Techniques for Managing Airport Runway Congestion

Working Paper

This paper has been produced to inform debate on an issue of emerging significance to the Australian aviation community. That is, how best to manage congestion at airports.

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TECHNIQUES FOR MANAGING AIRPORT RUNWAY CONGESTION

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FOREWORD

This paper has been produced to inform debate on an issue of emerging significance to the Australian aviation community. That is, how best to manage congestion at airports.

When the demand for access to airport facilities (to execute a landing or take-off) exceeds the ability of the airport to supply the level of access desired, congestion emerges. When congestion emerges, landing and take-off rights become scarce and airport authorities are required to manage the allocation of these scarce resources among the competing demands. There are a variety of techniques which can be used to do this.

This paper does not propose a policy solution, nor does it suggest which of the demand management techniques might be best for Australian airports. What it does is to lay the groundwork for policy debate by providing information on the different techniques that have been used worldwide and those that are discussed in the academic literature on airports.

Working Paper 27 was researched and written by Corey Dykstra and Tim Risbey under the project leadership of David Smith of the BTCE's Transport Services Branch. Early work on this topic by John Street and Loretta Power is gratefully acknowledged.

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September 1996

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ABSTRACT

This working paper reviews the techniques which can be used to manage airport runway congestion. These fall into two broad groupings: administrative; and pricing techniques. Administrative techniques include: restrictions on aircraft operations (quotas and bans); use of scheduling committees; and allocation of slots by lottery. Pricing techniques include peak period pricing and auctioning of airport slots.

Each technique is discussed in detail, with its advantages and disadvantages highlighted. The discussion of slot auctions, being a technique as yet untried in an actual slot market, raises a number of possible implementation issues.

The paper also reports a selection of international case studies, in which runway congestion management is examined at airports in Europe, Canada, the United Kingdom and the United States of America. The case studies find a range of techniques in use at different airports, suggesting there may be no such thing as a universally optimal solution.

The paper does not make a finding, vis a vis managing Australian airport congestion. Rather, it is hoped the discussion stimulates public debate of the issues.

CHAPTER 1 INTRODUCTION

This paper aims to inform the reader about the techniques that can be used to allocate scarce airport access among the competing demands of aircraft operators. Information is drawn from the literature on airports as well as from evidence of what is used at airports in Australia and overseas.

AIRPORT CONGESTION DEFINED

Congestion arises at airports when the demand for access to airport facilities exceeds the ability of the airport to supply the level of access desired. Land transport access issues aside, there are two main areas where airport congestion can arise: (1) in the passenger terminals (for example, at customs barriers, or in terms of access for aircraft to terminal gates); and (2) on the runway. Terminal congestion is by no means a trivial problem, but is not considered in this paper.

This paper deals the problem of *runway* congestion; that is, congestion arising when the demand for access to a runway, in order to execute an aircraft landing or take-off, exceeds the capacity[1] of the runway. Some authors define this type of congestion in quite specific terms. For example, Mills (1990) defines runway congestion as arising when 'the decision of an individual aircraft operator to execute a landing or take–off results in *additional delays* to other aircraft'.

The detail of the definition is probably not important. What *is* important is that congestion imposes substantial costs on society. These costs are incurred by three main groups: aircraft operators, airline passengers, and communities under flight paths. When runways are congested aircraft operators can experience delays in landing, sometimes being required to execute 'holding patterns' before permission is given to land. Such unplanned delays result in

1. Runway capacity can be defined as the number of 'slots' available at an airport in a given period (often one hour). A slot is the right to schedule either a landing or take-off within a particular period, and has specific time dimensions which define where it occurs within a day, within a week, and within a year. For example, a slot may give an airline the right to schedule a landing or take-off between 0900h and 1000h on Monday, Wednesday and Friday during the northern summer months of April through to October. It is Government policy that the capacity at Sydney's Kingsford Smith airport will be capped at 80 aircraft movements per hour, and that this cap will be realised by implementing a system of slot rights for airport access.

higher aircraft operating costs and in reduced aircraft productivity. Passengers on delayed flights can incur travel time costs or some other measure of disutility. Communities under 'holding pattern' flight paths experience increased air and noise pollution.

Where estimates have been made of airport congestion costs, they appear to be substantial. Examples from around the world include the following:[2]

- in *Western Europe*, the proportion of flights delayed for longer than 15 minutes doubled to 24 per cent between 1986 and 1989, resulting in an estimated congestion cost of *US$1.5 billion per year* (SRI International 1990);
- in the *United States*, during 1986, the direct cost of congestion to aircraft operators was estimated at *US$2 billion* (Hong and Harker 1992); and
- in *Australia*, the Prices Surveillance Authority, in 1993, estimated that congestion at Kingsford Smith airport was costing airlines and passengers at least *A$40 million per year* (PSA 1993).

