Pricing for Capacity Utilisation with Public Enterprises

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Abstract

Pricing individual services provided by public business enterprises so that the use of available capacity is, where possible, maximised during peak as well as slack demand periods will for many enterprises correspond closely to ideal marginal cost pricing. Such a pricing strategy will usually result in excess profits when the level of capacity is deficient and in losses when capacity is excessive. Optimal long-run capacity can thus be sought under this pricing strategy by increasing or reducing capacity over time with a view to achieving normal profits or a target rate of return. In the short run, before capacity can be changed, enterprise profits are driven by the pricing strategy, not by the target rate of return. For enterprises with large lumpy investments it is particularly important for the rate of return objective to be achieved over several years, allowing for reduced returns when new lumpy capacity is first introduced. For enterprises whose services involve significantly increasing congestion costs before full capacity is reached, pricing to achieve something less than full capacity utilisation is required but technological advancement is reducing the relevance of this complication.

1. Introduction and Summary

Pricing strategies for services provided by public business enterprises are often put only in terms of the general requirement that prices should cover full economic costs. That is, prices should not only cover current operating costs and the loss in value of associated assets but they should also cover the opportunity cost of capital tied up in the enterprise.

This broad pricing strategy may be given practical application by requiring each public business enterprise to earn at least a certain target rate of return on its assets. This is the approach taken under the Australian Government's guidelines for reform of its business enterprises.

A broad target rate of return strategy says nothing about the question of optimal capacity of enterprises' assets or about optimal day-to-day pricing of enterprises' services when those services involve slack and peak periods of operation, as well as perhaps lumpy investments. Services with these characteristics which are often supplied by public enterprises include airport services, telecommunications services, electricity generation, gas reticulation, public transport and the provision of parking.

Misconceptions are common concerning optimal pricing of services subject to slack and peak demands and the relevance to this of lumpy investments. One misplaced response to the peak load situation, for example, is to propose that dual-component tariffs be introduced: one component designed to cover the avoidable operating costs of providing services at any time; the second component, a capacity or congestion charge at peak times corresponding to the long-run marginal cost of supplying additional capacity.[1] Such propositions continue to be made despite the fact that the economic literature has for some time made clear that the separation of costs into operating costs and capacity costs has relevance for day-to-day pricing purposes only in very limited circumstances.

The pricing principles relevant to dispelling such misconceptions can, for example, largely be obtained from the discussion of efficient pricing of peak loads by Hirshleifer (1958) and the discussion in Williamson (1966) who took into account varying demand in sub-periods of different lengths. A recent article by Ng (1987) applies the principles to the case of lumpy water reservoirs under the conditions of uniform but increasing demand and constant, as well as increasing, costs.

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Some argue for 'multi-component pricing' of some services by the addition of a fixed component to cover costs which are independent of the level of services provided at any time. The term 'dual-component tariff' used here should not be confused with the use of the term 'two-part tariff' by, for example, Ng (1987, p. 30) when referring to the use of a fixed charge plus a unit price to earn extra revenue above that associated with marginal cost pricing.

This article draws on the efficient pricing principles in this literature to emphasise the limited relevance of dual-component tariffs and to work up simple, practical pricing strategies for public business enterprises supplying services which are subject to peak and slack demand periods, and which may involve lumpy investments. Those efficient pricing principles are all to do with pricing in the short run, that is before capacity can be increased or reduced. This accords with the particularly short-term contracts involved in, for example, the supply of airport services or telecommunications services.

The analysis of the article is divided into two parts: a simplified analysis (Section 2) where, in order to draw out more readily the basic principles of efficient pricing, the simplifying assumption is made that a public enterprise's short-run avoidable costs are constant until the capacity limit is reached; and a generalised analysis (Section 3) which allows for increasing congestion costs before full capacity is reached. Under the simplifying assumptions, the short-run pricing principles are met by the practical strategy of pricing to achieve market clearing (100 per cent capacity utilisation without queuing) whenever possible. The presence of large lumpy investments adds some complications but does not affect the relevance of this strategy. The practical pricing strategy under the generalised analysis is less clear cut as optimal pricing corresponds to a situation of less than full capacity utilisation.

