TRAFFIC MANAGEMENT POLICIES AT A MAJOR AIRPORT*

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ABSTRACT: *This paper discusses existing traffic management policies in use at major airports, both overseas and in Australia. It describes the London airports' use of various elements of peak pricing, and the U.S. approach of regulation and negotiation between users. Management procedures currently exist at several major Australian airports for international airlines and at Sydney for general aviation (to a limited extent).*

The two alternative approaches to management are then further developed. The airport authorities can impose a surcharge at peak periods, in the best traditions of classical economics, and hope that those flights with lower surplus values will automatically reschedule themselves to the less congested periods. Alternatively a maximum number of movements can be set by an outside body, and the airlines then decide themselves how these should be allocated between airlines. The likely effects at Sydney of adopting either of these two approaches are discussed and compared.

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1. INTRODUCTION

In April 1974 R Travers Morgan were engaged by the Australian Government to examine possible traffic management measures which might be employed at Sydney (Kingsford Smith) Airport (KSA) in order to defer the need for additional runway capacity in the Sydney area. Many of the measures considered were specific to the Sydney situation, either because of its physical layout or because of the particular mix of traffic. However, a major part of the study effort was devoted to comparing the relative advantages and disadvantages of two contrasting management philosophies - regulation and pricing.

This paper first discusses existing traffic management policies in use at major airports, both overseas and in Australia. It describes the London airports' use of various elements of peak pricing, and the U.S. approach of regulation and negotiation between users. Management procedures currently exist at several major Australian airports for international airlines and at Sydney for general aviation (to a limited extent).

The two alternative approaches to management are then further developed. The airport authorities can impose a surcharge at peak periods, in the best traditions of classical economics, and hope that those flights with lower surplus values will automatically reschedule themselves to the less congested periods. Alternatively a maximum number of movements can be set by an outside body, and the airlines then decide themselves how these should be allocated between airlines. The likely effects at Sydney of adopting either of these two approaches are discussed and compared.

2. THE SYDNEY PROBLEM

KSA is the busiest airport handling regular passenger transport (RPT) movements in Australia. Table 1 gives passenger and aircraft movements, by class, for the year ending June 1976.

TABLE 1

Passenger and Aircraft Movements[1] at KSA (year ending June 1976)

Class of Traffic	Passenger Movements (m)	Aircraft Movements ('000)	%
International	1.7	19.0	13
Interstate) Intrastate)	4.8	85.0	55
Commuter	0.1	19.5	13
General Aviation	-	29.5	19
TOTAL	6.6	154.0	100

(1) A movement is an embarkation or a disembarkation for passengers; and a takeoff or landing for aircraft.

Commuter airline and general aviation (GA) movements, predominantely by light aircraft, together number over 49,000, some 32% of the total. Although these aircraft only require short lengths of runway space for takeoff and landing, they disproportionately influence the capacity of the airport because of their low approach speed and their need to maintain relatively large spearations behind larger aircraft as a precaution against wake turbulence.

As with all capacity problems, the crucial parameter is the number of movements in the busiest period. The highest hourly number of aircraft movements recorded in the year to June 1976 was 51, of which 28 were heavy RPT movements, 11 commuter movements and 12 GA movements.

The number of aircraft movements has been steadily increasing at about 5% p.a., and the airport is expected to reach saturation (on the basis of standard operating criteria) sometime in the mid-1980's, the exact date depending on the traffic management measures taken in the interim. For practical purposes the runways can be considered to be currently running at capacity in peak periods, such as Friday evenings, and congestion delays of up to an average of 15 minutes per aircraft have been recorded recently. (The delays are even greater when periods of peak demand coincide with bad weather). However, although there are traffic peaks the traffic profile at KSA is already one of the flattest in the world, as measured by the ratio of peak to annual movements.

A key factor in the subsequent discussion is the central role played by KSA in Australian domestic aviation system. For practical purposes, all commuter and intrastate flights in N.S.W. are either to or from KSA and most aircraft in the fleet will make six or eight movements daily at KSA. KSA is equally crucial in the interstate network. A frequently-quoted statistic is that by 9 a.m. 50% of the interstate fleet has passed through Sydney and consequently the effect of congestion in the morning at KSA can persist in the system throughout the remainder of the day.

3. CURRENT POLICIES

Airlines dislike a peak just as much as the airport operating authority, as they incur additional aircraft operating costs from runway, taxiway and apron delays and require additional peak passenger and aircraft handling facilities and staff. However, a certain level of peaking is inevitable for three reasons:-

(a) passenger preferences for travelling at particular times, such as at the beginning and end of a working day for businessmen, and holiday periods for leisure passengers;

(b) the need to provide reasonable connections for passengers transferring between different airlines, whilst maintaining an acceptable level of aircraft and crew utilisation;

(c) the penalties which would be incurred from loss of revenue, particularly in a duopoly situation by one airline moving unilaterally from the departure schedule which is 'preferred' by the market.

