so that MC–AC has the same sign as the derivative of AC. Thus, if average costs are decreasing with output, marginal costs must be smaller than average costs.

3.2 Prices and Economic Rent

When discussing the issues addressed in Figure 3 in relation to the electricity supply industry, we need to distinguish the costs of incrementing generating capacity through new investment from the production of output given an existing level of capacity. The essentially short run nature of the previous analysis can lead to harmful outcomes if policies seek to enforce a price regime on this basis.

As Figure 2 illustrated, base load plant, such as large coal-fired power stations, that is used almost continuously typically has much lower operating costs than peaking plant such as gas turbines. Although the operating costs for base load plants are lower, the capital costs are usually much higher. Constructing base load plant is justified when the saving in operating costs relative to the peaking plant that the base load plant displaces at least compensates in present value terms for the higher up-front capital expenditure of the base load plant.

A wholesale electricity market ensures an appropriate mix of generating plant by ensuring that the base load plant earns "rents" relative to its short-run operating costs whenever plant with higher operating costs is called upon to supply the marginal amount of electricity to the system. The peaking plant will only be operated if the market price at least compensates for the high costs of operating that plant. The market price at those times must therefore exceed the operating costs of the base load power stations. The excess of price above operating costs during those periods represents a "rent". The discounted present value of such rents anticipated over the lifetime of the plant represents a return on the additional funds invested to provide the capacity in the first place. Investment in base load capacity will therefore be justified if the expected discounted value of the savings in operating costs relative to peaking plant at least covers the cost of the investment.

A question that naturally arises is how the costs of investing in peaking plant can be recovered. If generators are always willing to supply electricity so long as their marginal operating costs are covered, it might be thought that prices would, at any one time, be bid down to equal just the operating costs of the highest marginal cost supplier. Under these circumstances, the owners of the generating plant with the highest operating cost could expect to receive no more than their operating costs at any time. They therefore could earn no "rents" that could be used to cover up-front investment costs. In addition, owners of plant with lower operating costs would earn less than they should and therefore also could not expect to earn enough to pay for the capital costs of a plant of the efficient size or design.

Behind this argument is the fact that operating costs consist almost entirely of fuel and labour costs. The owner of a generating plant is thus imagined as being willing to supply electricity so long as the market price at least equals the cost of the fuel burned and the labour needed.

The defect in this argument is apparent from an examination of hydroelectric plant. In this case the cost of the "fuel" would appear to be zero, so that short run operating costs would seem to consist entirely of labour costs. An operator of a hydroelectric plant would not, however, agree to dispatch his generators whenever the market price of electricity rose above only his meagre labour costs. That would occur almost all the time, and the operator would soon run out of available water. The operator is cognisant of the fact that using water to generate electricity today, or during the current hour or half-hour period, means that the water will not be available to supply power at some other time.

An implicit cost of using water to generate electricity at any one time is the forgone opportunity to use the water at some other time instead. This implicit cost is referred to as an opportunity cost. When deciding whether to dispatch his plant, the owner needs to compare the current market price not with the explicit short run operating costs but with the sum of those costs and the opportunity costs of the water. Only then would the owner first use the limited supply of water to generate electricity during those time periods when prices are expected to be at their highest. If water is left over after all the peak periods have been supplied to full generating capacity, the periods with the next highest price would be utilised and so on until the available supply of water is exhausted. The opportunity cost of the water could then be measured as the excess of price over explicit short run operating costs in the marginal, or least desirable, period when the water will be used to generate electricity.

The "rents" earned on the limited water resource can be measured as the discounted value of the excess of prices earned over the labour and other short run costs over the expected lifetime of the dam and other facilities. If the hydroelectric capacity is efficiently supplied, the present value of these rents ought to pay for the up-front capital costs of constructing the dam, tunnels, turbines and so on.

3.3 Opportunity costs of capacity

Just as water has an opportunity cost, so also does the capacity to supply electricity at short notice using peaking plant. If the peaking plant were not available, some consumers would have to go without power when peak demands are placed upon the system. The opportunity cost of the peaking plant is thus the value of the opportunities that would be forgone if the plant were not available. The value of such opportunities is, in turn, reflected in the prices consumers are willing to pay for a marginal unit of supply during peak demand periods.