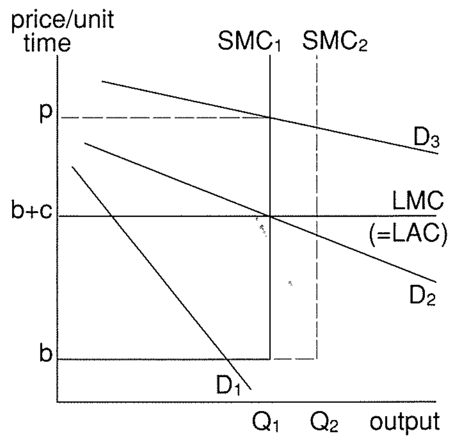
The application of the appropriate short-run pricing strategy – which would be applied separately to different services of an enterprise – might mean that an enterprise realises economic profits or losses. The level of profits or losses realised under these pricing principles, in turn, indicates whether investment should be undertaken by the public enterprise to increase capacity or whether assets should be sold to reduce capacity. Thus, profit results associated with the practical pricing strategies for public enterprises whose services are subject to peak demands provide relevant signals to feed into decisions regarding optimal capacity levels. Subsection 2.4 summarises the practical strategies for enterprises' pricing and capacity decisions under the simplifying cost assumptions, which are applicable to a wide and, because of technological advancements, growing range of activities of public enterprises.

Without the implementation of efficient pricing strategies there is no way of being sure whether the capacity of particular infrastructure controlled by government business enterprises is either deficient or excessive. The implementation of these pricing strategies at the sometimes congested Kingsford-Smith Airport in Sydney or parking lots in Canberra's city centre, for example, would assist in establishing the adequacy of airport or parking capacity.

2. Simplified Analysis

The analysis can be simplified without loss of relevant principles by assuming that both operating costs and capacity costs of a service provided by a public enterprise remain constant with increasing levels of output. Figure 1 represents this situation with operating costs per unit time at the level b and capacity or capital costs (including economic depreciation and the financial opportunity cost of capital) at c. Thus the long-run average (and marginal) cost – LMC – of providing the service is at the constant level of b + c per unit time. Initial capacity is assumed to be Q_1 and there are periods of different and independent demand for the enterprise's service.[2]

Figure 1 Simplified Cost Functions



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The assumption of independence simplifies the figures used here to illustrate the analysis but in practice the effect of peak load pricing to shift to a slacker 'demand category' those users who value the enterprise's service less at peak times is most important in making the most efficient use of available capacity and in reducing the need for increased capacity.

The basis of expressing capital costs per unit time deserves special mention. Capital costs relating to existing capacity are incurred continuously regardless of the level of capacity utilisation from time to time. With variable demands, therefore, when expressing capital costs per unit time there is the question whether these costs should be allocated over the total cycle or only over the duration of particular demands within the cycle. In the discussion and illustrations here capital costs are allocated over the duration of substantial or 'effective' demand (to use Hirshleifer's terminology), that is, periods during which demand is sufficiently strong to exceed operating costs, b – under the assumptions of Figure 1 – at the existing capacity level. This is consistent with efficient marginal cost pricing which maximises welfare and capacity utilisation by recovering overall capital costs only during 'effective' demand periods. During periods when demand is so weak as to fall below b at the capacity limit (D_1 in Figure 1), efficient pricing does not contribute to capital cost recovery; it only recovers operating costs incurred during those periods (while ensuring maximum use of available capacity subject to that cost recovery). It will also be seen that such weak demand plays no part in optimal decisions to change capacity.