WHAT CAN BE DONE ABOUT RUNWAY CONGESTION?

There are essentially two approaches by which runway congestion can be eliminated, or at least reduced. The first is by expanding existing runway capacity or by building new airports. The second is by using demand management techniques to better allocate existing runway capacity. [3]

Infrastructure expansion, or the building of new airports, is the best solution in the *long* term. However, the lead times involved in obtaining requisite approvals, conducting environmental impact studies, and for the actual construction of new airport infrastructure can run to very long periods.

Further, because runway works are very costly, airport operators tend to wait until it is *certain* that expansion is needed before undertaking new development, an approach that is more likely than not to result in periods where airport demand will exceed capacity. [4]

It is therefore clear that solutions are needed to address congestion problems in these interim periods where available capacity can not meet all the demands for

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2. These examples of congestion costs are not necessarily comparable as they refer to different time periods, and their methods of calculation may not be the same.

3. In some cases, small increases in runway capacity might be achieved through technological developments (a new radar system may reduce separation requirements), or improvements in technical efficiency (new air traffic control procedures may increase the hourly capacity).

4. If runway investments are undertaken too early then airport capacity could end up well above existing peak demand levels, creating a large financial risk for airport operators if their demand projections are not subsequently realised. Note that total aircraft movements normally determine the magnitude of an airport's revenue stream, either directly through landing fees or indirectly through concession revenues.

access. These 'solutions', or demand management techniques, work by rationing runway capacity among the competing demands.

Demand management techniques fall into either of two broad groupings: administrative techniques, or pricing techniques. Administrative techniques involve an executive body making decisions on who gets access to the runway and when, whereas pricing techniques rely on aircraft operators choosing to use a runway based on whether or not they are prepared to pay an access price. These techniques can be used in isolation, or in combination, in order to achieve specific outcomes at congested airports.

STRUCTURE OF THE PAPER

The rest of the paper is in three chapters.

Chapter 2 describes the main administrative and pricing techniques which can be used to manage runway access, and explains the need for a system which allows adjustments to an initial allocation of access rights.

Chapter 3 gives a snapshot view of how congestion has been, or currently is, managed at airports around the world. Airports in Canada, the United Kingdom and the United States of America are examined.

Chapter 4 briefly concludes the paper.

CHAPTER 2 TECHNIQUES FOR MANAGING RUNWAY ACCESS

ADMINISTRATIVE TECHNIQUES

A variety of administrative techniques are available for managing runway access. The main ones include: administrative restrictions on aircraft movements; the allocation of access rights by scheduling committees; and the allocation of access rights by lottery.

Restrictions on aircraft operations (quotas and bans)

There are a wide range of restrictions on aircraft movements that are, or have been, applied at airports around the world. The most common ones involve *quotas* or *bans* on certain types of movement.

Quotas are usually applied to the number of movements allowed per hour by an aircraft category, such as international scheduled regular public transport (RPT). For example, if the hourly capacity of a runway system is 80 movements, 30 of these movement slots might be reserved for international RPT flights.[5]

Advantages of quotas and bans

Quota systems are a simple way to treat congestion problems and are attractive to *airport authorities* because they can strictly relate the volume of access rights to the technical capacity of the airport. Relating access rights to airport capacity is important as movement delays begin to increase exponentially when demand approaches airport capacity — a small reduction in the volume of traffic at an airport approaching congestion can result in a relatively large decrease in overall traffic delay. Hamzawi (1992, p. 54) finds that airport authorities view quotas as an attractive measure for dealing promptly with congestion.

Bans can be used to exclude particular types of aircraft movements during congested periods. These would most commonly be movements which airport

5. However, should demand for international RPT movements within the quota period exceed 30, then other allocation techniques might be required to allocate the scarce capacity, such as slot allocation by scheduling committees, a method which is discussed later in the paper.

authorities feel are of less value than other types of movements, or perhaps are of less cost to the community if they are excluded. For example, an airport might ban freight aircraft from congested peak hours, allowing only passenger aircraft movements, on the assumption that the net benefit of a passenger aircraft movement exceeds that of a freight movement.

In essence, both quotas and bans appear to provide a prompt and direct means of achieving set objectives, whether they be airport efficiency objectives or government social objectives. For example, quotas can be used to ensure a minimum level of access exists at all times for 'essential' air services such as air ambulance movements. Alternatively, quotas can be used to meet social objectives such as ensuring access to airlines which serve remote or regional communities. Doganis (1992, p. 104) stresses that one advantage of quotas is that they can be used as a safeguard to protect certain types of service, regardless of how the *rest* of the airport's capacity is allocated.