Notwithstanding these constraints, by the time that congestion is serious enough to merit control by an outside body, the duration of the peak is likely to be considerable purely through internal measures available to individual airlines.

At most major international airports there are instruments which can influence the level and composition of air-traffic demand, although this is not always their main intention. These fall into two broad groups; air traffic control rules, and air navigation charges (or landing charges).

Air traffic control rules often exclude training flights and the lighter classes of general aviation by requiring all flights using a particular airport to be operated under Instrument Flight Rules (requiring a high level of intrumentation and pilot qualification). The prime concern of these rules is the safe operation of major airports rather than the regulation of regular passenger transport operators, commuter companies or the freight, charter and business jet aspects of general aviation. Such rules are not the active demand management policies which we are considering in this paper.

Air navigation charges are charges for the use of airspace and airport facilities and may potentially affect the composition and level of user demands by adding to airport users' costs of operations.

Typically, however, these charges are only used as a means of raising the revenue required to meet (either fully or partially) the costs to the aviation and/or airport authority of providing the facilities. They are not normally intended to influence demand and the way they are levied reflects this. For example, the Australian system charges RPT aircraft a sum equal to the product of a unit charge multiplied by a route factor. The unit charge is based on aircraft weight and although this reflects the greater impact of larger aircraft on the cost of aviation facilities, we believe that it may also reflect a principle of charging by the users 'ability to pay'. The route factor reflects the distance involved in a flight and the facilities provided over the route and at the airports. Behind the route factor element of the overall charge there is clearly a principle of charging by the 'value of service' provided. Such principles are concerned with fairness and expediency in raising revenue and are none the worse for that. However, what we wish to consider in this paper is the further principle that pricing or some regulatory system be used actively to influence the level and composition of user demand.

In mixed and free market economies the decision to interfere with the market demand at airports (and for other transport facilities) is more likely to be taken under the pressure of congestion or expected congestion than as a natural pre-planned course of action. In terms of market economics this reticence to intervene is no bad thing. People and institutions when left to their own devices will generally act to further their own economic interests. So long as there is no conflict in these interests and no significant external effects this is likely to give the greatest benefit to all parties in aggregate, as well as individually. So while there is spare capacity at an airport there are benefits in allowing its optimum use.

However congestion at airports at peak periods of demand is the manifestation of a conflict of interests between different airport users, and it is at this stage (in the economic jargon a situation of divergence between marginal private and marginal social costs*) that interference could act to increase the aggregate benefit.

The structure of charges for the use of London's Heathrow and Gatwick airports demonstrates a deliberate intention to reflect the additional costs of congested periods and thus to influence demand. The charges consist of three main elements.

(a) a weight element (payable on landings only) which is based on the maximum total wieght authorised for the aircraft and its contents;

(b) a passenger element, payable on all departing or terminating passengers. This element is payable at standard rates of 25p per passenger for domestic flights and 50p per passenger for international flights in the busier seasons of April to October (Heathrow) and July to September (Gatwick). These charges are further doubled at peak passenger times within the season which are 0500-0859 arrivals GMT (Heathrow) and weekends (Gatwick).

(c) a runway movement element (which is payable at Heathrow only) for each landing and take off. In the busy season (April to October) the rate is £40/movement in the periods 0800-0859 and 1100-1259, but it increases to £100/movement at the peak movement time, 0900-1059. In the off-season (November to March) this element is only charged from 0900-1159 at a rate of £40/movement.

Apart from the underlying weight element therefore the charging system at these airports explicitly recognises no less than three different sorts of peak problems - a seasonal peak, a passenger peak and a movement peak, and further differentiates these demand peaks by airport; a complex system indeed and one which may provide valuable information when it has settled down and been monitored.

By contrast to the pricing approach used at London demand management at congested airports in the USA is mainly by regulation and negotiation. As a response to increasing congestion in the late 1960's certain airports were designated High Density Traffic Airports (HDTA) at which special scheduling arrangements were applied. These airports were the three New York airports (JF Kennedy, Neward and La Guardia) plus Washington (National) and Chicago (O'Hare). Scheduling Committees were established, consisting of representatives of the airlines and other operators involved, and under the chairmanship of a US flag carrying airline. We understand that the airport authorities are not represented on the committees.

* Because of external effects such as noise pollution there is in fact always likely to be such a divergence. But for the purposes of this paper we are only considering the divergence of private and social costs caused by users delaying each other.

In summary the air traffic controllers specify for each period the number of take-offs and landings which can be handled safely and without undue delay under normal conditions. The committees then meet periodically to decide how the 'slots' should be allocated between different airlines during the subsequent periods. The proceedings of the committees are confidential but we understand that the initial distribution of slots is based heavily upon precedent and that subsequent changes arise out of discussion, argument, bartering and other kinds of non-monetary bargaining between the various operators represented, subject to the sanction of the committee.