There would appear to be a fundamental asymmetry, however, between the opportunity costs of water to the owner of a hydroelectric plant and the opportunity costs of the capacity supplied by a peaking thermal plant. In the first case, the owner is aware that using water at one time precludes its use at some other time. The owner thus has an incentive to compare the potential value of the water at different moments of time and to choose to supply only if the current price exceeds operating costs inclusive of opportunity costs. The owner of thermal peaking plant is not, however, constrained by the total amount of time he can choose to operate his plant. Running the plant now does not preclude running it at some other time. It would seem that the plant would be dispatched whenever operating costs, excluding any opportunity costs, could be recovered. Consumers might place a higher value on having the plant available than is reflected in current prices because competing generators bid prices down until they barely cover marginal operating costs.

The answer to this apparent conundrum is that market prices ration demand to equal the available supply. So long as demand equals the available supply capability of the system during at least some periods, capacity is *scarce*. Prices at those times will reflect the marginal value that consumers place upon having additional supply or the opportunity cost of additional capacity. Prices will be bid up above the short run operating costs of the marginal producer. The “rents” earned on the available capacity then represent a signal to the market reflecting the value that consumers place upon additional capacity. If the expected present value of these rents is enough to pay for additional peaking plant, this plant will be constructed. At the same time, base load generating stations will earn additional rents during the periods when capacity is scarce. If additional base load capacity can be operated for enough hours of the year, and at prices sufficiently in excess of the short run operating costs, then it is efficient to build the base load capacity and perhaps displace some of the older, higher operating cost, peaking plant.

3.4 Operating economies of scale

Many analyses of the existence or otherwise of economies of scale are based on the technical or engineering characteristics of the production technology. Firms using *technologies* that exhibit increasing returns to scale do not, however, necessarily experience lower costs as output expands. Firms combine many activities, each of which uses a technology with different economies of scale. For example, management and supervision are part of the activities of every firm. Managers need to acquire information, give directions to employees, ensure that directions are complied with and so forth. These activities are likely to exhibit decreasing returns to scale. The overall economies of scale depend on the mix of activities, and how that mix varies as output expands.

The way new generating capacity is added to an electricity supply system is likely to result in short run increasing costs as output expands. Most electricity systems experience substantial daily and seasonal demand fluctuations. Periods of peak demand may only last a few hours each year. Plant used only in peak periods therefore usually has a low capital cost but, in consequence, a high operating cost. In fact, the construction of base load capacity is justified only when the saving in fuel and other operating costs over the expected life of the plant has a present value sufficient to compensate for the large initial capital costs. Thus, gas turbines are less expensive to build than large coal, oil or nuclear base load plant but use a premium fuel. Similarly, in a mixed hydro and thermal system, the “fuel cost” of hydroelectricity is the opportunity cost of the stored water. Consequently, hydro capacity should be used in peak periods when the cost of thermal generation would otherwise be higher.

Older, higher cost plant is also used to produce higher levels of output. Newer plant often embodies technological advances that reduce operating costs. The maintenance costs, and lost time for maintenance, for older plants are also higher.

The result of these factors is that increases in the output of electricity in the short run are accompanied by rapidly rising marginal costs. Empirical analyses claiming to reveal increasing returns to scale in supplying electricity invariably include capital as a factor of production, and thus implicitly examine a long run supply function.

3.5 Investment economies of scale

The fact that new generating capacity is added in "lumps" indicates that there *are* economies of scale associated with investment. Many of the costs of adding to existing capacity, such as site preparation, engineering design, arranging transport of materials, procuring construction equipment and, to a lesser extent, the construction time, do not depend greatly on the size of the capacity increment. By delaying construction of new plant a larger plant size is warranted, allowing lower average construction costs per MW of generating capacity.

Figure 4 illustrates the traditional model of efficient capacity expansion when the capacity of new plant is fixed and demand fluctuates across peak and off-peak periods. For simplicity, marginal operating costs have been taken as constant at c_1 up to the current capacity q*.