Disadvantages of quotas and bans

A disadvantage of both quotas and bans is that, in individual instances of aircraft movements, they may result in an economically inefficient allocation of access rights.[6] Access might be denied to an aircraft operator who values it more than the operator who has it. The valuations placed on access by different types of operator are not the same and will differ according to factors such as the type of aircraft used, the market served, the time of the flight, and the purpose of the flight. These relative valuations cannot be predicted with certainty.

If quotas and bans are applied in order to meet efficiency objectives, allocative inefficiencies may still arise, but are likely to be an exception rather than a rule. The exception is best illustrated by an example. If, during peak periods of the day an airport operator chooses to ban all freight aircraft movements, it is likely this will be on the assumption that high capacity RPT airlines value peak hour access more than freight aircraft operators. Yet, in some instances this might not be true. Perhaps, on one particular day, a small regional RPT operator with few passengers might not value the peak period access right as much as would the operator of a high capacity freight aircraft with a time sensitive cargo.

Clearly, there will be actual and theoretical instances that can be argued either way, but the purpose of this example is to illustrate that because of the macro nature of bans and quotas, the techniques have the *potential* to result at the micro level in allocative inefficiency.

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6. Allocative efficiency refers to the optimum allocation of scarce resources between end users. In the case of allocating scarce airport access, an efficient outcome is where the user who values access the most gets it. In a simple example, we might consider a Boeing 747 passenger jet operator who values the right to land at 0800h on Monday morning at $10 000. If the operator of non-time sensitive freight aircraft would also like to land at this time but values the access at $2000, then the most efficient outcome is to allow the B747 to land.

A related problem can occur at the level of individual airline decisions. This concerns the case in which airport capacity is segmented into quotas by type of operation — that is, x access rights are available for international movements and y rights are available for domestic movements. This type of quota system has the potential to prevent an airline which operates both international and domestic services from making the most efficient use of its pool of airport slots. For example, the airline may want to switch from providing a domestic flight to a more profitable international flight, but is prevented from doing so if the international quota is full. Depending on how rigid the boundaries were between the slot pools, this could still occur even though the airline's withdrawal of a domestic flight creates surplus in the domestic access quota.

Swoveland (1980), in discussing US experiences with slot quotas, notes that at 'controlled' airports in the United States there were three slot pools: air carriers, air taxis (commuter) and general aviation (GA), with each pool allocated a fixed number of slots. He suggests that an advantage of this segmented approach was that it may have ensured access to some relatively high value GA users who would otherwise have been denied access, under a blanket assumption that GA movements were of lower value than RPT movements.

On the other hand, Morrison (1987, p. 58), suggests that this approach meant GA operators and commuter airlines were able to obtain and use slots that might have been more highly valued by RPT airlines. These contrary opinions (and they are opinion rather than fact) do suggest that it is important when setting the parameters of quota segments to be clear about the relative valuations that different users place on airport access, especially in the case where quotas are being used to meet social objectives.

Conclusions on quotas and bans

The airports literature provides a range of conclusions concerning the use of administrative restrictions on aircraft movements to manage excess demand. On balance, some of the more important findings include:

- bans and quotas are relatively easy to administer; however, some quota systems may require constant monitoring, as would the case where access to quotas is granted on a first-come-first-served basis;
- quotas are used with some degree of success in North America, Europe and the Far East;
- quotas are effective in controlling peak hour traffic, and can be used as a safeguard to maintain access for some forms of traffic, or to exclude or restrict other forms;
- however, quotas are unpopular with some aircraft operators as they restrict access at the most desirable times, they may reduce an airline's operational flexibility, and they are unlikely to be allocatively efficient.

Allocation of access rights by scheduling committees

Scheduling committees are usually made up of airline representatives, and in some cases airport operators, and meet at regular intervals for the purpose of allocating scarce airport access rights among competing demands. These access rights are in the form of airport slots.

Scheduling committees typically operate at two levels. At the first level, biannual meetings of the International Air Transport Association (IATA) coordinate worldwide international airline schedules. At the second level, local scheduling committees provide schedule and access coordination at their own airports. Depending on the level of demand for access, this might be for just international RPT flights or might be extended to include domestic RPT as well.

At the biannual IATA meetings, member airlines discuss their proposed flight schedules for future periods. Where conflicts arise regarding desired airport access, the scheduling committee makes allocation decisions according to an agreed set of principles which take into account the concept of historical precedence, the financial impact on an airline of not obtaining a desired slot, and the technical limitations[7] of each airport. The main principles can be summarised as follows:[8]

- airlines are entitled to keep slots granted to them previously (this is known as the principle of grandfather rights);
- services (flights) which operate for a longer duration have preference (for example, a year round service has priority over a summer peak service); and
- services which are operated on more days of the week have priority (for example, a daily service has priority over a service operated five days a week).