2.1 *Dual-Component Tariffs and Efficient Pricing*

If there were only two demand periods, D_1 and D_2, the capacity Q_1 illustrated in Figure 1 would represent the long-term optimum and efficient pricing for the peak (D_2) period and the slack (D_1) period would happen to correspond to a dual-component tariff arrangement, referred to earlier, with prices in these periods set on the basis of capacity and operating costs respectively. Revenue from slack demand customers would just cover operating costs, b, in the off-peak period and something less than maximum output would be demanded by those customers. Charging peak demand customers b + c per unit time (with c reflecting total capital costs allocated not over the total cycle but allocated per unit time over the period for which peak demand operates) would mean that the peak demand customers would just cover the full opportunity cost of capital as well as associated operating costs.[3]

Under these circumstances, the enterprise would be earning normal economic profits – reflected in a rate of return on assets ideally corresponding to its target rate of return – and at peak demand the capacity of the enterprise would be just fully utilised. The enterprise would be operating at long-run equilibrium with full cost recovery operative and the pricing structure would give the same outcome as the dual-component tariff arrangement.

The limited nature of this link between efficient pricing and dual-component tariffs may be shown by introducing a more intensive peak demand period (D_3) into Figure 1 such that the enterprise is no longer in long-run equilibrium. For illustrative simplicity the duration over the cycle of D_3 plus D_2 is the same as that of the original D_2 so that c is unchanged in the figure. Efficiency would require that, pending an increase in capacity beyond Q_1, the short-run price of services to D_3 customers be set at p, well above long-run marginal cost (b + c). That is because price p just covers the full short-run marginal cost operative during demand period D_3 at the capacity Q_1. With Q_1 of service units being supplied to customers in the D_3 demand class, price p represents the marginal opportunity cost of not supplying or not being able to supply another customer in the D_3 class with any service even though that customer would be prepared to pay just less than p for the service. Thus the efficient price, p, is equal to short-run marginal opportunity cost which depends on the operative level of demand at – under the assumptions of Figure 1 – the capacity limit.

As an illustration of this, a potential airport user or telecommunications subscriber may be prepared to pay just less than p for services during the D_3 period but is just excluded because the Q_1 of capacity is allocated to other users at the price p. At a price higher than p less than available capacity would be demanded. At a price lower than p queuing would occur. Similarly, the appropriate price for D_2 customers at the Q_1 capacity remains b + c per unit time. Thus, under the above simplifying assumptions the appropriate short-run marginal cost (SMC) schedule – incorporating full marginal opportunity costs – corresponds to operating costs out to the capacity limit, turning into a vertical line at that capacity limit. Efficient pricing is given by the intersection of the SMC schedule and the relevant demand schedule. That applies along the vertical segment of SMC because the relevant short-run opportunity cost depends on the operative level of demand at the short-run capacity level. In practice, this efficient pricing could be achieved simply by setting prices such that available capacity is just fully utilised with no queuing involved.

This discussion highlights the inappropriateness of setting prices on the basis of the dual-component tariff proposition. Pricing under this proposition ignores the additional short-run opportunity costs relating to the value of the service to those just price excluded at the capacity limit. Dual-component tariffs can only give the right result when there is one peak demand which would be just satisfied by the available capacity (under the Figure 1 assumptions) at a price equal to LMC and when slack demand is so weak that it falls below operating costs at the capacity limit. In this special case, referred to earlier, of long-run equilibrium with one peak demand period, LMC happens to equal the relevant short-run opportunity cost operative during peak demand. Because the dual-component tariff proposition is only applicable in this special case it is not useful as a general pricing strategy.

Figure 1 also shows the inappropriateness of assuming, as is implied by the dual-component tariff proposition, that long-run marginal costs must be greater than short-run marginal costs. Figure 1 shows that at capacity Q_1 short-run marginal cost corresponding to demand period D_3 is higher than operating plus capital costs. With appropriate economic pricing – that is, pricing to achieve full capacity utilisation – the enterprise operating at capacity Q_1 will in the short run earn above normal profits. Efficiency would require that capacity be increased. The question of particular interest is what is the relevant rule for determining optimal long-run capacity when variable demands are involved.