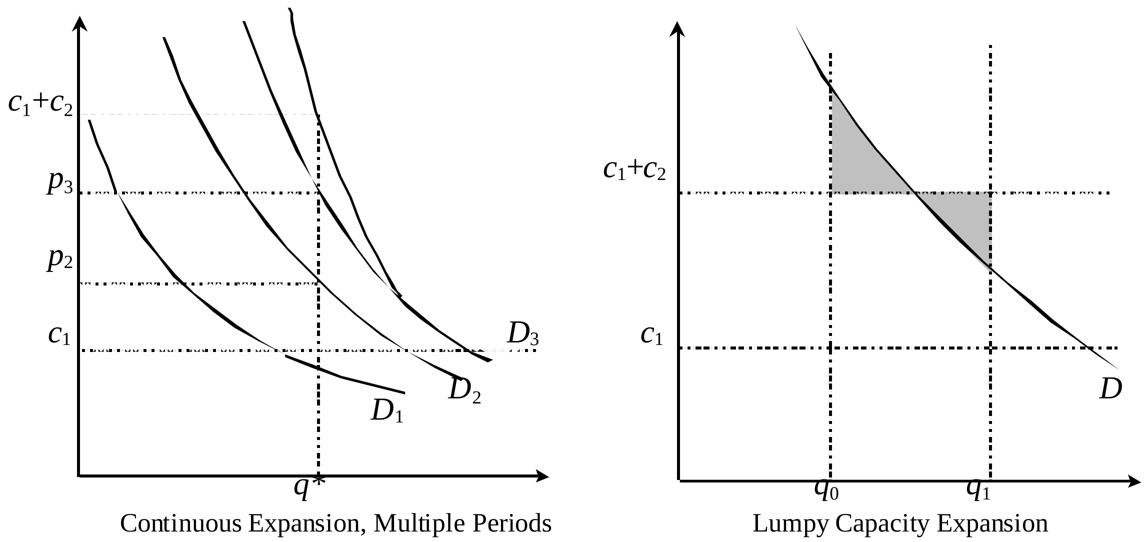

Figure 4: Efficient capacity expansion

In the left panel of Figure 4, the difference between the demand price in each period and c_1 can be viewed as an implicit demand for capacity expansion. Since new capacity will be jointly provided for all periods, these demands can be summed vertically to give an aggregate demand for new capacity. The subsequent discussion will ignore complications arising from the multi-period nature of electricity demand and focus on an "aggregated demand" (simply labeled as D in the right panel of Figure 4).

The right panel of Figure 4 illustrates the "trapezoid rule". This argues that capacity should be expanded when the trapezoid of consumer surplus gain from expanding capacity from q_0 to q_1 equals the cost of that increment $(q_1–q_0)c_2$. This will be true when the areas of the two shaded triangles in the figure are equal.

The efficient capacity expansion path will constrain demand in some periods – otherwise, the implicit value of new capacity would never match its added cost. If demand is not rationed by higher prices in "peak" periods it will be rationed through blackouts, brownouts or other reductions in service quality. As we argued in the text, the "opportunity cost" of new capacity when demand is constrained is the marginal benefit consumers are willing to pay for relaxing those constraints, or the price given by the demand curve at an output level equal to the capacity constraint.

Now suppose that capacity increments can be of any size instead of being fixed at $(q_1–q_0)$. Since capacity is added in discrete lumps, there must be some economies of scale associated with the production of new capacity. Eventually, decreasing returns will take over. The result will be a U-shaped average cost of new capacity as illustrated in Figure 5.