At the local level, scheduling committees are usually chaired by the largest local airline. For example, the Sydney airport scheduling committee is chaired by Qantas Airways. However, in some countries, such as Germany, the government appoints a coordinator to ensure impartiality in allocation decisions.

Once airport slots have been allocated, airlines are often free to exchange them, providing that the slots exchanged have broadly similar operating characteristics. It may also be possible for an airline to change the use of its slots; for example, by switching it from a domestic flight to an international flight, or from a scheduled to a charter service. Doganis (1992, p. 101) reports that up to 10 per cent of slots at Heathrow and Gatwick change hands every

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7. Technical considerations include the capacity of the runway system, aircraft gate and parking capacity, and the terminal passenger flow capacity of the airport.

8. Sourced from Doganis 1992, pp. 100–101.

year as a result of decisions of the scheduling committee and subsequent exchanges between airlines.

Advantages of scheduling committees

The principle of grandfathering slot rights, which is adopted by most scheduling committees, rewards airlines for past investments in developing routes and flight schedules. By virtually guaranteeing continuity of airport access, grandfather rights help to ensure continuity and certainty of flights, as well as encouraging incumbent airlines to develop new markets. Doganis (1992, p. 101) not surprisingly states that incumbent airlines are strongly against alternative principles of slot allocation.

The IATA scheduling committee system allows airlines to make international network decisions when bidding for slots. That is, the need for access to a number of airports at related times in order to offer a multi-stop flight or network of flights, can be taken into account.

While it could be argued that new entrants may obtain desired slots at *no cost* if slots are allocated rather than sold, this assumes that surplus slots are available after the grandfather allocation has been made. However, this is seldom the case at congested airports. Even if slots are obtained free of charge, they are unlikely to be at the most desired times and may not allow the potential entrant to establish commercially viable services.

A few further points are made by Doganis (1992), who feels that advantages of the scheduling committee system include: that the system works and is internationally accepted; and that the system is not disruptive to incumbent airlines.

Disadvantages of scheduling committees

The disadvantages of the scheduling committee system are also clear. Major criticisms revolve around the unfairness of the method in that it biases slot allocation towards incumbent airlines, it can be allocatively inefficient, and that it can have anti-competitive effects. A number of authors draw these conclusions, including for example, Fawcett and Fawcett (1988, p. 48), Brander, Cook and Rowcroft (1989a, p. 38), Mills (1990, pp. 296–297), and Doganis (1992, p. 102).

In fact, many of the complaints of unfairness and bias are actually criticisms of the principle of grandfather rights. It is argued that in practice slots are seldom reallocated and that new entrants have difficulty in obtaining peak period slots at congested facilities. It is also suggested that airlines with slots that are in high demand have no incentive to give them up, unless perhaps by doing so they can get slots they seek at other times or airports. Reed (1992, p. 65) found that *up to 80 per cent* of slots at congested airports in Europe were reassigned to previous users at *every* scheduling conference.

Grandfathered slot rights can produce anti-competitive outcomes. Contestability in airline markets might be reduced if new entrants have difficulty obtaining enough slots to service more than one or two routes. Doganis (1992, p. 101) finds that in Europe one airline often controls 30 to 50 per cent of slots at a major airport(s) and is able to exert 'more or less' monopoly power. At highly congested airports most peak period slots are perennially reclaimed by incumbents, limiting access by new entrants.[9]

Because the allocation of slots is *not* based on market, or price, signals and does *not* indicate the value of a particular slot to the airline receiving it, slot rights awarded by a scheduling committee may not reflect allocatively efficient distributions. A further disadvantage of this lack of price signalling is that airport authorities are not receiving guidance on the level and timing of future investment. Fawcett and Fawcett (1988) in reviewing the United States experience with scheduling committees found that they had done a poor job of allocating airport resources at the high density airports post-deregulation. They criticised the scheduling committees as anti-competitive and concluded that the use of scheduling committees was inconsistent with the goals of deregulation and that scheduling committees had failed to reduce congestion at capacity constrained airports.

Conclusions on scheduling committees

The airports literature provides a range of conclusions concerning the use of scheduling committees to manage excess demand. On balance, some of the more important findings include:

- scheduling committees, in allocating slots according to the principle of grandfather rights, appear to encourage certainty in airline route planning, and encourage continuity in services by rewarding the investments made by airlines in developing new routes;
- however, scheduling committees are also viewed as having anti-competitive effects, and by biasing slot allocation towards incumbent airlines are suspected of reducing the contestability of the aviation industry;
- in not using price signals to determine who obtains slot rights, the potential exists for scheduling committees to make inefficient slot allocations; and
- while scheduling committees have been used extensively around the world to allocate scarce access rights, airport congestion is generally on the rise, and scheduling committees tend to become less and less workable as the gap between airport access demand and supply widens.