2.2 *Optimal Long-Run Capacity*

The optimal long-run capacity beyond Q_1 in Figure 1 is reached when the community's net welfare gain relating to D_3 consumers arising from an increase in capacity is just balanced by the net welfare loss relating to D_2 consumers from that increase. A marginal welfare gain arises in relation to the D_3 demand schedule because the value put on additional units of the enterprise's services beyond Q_1 by D_3 users (as reflected in the position of the D_3 schedule beyond Q_1) is more than the cost of providing these units (as reflected in the LMC schedule). On the other hand, increasing capacity beyond Q_1 results in a marginal welfare loss in respect of the D_2 demand schedule because D_2 consumers value the increased service units less than their cost of provision. In determining the optimal capacity where the marginal welfare gains just balance the marginal welfare losses, these gains and losses in respect of D_3 and D_2 need to be weighted by the respective share of D_3 and D_2 in the total duration of the D_3 and D_2 periods. Demand D_1 does not come into this figuring as regardless of the increase in capacity, D_1 customers will continue to consume the same amount of services at price b. There is no welfare effect relating to D_1 consumers from an increase in capacity.

Thus, the long-run optimal capacity is reached when the welfare gain from increased capacity in respect of demand period D_3 weighted by the length of the D_3 period balances the welfare loss in respect of the D_2 period also weighted by the length of the D_2 period. At the margin, the welfare gain or loss is reflected in the difference between the relevant demand schedule and LMC at the capacity level. In general terms, extra capacity should be provided where long-run marginal cost is exceeded by the vertical summation at the capacity limit of the 'effective' demand schedules (for which an expansion of capacity will involve some take up by the consumers involved of the increased supply of services) weighted by the corresponding fractions of total duration of these demands. In other words, the optimal capacity is given by the intersection of the appropriately weighted and vertically summed 'effective' demand schedules and the LMC

3 It might seem odd that all capital costs are recovered by appropriate pricing during the peak D_2 period if the duration of D_2 is only a small fraction of the total cycle. After all, with no D_2 demand long-run equilibrium would require reduced capacity until pricing at LMC resulted in 100 per cent capacity utilisation under D_1 demand. The point is, however, that as the percentage of D_2 in the total cycle decreased, the capital cost per unit time of 'effective' demand, c, would increase thus increasing LMC and requiring a reduction in capacity for long-run equilibrium (ultimately leading to the inclusion of D_1 in 'effective' demand).

schedule.[4] On the assumption that D_3 operates for only a fraction of the time of D_2 the optimal capacity is represented in Figure 1 by capacity Q_2.

The achievement of optimal capacity Q_2 together with efficient marginal cost pricing and the assumption of horizontal LAC represent a situation where the enterprise's returns just recover total economic costs. In other words, with efficient pricing at long-run equilibrium the public enterprise would just be earning normal profits or just meeting its target rate of return (if set appropriately). The economic losses realised in respect of demand D_2 are just balanced by the above normal profits realised in respect of demand D_3. Thus, under the demand conditions illustrated in Figure 1, the enterprise would over time, while continually pricing to just use up available capacity where possible, increase capacity beyond Q_1 until normal profits were achieved at capacity Q_2.

As demand increased over time shifting all three demand schedules to the right, if capacity was held at Q_2 prices would have to rise to choke off queuing. Above normal profits would be earned. If the enterprise's capital assets were divisible, such that small additions to capacity were possible, incremental additions to capacity could be made in line with increased demand in order to ensure that under efficient pricing only normal profits were earned. Prices would be expected to remain fairly steady. If the enterprise's capital assets were lumpy – minimum capacity being necessary for cost-effectiveness – the principles involved are not changed but some complications arise.