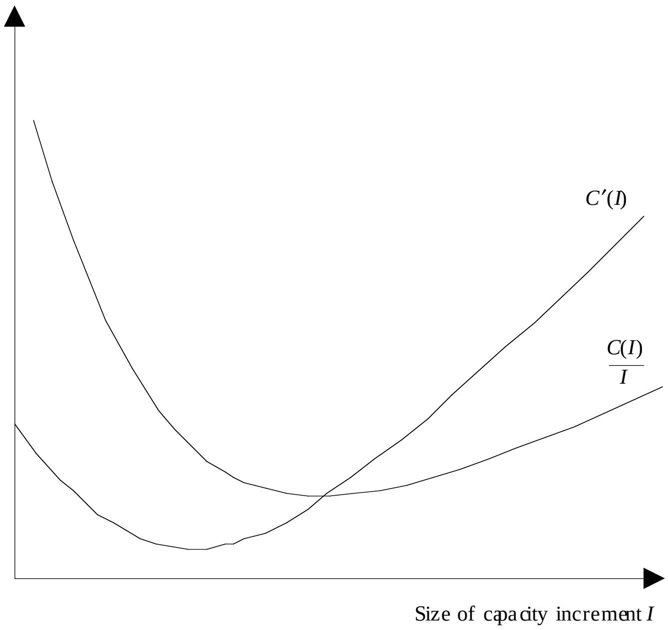

Figure 5: Cost of capacity increments

Hartley and Kyle (1989) examine a simplified version of this model where investment is the sole cost and where demand grows smoothly over time. A unit of consumption is defined to equal the amount that demand would grow over one year if the price were kept fixed. Hartley and Kyle show that the competitive equilibrium in this industry will be a stationary sequence of investments of a fixed size I each made at intervention price p as illustrated in Figure 6. Immediately after each investment comes on stream, prices will fall to $p–I$. Prices then return to p over the following I units of time.

Hartley and Kyle show that the *efficient* investment path under these conditions will also consist of a sequence of investments of a fixed size, now denoted I_O, and an investment time (or intervention price) p_O. They show that the efficient investment path cannot be supported as a competitive equilibrium, that is $I_O > I$. Observe to begin with that, if the cost of capital is strictly positive, the resulting sequence of investments will not break even. Intuitively, the low prices occur immediately after a new investment is added, while the high prices occur at the end of an investment cycle (as illustrated in Figure 6). The efficient rule, however, will require capacity to be added when the (undiscounted) trapezoid of consumer surplus gain equals the cost of adding the new capacity (as illustrated in the right panel of Figure 4).

Although it is not obvious from the graphical presentation given here, Hartley and Kyle also show that the marginal cost of a new investment is below average cost. Figure 4 then implies that the efficient investment size is below the level that minimizes average investment costs. Thus, even as $r \to 0$, so discounting makes no difference, the optimal investment size remains below the level that minimizes average cost. As a result, the efficient investment path cannot be supported as a competitive equilibrium even as $r \to 0$.[3]

Hartley and Kyle also examine the investment path that is the most efficient that could be achieved given a constraint that the present value of revenue needs to be sufficient to cover investment costs. They show that the result is again a sequence of investments of a fixed size each made at a fixed intervention price (or implicit value for capacity), as illustrated in Figure 6. Furthermore, they show that this sequence of investments differs both from the unconstrained efficient path (where costs will not be covered) and the competitive equilibrium path. Indeed, the investment size under the equilibrium path can be shown to be smaller than under the constrained efficient path, which in turn is smaller than the investment size under the unconstrained path that does not cover costs. In a sense, therefore, competitive firms can be said to invest “too often” and choose an investment size I that is “too small” relative to the constrained optimum. Each new entrant effectively has some “monopoly power”. By choosing a smaller investment size equilibrium prices will be higher.

3 Intuitively, the linear demand specification Hartley and Kyle used implies consumers are risk averse and hence value more frequent, and therefore smaller, investments with their associated smaller fluctuations in prices and marginal valuations of electricity supply. The result is thus likely to apply to other specifications so long as they imply consumers are risk averse, a reasonable requirement based on the empirical evidence.