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9. In February 1993 the European Council recognised that new entrants had difficulty obtaining slots at congested airports, in its common rules for the allocation of airport slots. See chapter 3, p. 25.

Allocating airport slots by lottery

Slot lotteries are not an efficient or practical mechanism for allocating *all* airport slots, although lotteries may form a small part of a slot allocation system. We have included a discussion of slot lotteries for completeness.

Lottery techniques can be used to allocate scarce landing and take-off rights. In essence this requires three steps. First, the airport operator or government determines the number of slots to be allocated by lottery. Note that this may not be all the slots available. For example, only 5 per cent of available slots at the four United States High Density Rule (HDR) airports were allocated by lottery. Second, the type of entrant and the number of 'entries' each airline can have is decided. For example, it may be that only new entrants are allowed in the lottery. Third and last, slots are allocated to aircraft operators based on randomly drawn 'entries'.

Clearly, runway access required for essential services on an ad hoc basis, such as air ambulance movements, could not be allocated by lottery. Sufficient capacity could be reserved or, alternatively, these ad hoc movements could be catered for as required, accepting that any resultant delays to other aircraft movements are likely to be random.

Advantages of slot lotteries

One of the few advantages of lotteries is that they can provide a means of allocating slots that is not inherently biased towards incumbent airlines. Slot lotteries might therefore form part of an overall system of slot allocation; the part that aims to promote competition and industry contestability by allocating a proportion of total slots to new entrants.

As with other administrative mechanisms, lotteries could be designed to allocate more slots to new entrants, thereby increasing the contestability of the market. Of course, allocating slots to new entrants does not guarantee that new entry will occur; rather, it provides an opportunity for new entrants to enter airline markets that would not otherwise have existed and at least introduce a threat of competition for incumbents. CAA (UK) (1993) found that new entrants who had taken advantage of slots at Heathrow freed up by European Union regulation tended to enter thinner routes where competition was absent, rather than compete head-to-head with incumbents on main trunk routes. It is also interesting to note that in the United States, at the four HDR airports mentioned earlier, of 145 slots allocated by lottery to new entrants or small carriers, just 10 were still in use by these airlines in January 1990. The rest had been sold on or acquired as part of a merger (Avmark 1992, p. 3).

Disadvantages of slot lotteries

The random allocation of slots can make the task of building a reasonable, competitive airline schedule difficult, if not impossible. This is true for new and

incumbent airlines alike. In the case of a new entrant, the airline might have won one or several slot rights, but these might not be enough to establish a viable network of routes. In the case of the incumbent airline, it might have won *enough* slots to support its network, but these slots might be scattered in such a fashion that they cannot be used to support the flights which are already scheduled to arrive and depart other airports at specific times. Disruption of this nature would be likely to impact detrimentally on the continuity of an incumbent airline's schedules and create uncertainty in how best the airline should invest in the future of its network.

Also, as a result of the randomness of the outcome, there is the potential for an allocatively inefficient distribution of slots to arise from a lottery. In other words, the potential exists for aircraft operators with low valuations on slots to win access rights that might otherwise have been allocated to operators who valued them more highly. An arrangement to allow for slot swapping after the initial allocation has taken place, or perhaps a secondary market in tradeable slot rights, might provide a partial solution to this problem.

However, the prospect of tradeable slots raises another criticism of lotteries. This is, that the random element creates the potential to provide substantial windfall gains to those aircraft operators lucky enough to receive highly valued slots. Windfall gains, which are realised upon the trading of a slot for financial or other consideration, result in price being brought surreptitiously into the allocation mechanism in a manner that neither provides a return to airport owners nor gives a price signal that might be used to guide airport capacity expansion decisions.

Conclusions on slot lotteries

The airports literature provides a range of conclusions concerning the use of lotteries to allocate scarce airport slots. On balance, some of the more important findings include:

- lotteries can be used as part of an overall system of slot allocation to circumvent the bias that scheduling committees tend to give towards incumbent airlines, and can thus be used as a means to foster the entry of new airlines and increase the contestability of airline markets;
- however, lotteries can result in inefficient allocations of slots and may require secondary market trading in slots so airlines can untangle unusable allocations — a corollary of this is that lotteries can generate windfall gains to airlines, in particular if the buying and selling of slots in secondary market trading is allowed;
- lotteries can result in slot allocations that do not fit in with airline schedules and can thus be a cause of uncertainty in airline scheduling and planning — but this might be remedied by establishing a secondary market for trading in slot rights; and

- the many disadvantages of lotteries mean that they are not a suitable means of allocating *all* airport slots, but could have a minor role in increasing competitiveness as a subsidiary part of a more efficient and workable slot allocation system.