2.3 *Increasing Demand and Lumpy Investments*

Airports, parking lots, optic fibre cables, electricity generators and water reservoirs are some typical lumpy assets. If our public enterprise is selling services provided by such assets and is operating at long-run optimal capacity Q_2 as in Figure 1 it could not add a small amount of capacity in response to a small increase in demand. Ultimately, however, with steadily rising demand (associated with steadily increasing efficient prices at the fixed capacity Q_2 and so steadily increasing above normal profits), the time would arrive when the addition of the lump of increased capacity would correspond again to the situation depicted in Figure 1 with the enterprise earning normal profits but at a capacity level of Q_2 plus the capacity of an additional lumpy asset. As demand continues to increase, this approach to adding capacity would result in periods of steadily increasing prices and profits followed by a sudden drop in prices when each new lumpy investment was added to return the enterprise to the normal profit situation. The enterprise would overall make above normal profits.

The question here is whether economic efficiency would dictate that each lumpy investment should ideally be added at some time before demand and prices rise to such an extent that the full equilibrium position of Figure 1 is reached on the addition of the new capacity. Williamson (1966, p. 814) and Ng (1987, p. 24) show diagrammatically, using a steadily increasing single demand schedule corresponding to D_2 in Figure 1, that this is indeed so.[5]

With this more efficient timing of the introduction of new lumpy capacity, prices would still rise steadily before each new investment is made and fall afterwards. Rather than producing

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If, for example, demand D_3 in Figure 1 is taken to operate for one-tenth of the total duration of both D_2 and D_3, the optimal capacity in Figure 1 is represented by:

$$.1\ (D_3 - LMC) = .9\ (LMC - D_2).$$

That is,

$$\sum_i a_i D_i = LMC$$

where a_i is the fraction of the cycle corresponding to the ith 'effective' demand schedule. With uniform demand the analysis collapses to the standard situation where the intersection of the demand schedule and the LMC schedule gives the optimal capacity.

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In broad terms, higher enterprise losses in respect of D_2 associated with lower prices arising from the earlier introduction of new capacity at a lower demand level are balanced by D_2 consumers benefiting from reduced prices and increased capacity. (This balance involving net consumer benefits did not arise with D_2 in the earlier decision concerning increased capacity beyond Q_1 because then demand D_2 was not increasing and passed through LAC at capacity Q_1.) The presence of peak demand D_3 in Figure 1 does not change this effect except to cause the new capacity to be added sooner because of the benefits of increased capacity to D_3 consumers.

fluctuating above normal enterprise profits, however, the saw-tooth pattern of price changes – see Ng (1987, p. 24) – would be reflected in economic losses immediately after the introduction of new capacity changing over time to economic profits, broadly balancing the earlier losses, before new capacity becomes due. The size of the price fluctuations would depend to a large degree on the capacity of each lumpy investment. If, for example, optimal peak load pricing was being applied at Sydney's Kingsford-Smith Airport, the addition of a second major airport in the Sydney region would be expected to result in significant reductions in economic prices at Kingsford-Smith. On the other hand, a new bus added to Canberra's bus fleet may not be expected to affect optimal bus price schedules significantly (although there is local dimension here in relation to individual bus services).

In practice, setting target rates of return for public enterprises to be achieved over a number of years would allow enterprises with lumpy investments to balance reduced earnings realised just after the introduction of new capacity with later increased earnings. In addition, for enterprises whose services compete directly with private business, competitive pressures might be expected to cause the enterprise to get close to the efficient timing of its lumpy investments (as with its private sector counterparts). At the very least, government business enterprises should aim to have lumpy investments ready for start-up when their introduction would be expected to cause the enterprise initially to earn something less than normal profits (or its target rate of return) from the service in question.[6]

2.4 *Practical Pricing and Capacity Strategies*

The discussion so far enables a reasonably straightforward strategy to be presented for pricing and capacity decisions of public enterprises:

- in the short run, prices are set at all times by the enterprise to achieve maximum capacity utilisation with the lower limit on pricing set by the level of operating costs. Even with pricing set at this lower level the demand in some periods might be so slack that significantly less than 100 per cent capacity utilisation is achieved. For other periods the price is set to achieve close to 100 per cent capacity utilisation without queuing;
- over time, for enterprises with divisible assets, investment plans are made such that capacity is increased where economic profits (excessive cost recovery or returns above target rates of return) are being realised and capacity decreased when economic losses are being realised;[7]
- for enterprises with very large lumpy assets, it would be particularly important for target rates of return to be achieved over several years, allowing for reduced returns following the introduction of new capacity. Some tardiness could be contemplated in retiring very large lumpy investments in the face of economic losses.

By taking into account the full economic implications of peak and slack demand coupled with capacity constraints and the possibility of lumpy investments, this strategy is more generally applicable than dual-component tariff arrangements and more comprehensive than rules specifying only that prices recover full economic costs.

Nevertheless, the strategy involving pricing to maximise capacity utilisation in each of an enterprise's

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For enterprises with monopoly power, there is the problem that constraining capacity and raising prices could be masked by excessive costs resulting in only normal profits being reported. The deficiency in capacity would not be apparent. Price caps involving a 'CPI-x' formula might have some relevance here.

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Decreasing long-run average costs rather than the assumed constant LAC could mean that losses could be realised at long-run equilibrium with efficient pricing. Nevertheless, genuine decreasing LAC is rare and even where it exists basing the capacity decision around the earning of normal economic profits should be a reasonable approximation in most cases. In the absence of the clear presence of decreasing LAC there is no economic rationale for government involvement in relation to services subject to peak and off-peak demands or lumpy investments. Private enterprise could, in many situations, be expected to operate broadly according to these same pricing/capacity strategies in supplying such services.

services does not remove the requirement to determine the economic profit or economic rate of return achieved from each service. The returns from individual services do feed into the overall rate of return realised by the enterprise.[8] However, it is the size of the economic profit or loss or the rate of return achieved by each service that determines whether the capacity of that service should be increased or decreased over time. Thus, while pricing to maximise capacity utilisation is a practical, flexible and simple pricing strategy, the harder task of measuring economic returns from individual enterprise services must still be undertaken to enable appropriate capital investment decisions to be taken.

The simple pricing strategy of pricing to maximise capacity utilisation with individual services follows directly from the simplifying assumption of constant SMC up to the capacity limit. This simplifying assumption is useful for establishing the principles involved. Moreover, this assumption may be quite close to the actual situation applying with many enterprises. Nevertheless, it is important to relax this assumption to get a feel for how that might affect pricing and capacity strategies.

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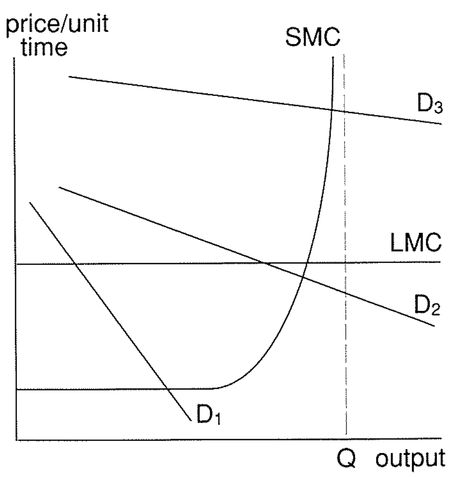
For both individual services and the enterprise as a whole, economic rates of return are determined by comparing economic income to the market value of associated assets. Economic income comprises net operating receipts plus the change in market value of the associated assets. The results can be expressed in real terms if transactions are valued at prices of one point in time.

3. More Generalised Analysis

Figure 2 removes the assumption that short-run marginal costs turn sharply upward from the constant level b at the capacity limit. The figure shows the SMC schedules to be of the more traditional shape forming a continuous function turning upwards towards the capacity constraint. The increasing SMC schedule could represent the usual increase in short-run costs as production is increased with fixed capacity or could also include increasing congestion costs as the capacity limit is approached. As an airport's capacity is approached, for example, aircraft could incur additional costs associated with being required to circle the airport before landing or being diverted to alternative airports. As a parking station fills up it becomes more and more time consuming to find a space.