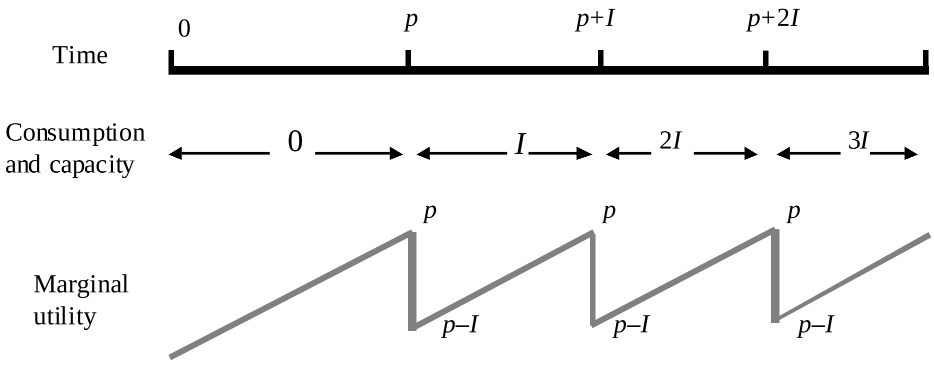

Figure 6: A stationary sequence of investments in capacity

The results derived by Hartley and Kyle do not imply, however, that a competitive electricity generating market is undesirable. The constrained efficient path of investments they analyze is in practice unlikely to be achievable. In particular, there is no reason to believe that a monopolist that is either owned or regulated by the government would choose the constrained efficient path. Furthermore, there are good reasons, and much evidence, to conclude that such a monopolist would not operate in an efficient way. Any potential gains in the efficiency of investment that were realized by a monopoly would be more than dissipated by operating inefficiencies.

It is also important to point out in this regard that factors omitted from the Hartley and Kyle model may make the competitive investment path more desirable from an efficiency point of view than their analysis would suggest. More frequent and smaller investments provide other benefits to offset the higher costs associated with forgone economies of scale. Consumers value a smoother path of capacity expansion since it is likely to lead to greater stability and predictability in price movements and make it easier to plan their own future investments.

In addition, more frequent investments may lead to greater technological change. Thus, the rapid technological progress in gas turbine technology in recent years, which has played a part in facilitating increased competition in wholesale electricity markets, may also have been partly a *consequence* of electricity markets being made more competitive. Firms in more competitive markets began to look for technologies that had lower economies of scale and thus were suitable for making more frequent investments without raising investment costs. In summary, our experience with monopoly, and more recently competitive, electricity markets suggests that the overall outcome resulting from competition is likely to be the most efficient that can be achieved in practice.

There are other important implications of the Hartley and Kyle analysis. First, despite economies of scale in the investment process, they show that a competitive equilibrium is feasible. Empirical evidence would suggest this must be the case since, as we note in the text, there are many competitive industries that nevertheless are characterized by economies of scale in the investment process. A second important implication of the Hartley and Kyle analysis is that investment in capacity, and the production of output using a given capacity, ought to be treated as two separate production processes. Econometric analyses that include capital along with fuel and labor as factors in a "timeless" production process will misconstrue the economies of scale in electricity generation. In particular, while the model implies that investment levels are "too small" in a competitive equilibrium to fully exploit investment economies of scale, this is *no justification whatsoever* for combining generating plant into portfolios within a single firm. The model implies that there would be *no* reduction in costs resulting from such a combination.[4]

Furthermore, the above discussion assumed a competitive output market. If only a few firms own most of the capacity, Green and Newbery (1992) show that the firms will have an incentive to restrict output relative to the available capacity. The result will be, as happened in the UK, inefficient use of existing capacity and an artificial stimulus to investment. Aggregating generators into a small number of firms decreases competition in the wholesale electricity market. The ostensible benefits from exploiting economies of scale, which are supposed to offset the losses associated with gaming in the wholesale market, are illusory.

4. Market Determination of Electricity Generating Capacity

4.1 Investment cycles in electricity generation

The market approach to adding generating capacity is a decentralised process involving many players and potential players. Any entrepreneur who believes prices are likely to exceed operating costs often enough, and by a large enough amount, over the life of plant is free to add capacity to the system. If the belief turns out to be mistaken, investors in the project will earn a rate of return that is insufficient to compensate for the opportunity costs of having savings invested in this project rather than some alternative. If too few entrepreneurs believe that prices will be high enough to justify adding capacity to the system, consumers will be rationed to the available capacity too frequently and existing producers will earn a return on their investments that are above competitive rates of return in the capital markets. High returns extending over a reasonable period of time will, of course, attract the attention of investors and bring new entrepreneurs to the market to satisfy demand.

The essential characteristic of a competitive industry is freedom of entry. Competition is a process involving a continual balancing of the costs of meeting the demand of consumers for greater supply and the value of doing so. Market prices do not reflect marginal costs of supply calculated according to some formula but rather reflect judgments that resources are worthwhile being used for this purpose rather than myriads of other possibilities.