Now to the administrative mind this may seem all very arbitrary and untidy, but it is not difficult to speculate about the various pressures which are responsible for bringing about allocations which are believed to have been broadly acceptable to all parties. Firstly a high degree of scheduling cooperation between different types of airlines is good for everybody's custom. International passengers often interline to and from the domestic carriers, whilst commuters provide passengers for both. Thus there are joint industry benefits to be gained by cooperative scheduling. The U.S. International carriers are no doubt also influenced in their dealings with foreign airlines by the desire to retain goodwill for their own negotiations abroad. Any nationality bias would therefore be a risky business. One can further speculate that any airline tending to gain an exaggerated concentration of slots, or any collusion between certain airlines, would lead to a broadening coalition of opposition from other committee members. And any airline which did not take up a slot for which it had previously argued would find it much harder to sell such an argument at subsequent committee meetings. Finally, the pressures on the committee to find a consensus position are strengthened by the knowledge that if the airlines cannot agree amongst themselves then they would probably have to surrender part of their autonomy to an external body to find a solution for them. In this paper we compare this kind of regulatory/negotiation approach (a 'slot system') to demand management to the pricing approach.

We have already described the Australian system of air navigation charges for RPT flights, and concluded that it is not a demand management device. In fact general aviation pays only a fixed annual licence fee, regardless of the number of movements made.

However, there are currently certain limited elements of demand management at Australian airports. RPT movements have priority over certain general aviation movements at Sydney (KSA) and there is an international scheduling committee at the same airport. This committee is made up of representatives of the international airlines and is concerned with the allocation of parking positions at the International Terminal during the peak period between 08.00 and 11.00. Similar committees operate at Brisbane, Melbourne and Perth airports. Apart from these elements it is fair to say that at present there is no comprehensive policy of demand management in Australia.

4. ALTERNATIVE APPROACHES

We have described the situation at Sydney Airport, demonstrated the expected growth of a capacity problem and the likelihood of increasing congestion at certain times, and said that there is at present no comprehensive policy for influencing the level of demand to alleviate this situation. Assuming some kind of demand management is necessary and desirable, is it 'better' to use a price mechanism and achieve a market solution, or to limit total demand by edict or regulation and allow the users themselves to negotiate the allocation of slots? (We will return later to the question of what is meant by 'better'). These two approaches can be complementary, for example by introducing an auction element into a scheduling committees proceedings. However, in this paper we wish to compare and contrast the two approaches and for this reason we treat them as alternatives.

First we consider the pricing approach. The philosophy behind using a price mechanism is that the best interests of the community are served if those who value the service most in money terms are allowed to use it. If the value to the user is measured by the price he is willing to pay for it then the market will filter out the lowest value users who are least willing to pay and this will tend to maximise the net benefit to the community. However, the price mechanism is not a unique system but requires careful consideration of a number of different dimensions before specific pricing measures are chosen. We draw attention to three.

First, it is important to consider whether the objective is to try to 'spread' a daily demand peak (or peaks) or to reduce the overall level of demand at an airport. In the former case any surcharge should have a time-specific dimension to encourage rescheduling to off-peak times. The potential for such peak spreading depends upon the 'peakiness' of the daily demand profile. In this paper we are considering a time specific peak surcharge, although in the particular circumstances of KSA such a surcharge may well also reduce demand because of operational constraints on spreading the peak.

Second, the congested facility must be clearly identified. Is it the airspace and runway system? Or passenger handling facilities on the ground? Or apron and gate capacity? If runway capacity is the problem then the 'congestion' charge should be aimed at aircraft movements. But if the bottleneck were the passenger handling facilities an aircraft movement charge could make matters worse by encouraging the consolidation of demand into bigger aircraft, thus causing a more discontinuous and lumpy passenger through-put. So for passenger peaking problems a passenger surcharge will be more appropriate than a movement surcharge. An apron and gate problem demands yet another approach. (At London Heathrow there is a parking charge for aircraft, payable after two hours free parking, to discourage carriers from waiting too long for the best departure times). At KSA the most imminent capacity constraint is the runway capacity. With a runway capacity limit rather than a passenger handling limit, measures which discourage marginal aircraft movements are good economically if they can also maintain high passenger throughput by encouraging higher load factors or larger aircraft. A passenger charge in the peak is inappropriate as it would reduce the load factors. Our particular interest is thus in charges on runway movements.

Third, there must always be a healthy scepticism about whether people and institutions such as airlines will react to the price mechanism in the way that economic theory suggests they should. This should be taken account of in the level and structure of charges.

As just one example of imperfection in the airlines' reactions, a peak surcharge levied at a particular airport on a per passenger basis but collected direct from the airlines would do little to spread a passenger demand peak if the airlines simply treated it as another cost and passed it on equally to all passengers in its network throughout the whole day. Economic theory does not predict this to be the most efficient reaction but it is a likely outcome if airlines try to maintain good public relations by minimising complications for passengers. Similar real world practicalities will be illustrated when we consider our predictions of the effects of pricing to KSA.