Although Figure 2 would represent a more realistic situation for some public enterprises, the principles stemming from the simplifying assumptions of Figure 1 are not affected by the relaxation of assumptions. In the short run, prices for consumers in different demand categories would ideally be set at a level corresponding to the intersection of the relevant demand schedule and the SMC schedule associated with the current capacity level. In the long run, optimal capacity results when the appropriately weighted sum of these short-run prices – excluding prices that are only covering operating costs because of the weakness of the associated demand – equals LMC.[9] In other words, as Hirshleifer (1958, p. 461) explains, capacity would be expanded to the extent that new capital costs are a cheaper substitute for higher variable costs – including congestion costs – which would be incurred if increased levels of services were provided without increased capacity.[10]

Figure 2 Generalised Short-Run Cost Function



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The difference between the Figure 1 and Figure 2 cases is only a superficial one: in the Figure 1 situation the vertical summation occurs conveniently along the vertical SMC schedule at the capacity limit, whereas the amount of service provided at the optimal price for each 'effective' demand category differs in Figure 2.

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Looked at in another way, capacity would be increased until the weighted average marginal reduction in congestion costs due to increased capacity (that is, the reduction in SMC associated with each effective demand schedule weighted by the duration of that demand) is equal to LMC. For a mathematical derivation of the optimal capacity see Williamson (1966, footnote 12, p. 826).

While the principles are unchanged the ease of applying them in practice is reduced considerably. In particular, pricing strategy can no longer simply be based on maximising capacity utilisation. When increasing congestion costs (or more generally increasing variable costs) result as the capacity limit is approached, optimal pricing requires prices to be set such that something less than 100 per cent capacity utilisation is achieved. Further, the level of optimal capacity utilisation can vary with peak and slack demands. On the basis of the SMC schedule in Figure 2 corresponding to capacity Q, for example, peak D_3 demand prices would ideally be set to achieve a higher level of capacity utilisation than that during D_2 demand times. But without knowing full details of cost and demand schedules there is no clear, practical way of knowing what level of capacity utilisation is required to achieve optimal pricing at a particular time. This, in turn, affects the confidence of changing capacity on the basis of whether or not normal profits are being achieved by the enterprise.

In many cases estimates of peak and slack demand schedules, as well as the SMC schedule, should be possible – even though the estimates may in some cases be necessarily rough. Data would often be readily available on differences in relative demand for services at different times and studies have estimated the effect on costs of increasing use of available capacity in particular services, for example, that of increasing the volume of traffic on roads of given capacity.

In the absence of a knowledge of an enterprise's cost schedules and the peak and off-peak demand schedules for the enterprise's services, however, the pricing and capacity strategies stemming from the simplified analysis of Figure 1 may often be the most practicable approach to take. Lessons from the more general situation illustrated in Figure 2 could also perhaps be used to temper appropriately the strategies arising from Figure 1. One approach might be to attempt to set prices such that capacity utilisation was maximised against the practical constraint that consumers should not be asked to face 'excessive' congestion costs – on the basis that with many public enterprises congestion costs would be a major cause of increasing short-run marginal costs towards the enterprise's capacity limit.

Any such adjustments to the earlier simple price/capacity strategies would, however, be very rough and it is relevant to note that increasingly sophisticated technology means, in relation to some services provided by public enterprises, that the short-run marginal cost schedule is closer to that depicted in Figure 1 than in Figure 2. This would be so in cases, for example, where technological improvements allow consumers to know at little cost when other consumers' use of the services would increase congestion costs significantly.