Perhaps Doganis (1992, p. 104) best sums up slot lotteries in suggesting that, overall, the introduction of randomness through lotteries does not seem to add much except that it may help new entrants (if they happen to win a slot), but that this is at the expense of greater uncertainty for all operators.

PRICING (MARKET BASED) TECHNIQUES

A pricing approach to managing airport access has two aims; first, to ensure that scarce access is allocated to those users who will obtain the greatest benefit from it, and second, to allow the pricing mechanism to provide a guide for future airport investment decisions.

There are two main demand management methods which rely on prices. One, which is used in practice at airports around the world, including Sydney's Kingsford Smith airport, is peak period pricing. The other, which from our investigation of the airports literature does not seem to have been used in practice, is airport slot auctions.

Peak period pricing

Peak period pricing typically takes the form of a surcharge levied on the use of an airport during busy hours with the aim of encouraging some aircraft operators to shift flights out of the most congested periods to other less busy times.

The introduction of a peak period surcharge, if additional to normal landing charges, increases the cost of an aircraft movement in the peak period relative to a movement in the non-peak period, and thereby reduces the demand for flights in peak periods by making some of them economically unviable. An efficient peak period surcharge would be one that succeeded in eliminating all excess demand from the peak period.

Advantages of peak period pricing

Peak period surcharges are used at a number of international airports around the world, and experience has shown that the introduction and adjustment of peak period surcharges is relatively easy and has been managed quite simply in practice. Hamzawi (1992) and Fisher (1989) discuss examples of this.

Peak period surcharges do not explicitly exclude individual aircraft operators, as might be argued, for example, do 'grandfather rights'. In theory, airport

access would be available to *any* aircraft operator who was prepared to pay the peak period access price.

Peak period surcharges *have* been successful in removing some lower value users from airport busy periods. For example, Kearney and Favotto (1993) found that at Sydney's Kingsford Smith airport the introduction of a peak period charge had a very significant impact on general aviation aircraft movements in the two daily peak periods. Aggregating the peaks, average daily general aviation movements in the peak periods declined from 79 to 17.[10]

Disadvantages of peak period pricing

Even if a peak period surcharge is able to suppress aggregate peak demand to a level commensurate with capacity, some administrative method may still be needed to sequence or schedule movements *within* the peak in order to avoid clumping and thus congestion. For example, if an airport has 80 slots available during one hour and peak period prices have reduced demand to 80 movements, congestion might still arise if two thirds of these movements are attempted in the first fifteen minutes. These clumping problems may either be addressed by scheduling committees or through splitting the peak period into smaller units and introducing greater price discrimination between them.

Such an approach has been used by BAA Plc at Heathrow and Gatwick airports, where the introduction of varying levels of peak period prices are used to partially suppress demand in certain periods. However, scheduling committees still operate at these airports, allocating peak period access rights along traditional lines such as grandfather entitlements (Doganis 1992).

Peak period pricing based on marginal social cost[11] is supported in the literature as a 'first best' solution for managing transport infrastructure congestion (PSA 1993), *but* determining the appropriate price that reflects the marginal social cost is not easy. Swoveland (1980, pp. 3–14) notes that in practice the strict implementation of marginal cost pricing is almost impossible, as estimating demand curves and the marginal social cost of an aircraft movement is very difficult. As a result, it appears that some airports instead determine prices largely on the basis of their demand suppression effect.

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10. Despite this, it should be noted that the major domestic airlines still complain of congestion in the peak hours and attribute part of this to the continued use of peak hours by low capacity intrastate RPT aircraft.

11. For any given level of congestion, efficient pricing involves setting prices to take into account the sum of the delay costs that are created by an incremental aircraft movement, and experienced by other aircraft when making their movements, together with the runway wear and tear costs that are caused by the individual movements (the marginal social cost) (PSA 1993, p. 98).

Conclusions on peak period pricing

The airports literature provides a range of conclusions concerning the use of peak period pricing to manage airport access. On balance, some of the more important findings include the following:

- the method is easy to implement and does not inherently discriminate against any user group; that is, if charges are 'set correctly' the method can help alleviate congestion problems, and the revenue raised can be used for airport expansion;
- however, even if the intention of peak period charge is to remove certain types of movements from the peak, it is still difficult to determine the appropriate charge to do this, other than through a process of trial and error;
- further, once determined, the peak period charge is not likely to be static for very long as underlying demand for peak period access will continue to change — regular adjustments to the charge may be needed;
- it may be difficult to use peak period pricing as a peak demand spreading technique due to the low cross elasticities of demand between peak and off-peak periods for some categories of users,[12] such as domestic RPT airlines who have flight schedules tightly tied to daily business cycles and network requirements; and
- some critics of peak period pricing argue that it is inequitable, favouring large RPT airlines who can spread the access charge across a large passenger revenue base.