An entrepreneur contemplating building a new generating plant must make a conjecture about the future evolution of the industry. As in any other business, an investment project has to be

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[4] Unfortunately, this has not prevented the NSW and Queensland governments from relying upon such faulty econometric analyses to justify combining their generating firms into a small number of entities each owning and operating several generating plants.

justified by a forecast that market demand will be adequate to take the additional supply without an unacceptable fall in prices. Forecasts need to be made also of the likely behaviour of other market participants. An investment proposal might be based upon a premise that existing higher cost suppliers will be driven from the market. Realistic scenarios also need to be developed for the time profile of new investments likely to occur over the life of the plant under consideration.

The fact that an entrepreneur considering an investment in the industry would take account of the likely response of other suppliers suggests to some that the industry is not truly competitive. Under this view, a competitive industry would be characterised by firms that behave atomistically, making their own decisions independently of what any other suppliers choose to do. In our view, however, the critical feature of a competitive market is freedom for anyone to enter as a supplier. Firms can be aware that their decisions depend upon the decisions of other market participants. They must not, however, be able to control the decisions of other firms, or explicitly collude or co-ordinate their business decisions in a way that disadvantages other actual or potential market participants.

As illustrated in Figure 6, the likely outcome of such uncoordinated decision-making in an industry characterised by freedom of entry is that capacity additions will occur in cycles. Immediately after the addition of new capacity, demand will match the available capacity rarely if at all. Prices will therefore rarely rise above marginal operating costs, and the new capacity will earn a very low, or even zero rate of return.

Eventually, as existing plant deteriorates, suffers increasing costs and is perhaps withdrawn from service, or as demand continues to grow, the amount of time when demand is constrained by the available capacity will begin to increase. Increasingly, demand will be rationed to the existing capacity by high market prices. The excess of prices over marginal operating costs represents a return to the capacity that has now become relatively scarce. These returns represent a signal to entrepreneurs that more capacity is needed in the system. Entrants will be encouraged to build new plant. Investments could be expected to earn most of their return toward the end of a "cycle" immediately before the high rates of return encourage an entrepreneur to build a new plant, at which point the period of low prices will return.

One finds this process of fluctuating returns to capacity in other industries characterised by lumpy additions to capacity, such as office construction or oil refining. Office rents tend to decline dramatically immediately after new buildings are constructed and then gradually rise as the excess capacity is removed from the market either by tearing down old buildings or by the growth in demand. Eventually, high rents encourage another firm to build a new office tower. Similarly, petrol "price wars" often follow the construction of new refining capacity as wholesalers compete fiercely for the available customers. As demand grows to more closely match the available capacity, however, one begins to see periods of high prices at times of excessive demand, such as peak holiday driving periods or, in the United States, during unusually cold winters that raise the demand for heating oil. There is every reason to expect that a competitive electricity supply industry would be characterised by similar cycles of investment and the associated price variations.

4.2 *Decentralised markets versus centralised planning*

The picture we have painted of the operation of a decentralised competitive market in electricity supply may appear rather chaotic relative to the process that used to occur under centralised monopoly control. The differences are, however, more apparent than real. The risks of mistakenly forecasting demand, or depreciation rates of existing plant including as a result of unexpected technological change, are not unique to competing firms. Indeed, it could be argued that by relying upon a very few decision-makers who all talk to each other, a monopoly supplier is perhaps more likely to make systematic forecasting mistakes. A major advantage of a market is that it exploits the information, ideas and forecasts of many independent people rather than assuming all wisdom resides in a few anointed “experts”.

By allowing many people to participate as suppliers, a market also encourages experimentation with new technologies and other ways of doing things. By contrast, a monopolist, particularly one protected from challenge by government legislation, has little incentive to experiment with new approaches. While it appears more fluid, the more dynamic market environment also encourages greater innovation. The electricity supply industry is changing from being a low risk, safe investment, to becoming an exciting entrepreneurial business where admittedly risks are greater, but also where new ideas and approaches may earn premium returns.