There are also theoretical reasons for believing that passengers, as consumers, have certain 'price' thresholds below which they do not react to price changes (and below which changes in price do not constitute a perceived loss of welfare). Thus, if an airline were to pass on a given surcharge to their passengers travelling during the surcharge period, the effects on passenger demand could be principally determined by where the charge per passenger fell in relation to the passengers' price thresholds, regardless of the real importance to them of travelling at a particular time. Thus the fact that one set of passengers does not respond to a peak surcharge does not necessarily mean that they value a particular time of travel any more than another set who do. It may merely be a consequence of differences in initial ticket prices and consequent differences in reaction thresholds. Whichever way the pricing system is structured the basic characteristic remains that the rationing is left to the various processes of the market, with its varying degrees of imperfection.

5. CRITERIA FOR COMPARISON, EFFICIENCY VERSUS EQUITY

We now consider the basis on which to say that one approach to demand management may be 'better' than another. Two possible dimensions are economic efficiency and equity.

In conventional cost-benefit analysis a project (or policy) is held to be efficient if the 'Hicks-Kaldor' criterion is met. This holds that a project is efficient if the gainers of the benefits could compensate fully the bearers of the costs (the losers) and still remain better off from the project. We emphasise the 'could' because the criterion does not require that the compensation actually takes place, only that the benefits of the gainers are sufficiently great (ie. greater than the costs to the losers) that it could. This formal statement of the position is probably better recognised as the decision rule that the various costs and benefits should in aggregate sum to a net benefit.

Now although the aggregate net-benefit rule is a matter of common acceptance the underlying Hicks-Kaldor criterion is not a fundamental economic truth but merely an expedient which enables the practitioner to add one man's benefit to another man's costs, whilst not taking a view about the particular distribution of gainers and losers. To the losers it is not a particularly appealing decision rule. Equity, however, is explicitly concerned with this distribution. For any particular level of net-benefit there are in principle a very large number of ways in which the costs and benefits could be shared out, although in practice there will not always be any institutionalised mechanism for actually doing the sharing. The desirability of any particular share-out is purely a matter of opinion. For the purposes of this paper we are going to assert that in this particular context a project will be more 'equitable' or fair' the greater the extent to which the gainers actually compensate the losers. We believe that this accords well with the way a publicly accountable government department would feel when charged with the responsibility of instituting a policy to ration the use of a publicly owned facility. In our context, the gainers are the groups of airport users (airlines and passengers) who are allocated the available capacity at the times which they desire. The losers are those other groups who are required to make adjustments.

To summarise, we wish to predict the practical effects of pricing and regulation/negotiation, and to draw conclusions as to which might be:

(a) more efficient, tending to minimise the net costs of the adjustment to rationing;

(b) more equitable, tending to lead to a compensation of the losers who must adjust, by the gainers who retain the available capacity.

In the next sections we discuss these predicted adjustments.

6. PRICING

In this section we assess the effect of peak period movement surcharges at KSA. We first discuss the first-order effects of how the airlines are likely to react initially to such surcharges and the possible ways in which the charges may be passed on to the fare-paying passenger. We then consider the thres hold charges at which airlines might react by trying to avoid the charges, as a second order, and more fundamental effect.

6.1 FIRST-ORDER AIRLINE REACTION, PASSING ON THE CHARGES

The reaction of airlines to surcharges and the way in which they try to recover the costs is crucial in assessing the likely impact of any pricing strategy. We consider that the initial reaction of airlines would be to try to pass charges on to the passengers in some way or other. It is convenient to consider each of the four main classes of user in turn.

Most usage of general aviation (GA) is on an individual journey basis and any surcharges at KSA would thus be collected directly from the charterers, (or paid personally by private pilots). There is little opportunity, and no obvious incentive, for recovering the cost from other GA users, either at KSA or elsewhere.

Over 98% of all passengers carried by the intrastate and commuter airlines travel to or from KSA, and any KSA surcharge would thus fall on KSA users. However, whether a peak surcharge would fall on peak-period passengers alone is open to question. In our view the intrastate and commuter airline would argue that any major rescheduling out of the peak to avoid the charge would reduce their aircraft utilisation from the present high level because there are no other routes on which they could be used at peak times other than to or from Sydney. This reduction in utilisation would not be in the best interests of their passengers. If they continued to use KSA at peak times and pay the surcharge they would therefore treat it an overhead to be recovered from all passengers at all times of the day.

The interstate airlines have more options for recovering the charges; not only can they spread the cost over all passengers to or from Sydney but they can also spread it over their entire network. (About 50% of interstate passengers travel either to or from KSA). It is also open to conjecture whether such a surcharge would actually constitute an increase in overheads. If total air navigation charges recovered in Australia remain constant as a matter of policy, then the imposition of peak period surcharges would mean a corresponding reduction in charges for users at other airports and at non-peak periods at KSA. Two major beneficiaries would thus be the interstate airlines. (Their increased costs at Sydney being covered by corresponding reductions at Melbourne and other ports).