Auctioning airport slots

Auctions are widely used in commodity markets to determine the allocation of scarce goods and services. Auctions tend towards allocative outcomes that are efficient, as those users placing the highest values on auctioned commodities will acquire them.

Auctions have not, however, been used in practice as a means of allocating airport slots, and so the airports literature on this subject is theoretical. In theory, an auction of airport slots would work the following way:

(1) the airport operator would first determine the airport's capacity and thereby fix the number of slots available for auction;

12. A low cross elasticity of demand means a user of the peak period is unlikely to be attracted to an off-peak period even by a large price differential between the two.

(2) aircraft operators would be able to bid for any of the slots in the auction; and

(3) slots would be allocated to the highest bidders, with actual prices paid for slots being dependent on the auctioning system used.

The concept behind auctioning of airport slots as a means to manage congestion is that excess demand (which results in congestion) would be avoided, as the quantity of goods (slots) to be sold is fixed at the capacity of the airport. Doganis (1992) believes that because auctions use *only* price to ration access to airport slots, then auctions should establish the true market value attached to a slot. [13]

An additional benefit proposed for slot auctions is that they increase the contestability of the airline industry. This is on the assumption that all aircraft operators have the right to bid for slots in an auction. This differs from the inherently biased 'grandfather rights' approach used by some scheduling committees. Brander et al. (1989a) state that aircraft operators would have to compete for slots by taking into account in their bid price the true value of the slot to them, whereas if slots are allocated free of charge by scheduling committees, the value of the slot does not play a key role in its allocation.

The major disadvantage of a slot auctioning approach, particularly as it will take place in a new and untried market, is likely to be that bidders will initially lack adequate information on which to make sound judgements about the value of slots, and this might lead to an inefficient outcome. Also of concern are a number of issues concerning the structure of the auction and the downstream implications of having sold specific access rights to airport users.

Given that the auction approach is as yet untried and untested, but a mechanism favoured by economists and thus likely to be prominent in a debate of how to manage Australian airport congestion, the rest of this section deals with some issues of substance that would require resolution if a slot auction system were to be implemented.

Auction format

In established markets auctions tend to lead to an efficient[14] allocation of goods. However, this outcome depends largely on the amount of information potential

13. Slot auctions would of course only work when slots were scarce (that is, congestion was present or anticipated within the life of the slot right).

14. Here we mean efficient in an allocative, or economic sense, rather than what might be considered as socially optimal.

bidders have about the auctioned good — the more information about the good and its value, the better the outcome. The *format* of the auction is important in ensuring enough information is available to bidders.

Balinski and Sand (1985) make some pertinent observations about the format of the auction most likely to produce an efficient outcome in the slot market. Traditional auctioning methods, such as the one-off English or Dutch methods,[15] do not account for the complex interdependence among slots an airline requires for scheduling flights. In other words, bidders cannot bid for *parcels* of slots that might be needed to set up a viable network of flights. Further, bids are made without any information of what other bidders might value the slot at, a problem that can lead to the 'winners curse', where too much is paid by the winning bidder.

Repeated simultaneous auctions are thought to overcome these problems by allowing bidders to iteratively learn of the demand pressures that exist in each slot market and thereby enabling them to develop informed and rational bidding strategies and prices that take account of this information.

A repeated simultaneous auction consists of numerous (repeated) rounds of an auction in which each round has many goods auctioned at once (simultaneously). In the case of slots, the many goods are the many slots. The outcome of the first round is made available to bidders. Each bidder may then submit new bids, using the information revealed in the first round to determine their bidding strategy. Auction rounds continue until no new bids are made.

In an ideal, fully informed rational market, this process should ultimately generate a set of non-discriminatory prices, where all slots in the same time period are auctioned for the same price. This is based on the notion that if, say ten slots are available during a particular period, bids will be just high enough to exclude the eleventh bidder. There is no incentive for any of the top ten bidders to outbid each other since the slot rights within a set period are homogenous.

Balinski and Sand (1985) conducted simulations to test for the manageability and convenience of a repeated simultaneous auction system for slots. They concluded that the experiments contributed to a practical interest in the

15. An English, or progressive, auction begins with a low bid to buy, and bids then increase, with the last (highest) bidder winning. A Dutch auction begins with a high offer to sell, which then goes down, with the first bidder winning.

technique of repeated auctions, but that further trials and studies were required before they could reach a conclusion on its manageability and convenience.[16]

It seems that the auction mechanism potentially offers a solution to both the airport congestion and slot *allocation* problems. However, given the complexities associated with 'pure' auctions, it may be necessary to implement a simplified form of such a mechanism if auctioning slots.

Investments by incumbent aircraft operators

Scheduling committees have generally awarded slots at congested airports to incumbent airlines (grandfather rights). Partly as a result of this certainty of access some airlines have made substantial investments in terminals and other airport facilities.