Thus in the aviation area congestion costs can be reduced to a minimum by scheduled landing arrangements. Under these circumstances, market-orientated allocation of landing 'slots' could be based on prices set flexibly over time to achieve 100 per cent capacity utilisation (with no queuing) wherever possible. With motor vehicle parking areas technology would allow the virtual elimination of costs of finding a parking spot in an almost full parking area by displaying a plan of the parking area with the location of individual unused places illuminated. Moreover, in the telecommunications area congestion costs up to the capacity limit of modern telecommunications links would be minimal. Subscribers can either get through or not and until capacity is actually reached they are not aware of any congestion effects.

These considerations support cost schedules more in line with Figure 1 than Figure 2 and therefore highlight the relevance of the pricing and capacity strategies associated with the simplified Figure 1 arrangements. Those strategies would be relevant with many services, such as, airport services, the provision of parking and the use of telecommunications networks (as opposed to obtaining access to a network or renting capital equipment from a telecommunications enterprise). In these cases difficulties in implementing the simplified pricing/capacity strategy could, in relation to pricing, hinge mainly on measuring the extent of queuing at particular times for particular services (especially in the telecommunications area) and, in relation to decisions on capacity changes, on the determination of economic profits or losses associated with particular services.

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Responses to World Oil and Coal Shocks, in a Short-Run Fuel Substitution Tax Model

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Abstract

This article examines effects on major Australian macroeconomic and structural variables of simultaneous shocks to world oil and black coal prices. The illustrative numerical results have been produced with the short-run fuel substitution tax model, ORANI-LFT. The current version of that model reflects the Australian Government's pre-1988 oil regulatory framework, and the simulations reported in this study reflect the recent switch from significant dependence on crude oil levy revenue to petroleum products excise revenue. Empirical results show that combined world oil and coal price shocks lead to substantially different effects than would occur from an oil shock alone. A major implication of this, for a small open economy such as Australia, is that particular attention has to be paid to the interdependence of world energy markets, both when analysing the effects of such shocks and when formulating appropriate macroeconomic and energy policy responses. It is also pointed out how the model could be modified for investigating effects under deregulated oil market regimes.

1. Introduction

This article reports results from the Australian short-run fuel substitution tax model, ORANI-LFT, which is used to simulate the effects of simultaneous world oil and coal price shocks. Our aims are:

- to get some feel for the relative directions and strengths of impact from these two major interdependent world energy markets, and
- to provide some analytical basis for examining recent Australian experience with weaker world coal markets.

One key institutional element incorporated is the Australian Government's recent switch from significant dependence on crude oil levy revenue to petroleum products excise revenue, while preserving nominal liquid fuel tax revenue neutrality. As shown in Chart A this occurred primarily in 1986-87 when, in dramatic contrast to movements over the period 1975-76 to 1985-86, crude oil levy receipts fell from their peak level of $4019 million to $2062 million. This fall was offset by an increase from $2813 million to $4666 million in petroleum products excise receipts.[1]

Another key feature is that results currently reflect the modelling of two important strands of the Australian Government's pre-1988 oil regulatory framework, namely the import parity pricing and domestic allocation systems for crude oil. But with the Government's decision to deregulate crude oil marketing having taken effect from 1 January 1988, the article also points out how the model can be used in the future to investigate impacts from various forms of 'deregulated' oil market.

The catalyst assumed for the fall in crude oil levy revenue is a ten per cent fall in the world price of crude oil, and the coal shock is implemented through a ten per cent cut in the world price for Australian black coal.

The background to and relevant aspects of ORANI-LFT are presented briefly in Section 2. Major results are given in Section 3, and concluding remarks appear in Section 4. The numerical values presented in Section 3 should be considered illustrative, and are not suitable for direct use in policy and forecasting work at this stage. That would require both an updated database and further analytical work of the type indicated in Section 4.

2. The Fuel Substitution Tax Model: ORANI-LFT

ORANI-LFT is a short-run applied general equilibrium model, consisting

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1 These figures have been taken from The Treasury (1987, p. 326).