The internationals have even larger networks over which to spread a peak surcharge. In practice, however, they are aware of their costs on a route specific basis and would probably pass the surcharge on directly to Sydney passengers, at least to the same extent as they pass on Australian landing fees. The charge would be lost into the total ticket price.

6.2 PASSENGER REACTION

With such a range of potential initial airline reactions it is worth establishing the environment in which pricing policies will be most productive. If it is hoped that passengers faced with fare surcharges will change the time of their journey and thus cause the airlines to reschedule flights out of the peak, then the most effective method would be by a per capita surcharge collected directly from peak passengers rather than by a movement charge which the airline passed on to the passengers.

The analysis of this situation has been described in a paper to the first ATRF*. The model indicated that there is scope to alter the time profile of passenger demand, especially for people on leisure trips. However, peak flights are characterised by high load factors of 80%-100%, whilst the demand would have to be depressed towards the 35%-40% levels at which aircraft cover their variable costs of operation before airlines would cancel flights. The model indicated that a passenger surcharge would have to be in the order of $10/passenger for this to occur and even then this would be only on the very shortest routes. Even the cancellation of flights is an unrealistic scenario from the point of view of the way airlines operate. More likely is the recognition that there is a hard core of business passengers during morning and evening peaks, who put considerable value on these particular flight times. Faced with lower demand the airlines could continue to serve this hard core demand and maintain profitable load factors by using smaller aircraft.+

In other words, we see little benefit for runway capacity in either a passenger surcharge or a flow-on charge, both of which will probably simply reduce the passenger/movement ratio. We now consider the second-order effects of movement surcharges when airlines, as a matter of longer-term strategy, might consider how this cost item could be avoided or reduced.

6.3 SECOND-ORDER AIRLINE REACTIONS TO PRICING

We first discuss the longer term implications for general aviation (GA). In 1974 a survey was undertaken to assess, amongst other things, the impact on GA of imposing a $35≠ surcharge on each movement. This showed that, faced with such a surcharge, equivalent to about $20 per GA passenger, 60% of GA would prefer either to operate from Bankstown, the main Sydney GA airfield or not fly at all. In 1974 about half the GA flights were actually carrying passengers, whilst a further quarter were positioning flights associated with this activity, mostly to or from Bankstown. (Although there would be some operational problems in using Bankstown as a base these could be overcome for a relatively small capital outlay).

Before discussing the reaction of the scheduled airlines, it is worth restating two points. Firstly, in contrast to the GA operators, who are probably represented acceptably by the classical economic model of a large number of independent suppliers of services, the scheduled airlines are monopolists in the case of the intrastate and commuter lines, duopolists in the case of the interstate airlines, and imperfectly competitive in the case of the international airlines. Their reactions are correspondingly much 'lumpier' and 'stickier' than those of general aviation and it is necessary to determine thresholds or trigger points at which they would actively consider how they might avoid the surcharges.

* Lack GNT Amos PF. A model for the evaluation of peak pricing of transport facilities, Australian Transport Research Forum 1975.

\+ Only on the very dense Sydney-Melbourne route are airlines likely to be able to amalgamate flights without significant operational problems.

≠ All money values quoted in this paper are in 1976/77 prices.

Secondly, as conceived a surcharge would apply to all movements taking place at KSA during the peak period. As time passes the daily movement profile will flatten and the peak surcharge period will probably be at least five hours of the day. Peak spreading will therefore be difficult, because it will require relatively large changes in movement times to avoid the peak period. Most domestic airline services operate on an interval basis, and moving flights out of the five hour peak period would cause substantial disruption of the service. So much so that it would probably be in the interests of the intrastate airlines to move operations to Bankstown, if possible, in preference either to paying a large charge at KSA or to modifying their shcedules to avoid the peak period at KSA.

On the basis of our research into the practical objectives of airline scheduling we judged that the most important factors influencing the intrastate airlines' reaction to a surcharge would be the inferior accessibility for passengers at Bankstown and the cost of the surcharge as passed on to the passengers if they remained at KSA. To represent the application of these partly subjective criteria, we compared the increase in surface access costs of moving to Bankstown with the costs per passenger of the surcharge if the operator remained at KSA. This indicated that a $50 surcharge would encourage commuter operators to operate from Bankstown rather than KSA and that a $150 surcharge would encourage the intrastate operators. (This assumes the Bankstown option were open to these classes of user, which is not necessarily the case.)

In practice, levels of surcharge would have to be somewhat higher to achieve their effect because of normal inertia in triggering the decision, and would probably be closer to $75 and $200 respectively. We estimated that the $200 movement surcharge would not cause interstate and international airlines to reschedule their operations. (The Bankstown option is not available for the types of aircraft used by these airlines).

As will be seen from Table 1, the removal of general aviation, commuter and intrastate flights to Bankstown consequent on peak surcharges of this order of magnitude would effectively solve the capacity problem at Sydney for the foreseeable future.