A related issue is that different individuals bear the risks in a competitive industry than in an industry that is owned by governments, or heavily regulated by them. In a competitive industry, investors are adversely affected if the demand for capacity is over-estimated. In a regulated industry, prices are usually determined by assessing costs. Excessive investments are passed on to consumers in the form of higher prices. Investors are, however, much better able to bear the risks. A major function of private ownership and capital markets is to allow those individuals who are most willing to do so to bear the unavoidable risks of doing business. In the case of an under-estimate of future demand, market prices are likely to be higher in a competitive industry than under a regulated monopoly. In the case of the government owned or regulated firm, demand is usually rationed by means other than allowing prices to rise. The outcome is likely to be less efficient than rationing through higher prices, however, since there is no guarantee that the consumers who place the highest value on the limited available supplies will be the ones to receive it.

4.3 *Current excess capacity is a consequence of past mistakes*

In the current Victoria/New South Wales context, there would appear to be few opportunities for suppliers to earn an adequate return on their investments in generating capital. It would be a mistake to extrapolate from this situation to the normal state of affairs in a competitive electricity market. Capacity is undoubtedly in excess supply in the inter-connected Victorian and New

South Wales electricity market. A consequence is that prices are not being set at a level that would represent an adequate return on capital. This situation is not the result of the operation of a competitive market but rather the consequence of past demand forecast errors made by the former monopoly government suppliers. The situation will change as demand gradually expands and high prices are more often required to ration demand to equal the available capacity.

The wholesale prices in Queensland and South Australia illustrate prices that are in excess of marginal operating costs for substantial periods of time. These relatively high prices have stimulated more plans for entering those markets. Some would argue, following the NEMMCO Statement of Opportunities[5], that in South Australia such stimulation has not been as great as might be expected. Such a view may be correct but is so partly because potential entrants expect the expansion of inter-state trade in electricity from New South Wales and Victoria. Indeed, construction of new transmission links to South Australia is projected to help bring about the disappearance of much of the excess capacity in the current Victorian and New South Wales markets.

4.4 Paying for capital costs of base load plant

There is debate regarding the capital structure of firms in the electricity business and their commercial behaviour. In principle, the capital structure of the firm is not relevant to the marginal price of its outputs. The capital structure is the financial basis on which the firm's assets have been acquired. For a prudent firm (and a prudent lender) this often means ensuring a ratio of debt and equity that reflects the vulnerability of the firm's cost and revenue. Normally, where firms' assets are highly liquid or where their revenues are stable, increased debt levels are more acceptable.

That said, the proportion of total assets accounted for by borrowings should not influence the firm's pricing strategy. Prices should be set to maximise profits whatever the capital structure and profit maximisation occurs at the highest price possible that is in excess of non-fixed costs. In periods of over-capacity a firm's prices may fail to cover the costs of servicing debt. Nonetheless the firm will still be obliged to price at these levels since the alternative is an even greater shortfall in revenue net of costs. There should be little difference in the perspective of shareholders receiving inadequate returns on equity compared to lenders not receiving interest payments.

However such differences may be evident in practice due to two reasons. First, debt holders by definition expect to incur a lesser risk of non-payment than equity holders. They are likely to add scrutiny to management and be alert to opportunities for extricating themselves from loss making situations without consideration of the interests of the equity holders. A loss on the total

5 http://www.nemmco.com.au/nem_resources/polproc/planning/pl_sy1473.htm

equity and borrowings of 10%, where there is a 50/50 debt/equity split translates to a loss of 20% for equity holders and zero for the debt holders. The latter will be alert to opportunities to ensure any such losses are incurred by the shareholders and may therefore be earlier activators to management of remedial steps.

Secondly, government ownership may leave - indeed normally has left - management with fewer concerns about incurring losses. This is especially so where, as is frequently the case, the losses can be sheeted home to political override of commercial judgements. The inability to go bankrupt is likely to influence the behaviour of management. It may mean for example a greater willingness to continue incurring losses than would be permitted of a private business. In such situations the pricing at marginal cost (or even below) may persist for longer than private sector operators would permit.

Such considerations as these may be among the reasons that the NSW government is contemplating having its energy businesses take on more debt. While two of its generator businesses have performed creditably in terms of returns, one is likely to have seen most of the value of its equity eliminated.

References

Hartley, Peter R. and Albert Kyle, "Equilibrium in an Industry with Lumpy Investment," *The Economic Journal*, 392-407, 1989.

Green, Richard J. and David M. Newbery, "Competition in the British Electricity Spot Market", *Journal of Political Economy*, 100, 929-953, 1992.