If however, the removal of some intrastate airline flights to Bankstown is not a viable policy option there is the problem of how the intrastate airlines could otherwise react. Any reduction in the number of peak movements made would lead to reduction in aircraft utilisation, a reduced level of service to passengers and increased operating costs; whilst if they maintained the schedules and paid the surcharge, passing it on directly to the passengers, we have already said that a level of about $10/passenger ($500 per movement) would be required to reduce load factors to the marginal flight cost break-even point. We believe that if the Bankstown option were not open to them the great problems caused to both intrastate airlines and their passengers would make heavy peak surcharges publicly unacceptable.

International movements which occur in the peak are relatively infrequent services and could possibly be rescheduled, subject to certain limitations. However, because the consequent alterations to schedules would be considerable and would have repercussions at other international ports, it appeared to us that the airlines would be insensitive to any charge less than the revenue loss from a 1% change in load factor. This is a rule of thumb for the margin of latitude within which an airline would not consider action to alter its costs or revenues. For a B74/ 1% of load factor would typically represent a marginal revenue of, say, $2000. Clearly, any realistic level of movement charge would be far less than this and the basic scheduling inertia would thus not be overcome.

In summary, what are our conclusions on the impact of various movement pricing strategies at KSA? If adjustment costs are to be minimised the airlines who should adjust are those with the operational flexibility to either divert from the peak period (such as internationals to a degree) or divert to another airfield (such as GA). In practice

(a) GA operators can pass on surcharges easily to the particular specific groups hiring their services during the surcharge periods. Those hirers can readily be offered alternative quotations for either a KSA or a Bankstown flight. We estimate that a relatively small surcharge of about $35/movement would cause most of GA to divert to Bankstown (leading to some actual reduction in demand).

(b) If the commuter and intrastate airlines are given the opportunity to transfer their operations to Bankstown they are likely to do so at surcharge levels of about $75 and $200 per movement respectively.

(c) If this transfer is not a viable option their reaction will be much delayed. They are likely to spread the surcharge over all passengers, depressing demand and encouraging the use of smaller aircraft (or delaying the introduction of larger aircraft). Rescheduling from the peak period, which itself will significantly increase operating costs because of losses in aircraft and crew utilisation, is unlikely until very high surcharge levels are reached, say $200 and $500 per movement. At that level the viability of the whole airline operation must be in doubt, particularly for the commuter airlines, and we cannot foresee public and political opinion allowing such a situation to arise.

(d) Although internationals in theory have the flexibility to reschedule they are unlikely to even consider doing so for surcharges of under $1000 per movement, because the much greater financial scale of their operations gives them a higher trigger point for action.

(e) Throughout this analysis we have assumed that the surcharges would be applied so as to keep the total level of air navigation charges constant i.e. there would be corresponding reductions elsewhere in the system. The net effect on the interstate airlines will thus be very small and, as they would probably spread any increase in cost over the entire network, almost unnoticeable by passengers.

7. REGULATION: A NEGOTIATED SLOT SYSTEM

We now discuss an alternative to pricing, negotiation between the various users for a given number of slots. The essence of the negotiation approach as operated by international airlines is that they can trade off concessions at various airports around the world in a series of quid pro quos. They are also able, of course, to trade concessions at different points in time. A desirable pre-requisite, therefore, is the existence of scheduling committees at more than one airport. At a single airport such as KSA, a major problem will be the negotiation of settlements between the various classes of user, many of whom come into contact only at this one airport eg. intrastate and international. (This is likely to be alleviated to some extent by the vertical links between airlines eg. Airlines of NSW and Ansett).

Another feature of scheduling committees is that they are likely to function better as a means of preventing increases in movements rather than a means of reducing an existing level. It therefore follows that such committees should be established well in advance of chronic congestion arising. The following sections discuss the likely reactions of various classes of user to quantitative restrictions on their movement rates. The knowledge of what they could and might reasonably do to adjust to a slot system is obviously an important element in deciding the initial allocation of slots between classes of user.

Under any analytical framework, GA is likely to be identified as, on average, a low-value user and thus receive relatively few slots under a negotiated system. Demand will almost certainly be in excess of supply and, in the absence of a GA industry regulating agency, the airport operating authority will have to ration movements by some form of priority system. This is in effect already in existence. There need not necessarily be any minimum number of GA slots, although at Heathrow there are two per hour for IFR GA.

The commuter airlines are unlikely to require further slots for their existing services, as they already operate on an hourly interval basis. One obvious allocation is therefore to hold slots at their present level. Maintenance of existing slots would prevent the development of new services but any further restrictions would threaten the viability of the entire operation at KSA and they would probably divert to another airport. Since any new commuter services are likely to be of lower community benefit then the present ones, it makes sense, prima facie, that they should receive lower priority in rationing.

As argued earlier, intrastate airlines would find in inefficient to reduce operations in the peak airport hours. At present they operate frequencies to most ports which, in a growth market, they would wish to increase in the longer term. We consider that rather than reschedule services out of the peak or use larger aircraft (which would tend to delay increases in frequenty) they would prefer to perate out of Bankstown when they wanted, and with the frequency they desired. Moreover, moving even partially to Bankstown would relieve those services of the congestion they would otherwise experience at KSA. If moving services to Bankstown were not a policy option and their slots were actually reduced, intrastate airlines would be compelled to either:

(a) cut out peak services, causing reduced aircraft utilisation;

(b) introduce larger aircraft, causing delay in the growth of service frequencies (off-peak as well as peak) and requiring the improvement of country airports.

We consider that the reaction of the interstate airlines to a limitation on movements would be to accelerate the introduction of wide-bodied aircraft on routes which already have high frequencies, so as to be able to carry a growing number of passengers in a constant number of aircraft. The airlines are also likely to shelve the introduction of non-stop services to ports not previously served directly. A continued reduction of slots beyond this would result in reduced frequencies on the Melbourne and Canberra routes, and subsequently on the Brisbane route.

As airport congestion is the reason for movement limitation, the most obvious single step toward reducing congestion would be the partial pooling of services by the two interstate airlines. This would have to occur throughout the network and there must be doubts as to its political acceptability. The main disadvantage of this would be the reduction in passengers' ability to choose between the two interstate airlines for any flight time. But the pooling of demand into larger aircraft need not cause any reduction in service frequencies if the airlines could be persuaded to stagger their schedules.

By contrast with the domestic airlines, the international airlines have a reasonable amount of room in which to manoeuvre to avoid peak periods. They do, however, have significant restrictions in the form of 'windows', caused by curfews and commercially undesirable departures and arrival times at other airports round the world.* We consider that it would be difficult to restrict the actual number of flights by the international operators (as opposed to scheduling changes). In general, they fly the largest aircraft available and there would thus be little scope for increasing aircraft sizes. Moreover, restrictions could have an effect on schedules around the world, and also lead to retaliatory action on the part of other countries. But there is some scope for limiting the international slots at KSA, without risking repercussions outside Australia, by reversing transit legs between Sydney and Melbourne. (A Sydney-Melbourne-Sydney pattern requires 4 movements at KSA, a Melbourne-Sydney-Melbourne pattern only 2 movements at KSA).

In summary the likely responses of the various operators to restrictions on their movements are;

* As an extreme example, flights to Tokyo from KSA via Manila can depart only during a 3 hour period in the morning and a 1½ hour period at night.

(a) Most general aviation would be diverted to Bankstown;

(b) Commuter operators would experience considerable operational difficulties with a reduction in their present number of movements. If the existing number of movements were held constant, new services would be delayed and those which did emerge would operate from Bankstown;

(c) If the option were available, the intrastate airlines would operate some or all of their services from Bankstown. Failing that option they would accelerate the introduction of larger aircraft (unhampered by the financial burden of a surcharge) and reduce or delay the growth of service frequency;

(d) The interstate airlines would accelerate the use of larger aircraft. This could lead to a reduction in service frequency but need not if routes were pooled and services staggered;

(e) The international airlines would reschedule flights where possible, and reverse transit legs to Melbourne.

8. COMPARING THE TWO APPROACHES

We are now in a position to compare and contrast certain features of the two approaches, and to draw certain conclusions about their economic efficiency and equity.

First we deal with efficiency. The most important point is that under a slot system there seem to be many more adjustments possible than under a pricing system, especially for interstate and international operators. This is because a surcharge which is set high enough to cause these groups of user to adjust their operations would in practice either;

(a) not be necessary (if the Bankstown option were available all other users would have transferred there at a much lower surcharge, thus solving the KSA problem);

(b) not be acceptable (if Bankstown were not available, such a high surcharge would disrupt the financial viability of the intrastate operations, a situation unlikely to be tolerated by their NSW passengers at the main NSW airport).

In other words the threshhold surcharge level necessary to overcome the inertia of the interstate duopoly and the international scale of operations would never in practice be reached. And yet, we have shown that if these airlines' slots were directly limited, so they had to do something, then there are various adjustments which they could make. Nor are these adjustments necessarily more costly, in economic terms, than those which the intrastate operators would have to make under a pricing system. For example, consider the adjustment costs in terms of the net loss

of consumers' (passengers) surplus and producers' (airlines) operating cost. Let us assume for simplicity that the loss of surplus for any one passenger who is forced tomove from his preferred departure time (the time diversion cost) is inversely proportional to the duration of his trip. (This is intuitively reasonable - it ought to be easier for an international passenger, on a journey averaging six weeks duration, to shift three hours than for a domestic passenger on a journey averaging three days). On this assumption, the 'pecking order' in terms of loss of consumer surplus is (in increasing order of loss per flight, taking account of average passenger loadings) general aviation, commuter, international, intrastate and finally interstate. Loss of producer's surplus ie. increases in operating cost, could be broadly expected to follow the same pattern. Although international airlines operate the largest aircraft, they are not so dependent on KSA as the hub of their system and thus have greater flexibility in terms of rescheduling. (To reiterate the importance of KSA to the domestic airlines. 100% of NSW intrastate flights and nearly 50% of Australian interstate flights pass through it).

Pricing could thus be regarded as efficient to the extent that we predict general aviation and the commuter airlines would be the first classes of user to adjust and they would adjust at a comparatively low surcharge level. However, it is very unlikely that the next class to adjust (to a higher surcharge) would be the internationals, who are next in the economic pecking order. Economic efficiency thus comes unstuck, particularly if the Bankstown option is not available, as the intrastates would be wrestling with surcharges which an international carrier, however adjustable, would barely notice.

Again with a slot system we have pointed out the adjustments that could be made, at no loss to frequency, by the pooling of interstate routes using larger aircraft, coupled with staggered schedules. The implications of this need careful study and we would not wish to express an opinion as to its efficiency one way or another. However, the important point is that under a pricing system there would be no pressure on the airlines to consider it, since under present arrangements the airlines would both suffer the surcharge equally, thus leaving their competitive position intact, and they could also expect that over a period their total air navigation charges would remain unaffected anyway. But given a physical limitation on their movements, and an inability to meet growing peak demands with existing fleets, the whole issue of fleet structure, route pooling and staggered scheduling would open up; if not by the interstate airlines themselves then by the other groups of users who would be required to limit their own movements.

The initial allocation of slots between different user groups remains a real problem. But at least within each group the users would be compelled by the limitations to consider the most mutually efficient response. And over a period of time, assuming the groups' allocations are not unchangeable, each group will be compelled to demonstrate to the others the economic merit of its own allocation. In the final analysis there will always be recourse to the umpires, in the form of public opinion and the relevant government department.

In summarising the economic efficiency arguments we do not claim that all the adjustments which could be made would actually be made under a slot system. We are saying they are more likely to be considered and to that extent more likely to be implemented. Nor are we saying that overall a slot system would be more efficient than pricing But we believe that, in practice, it could well be.

What can we say about the equity of the two approaches, bearing in mind our assertion for this paper that a course of action is more equitable the greater the extent to which the gainers compensate the losers. Again, in principle, a price mechanism should allow the most equitable solution. The surcharge revenue earned from the gainers of the capacity could in theory be channelled to the losers by, for example, rebates in Air Navigation Charges for off-peak flights or for operating from Bankstown, or by expenditure on upgrading airlines and passenger facilities at Bankstown including interlining facilities with KSA. But an equally likely scenario is that the surcharge would be swallowed up in total ANC revenues, and, assuming a constant overall level of ANC, would result in a dissipated and unidentifiable flow-back to various sectors of the air transport industry.

With a negotiated slot system the two potential areas of inequity are in the allocation of slots between classes of user and in the distribution of slots between operators within a particular class. The easy way out for administrators is to allocate slots to different classes of users on the basis of the status quo. This may be adequate initially and none of the existing user groups would lose but as pressure for slots grows over time there is no doubt that more difficult decisions will be required. However the very fact that responsibility for the group allocations would rest with a government department and hence depend ultimately upon a publicly accountable decision, would put pressure on that department to provide some sort of compensating measures to the losers. This after all, is the same principle underlying property resumption payments in road schemes.

Within each group the slots would be negotiable and there is much less of an equity problem. The two interstate airlines are of equal size and negotiating strength, as to a lesser extent are the two intrastate airlines. And for the international airlines the give and take of international scheduling agreements is a well advanced art. There is every reason to suppose therefore that within each group, airlines will require reciprocal and compensatory concessions before agreeing to make adjustments to their own operations. Equity, as defined, will again not be perfect. But we would hazard a guess that most airlines would prefer to take responsibility for representing their own interests within an institutionalised negotiating framework rather than leave the issue of equity to be solved by an outside body, as would be necessary with a price mechanism.

9. CONCLUSION

This paper draws no definitive conclusion about whether in general the price mechanism is a better way of allocating scarce resources than other forms of rationing. What we have attempted to do is to demonstrate that in one particular case, the kind of problem for which the price mechanism is often put forward as the most efficient solution, we have found that mechanism lacking in practice. Because of the imperfections of the market and the practical constraints on the way in which the particular airlines operate, we are not convinced in this case that the market provides the most efficient solution.

Further the price mechanism leaves the question of equity untouched. Although, in theory, revenues from movement surcharges could be reallocated to provide a solution which would be reasonably fair to all concerned, this is extraneous to the actual market and requires specific additional decisions which cannot be guaranteed. By contrast the issues of fairness and compensation are at the hub of the negotiating process itself.

In summary, in allocating resources the 'Invisible Hand' of the market place seems often to be treated as an end in itself. Its visible imperfections and practical limitations should always be most carefully considered.