The introduction of an auctioning system, and its potential impact on route operating costs and airport access, might render some of this investment superfluous to operational needs or at least introduce an element of forward planning uncertainty for airlines that was not present before. To ameliorate such potential impacts it might be necessary to have a gradual phase in period to a slot auction system, which would allow incumbent airlines to adjust their level of investment at airports to account for any changes in operations as a result of slot prices impacting on the financial viability of certain flights. Brander et al. (1989a) and Doganis (1992) both suggest introducing auctions over perhaps 2 to 3 years, auctioning a *portion* of available slots every 6 months.

It is difficult to judge just how significant an auction determined slot price might be to an individual aircraft operator, when all other aircraft operating costs are taken into account. However, it is clear that airlines flying larger passenger aircraft have a greater potential than smaller aircraft operators to spread the additional cost per landing or take-off across a larger revenue passenger base.

Competition considerations

If left to the market, auctions have the *potential* to lead to well financed airlines squeezing out smaller incumbents and new carriers. Hamzawi (1992) suggests

16. It is interesting to note that while not used for allocating airport slots, repeated simultaneous auctions have been used in markets for goods with similar characteristics, for example, radio frequency spectrum. Cramton (1995) analysed the Personal Communication Services (PCS) spectrum auctions held in the United States for narrowband and broadband licences. He found strong evidence that the simultaneous multiple-round auctions where many licences were auctioned simultaneously was successful — 'bidders were able to react to this information, shifting bids to alternative licenses ... the information allowed arbitrage across similar licenses, so prices on similar licenses were close ... finally, the information revealed in the bidding enabled firms to piece together complementary licenses into efficient aggregations' (Cramton 1995, p. 1).

that these smaller or new airlines would find it difficult to compete and that auctions might therefore be viewed as anti-competitive.

However, Brander et al. (1989b) argue that it is not feasible for existing carriers to restrict entry through slot auctions, and while an auction system may exclude small or regional airlines from the airport in peak periods, off-peak access remains possible unless the airport is congested at all times. It is possible of course that, if smaller or regional airlines are restricted to accessing an airport in off-peak periods, then some of their passengers (making domestic or international connections) *might* experience some additional schedule delays.

All of the demand management techniques discussed in this paper require some form of 'use it or lose it' provision. This is to ensure that airport capacity utilisation is maximised and that aircraft operators with unused or under-utilised slot rights can not prevent others from using them. 'Use it or lose it' provisions apply to slots allocated at the four HDR airports in the United States. With some exceptions, airlines must use their slots 65 per cent of the time (evaluated within a two month period) or forfeit them.

What happens to the money raised by slot auctions?

A final issue for consideration might be 'what happens to the money raised by slot auctions'? This concerns not just issues of future airport investment, but also the question of *who* currently owns the property right associated with airport slots. A variety of slot ownership options might be considered, ranging from public ownership, private airport lessee ownership, or airline ownership. A combination of these might even be appropriate in order to meet social objectives.

Doganis (1992) suggests that all revenue raised through auctioning slots should be collected by the government and, where possible, be used subsequently to expand airport capacity. He argues that collection of auction revenues is especially appropriate to prevent private airport owners earning high monopoly profits where there is little scope for the owner to invest in additional capacity.

Fawcett and Fawcett (1988) go even further than Doganis and suggest that it would be wise for funds to be appropriated to a *specific* airport development fund, such as the Airport and Airways Development Fund used for such a purpose in the United States, rather than go into consolidated government revenue. Presumably this is to avoid the problem of funds being 'lost' in consolidated revenue.

Conclusions on slot auctions

The airports literature discusses in some detail the theory of an airport slot auctioning approach. On balance, some of the more important points raised include those listed below:

- While there is no practical illustration yet that slot auctions can be successfully implemented, in theory such a system of demand management would allow airlines to freely bid for one or more of a predetermined number of access rights within a given time period, with the rights going to the bidder prepared to pay the highest.
- This approach should ensure slots are obtained by the users who value them the most, and the auction would help establish the 'true' market price of a slot and thus provide a guide for future airport investment.
- It is also suggested that allocating slots by this method would increase the contestability of the aviation industry.
- However, there are also some concerns expressed about a system which auctions airport slots. The main one concerns the difficulty of successfully implementing auctions, given that there is no tried and tested system. The secondary concerns are equity or social issues, such as: the potential for large airlines to exclude entry by weaker rivals and those that are capital poor; and the inherent inequity of a method that favours large RPT airlines who can spread the slot price across a large revenue base.

ADJUSTMENTS TO THE INITIAL ALLOCATION OF SLOTS

Of the demand management techniques discussed above, some achieve their outcomes by allowing access to only those aircraft operators who have acquired an access right (a slot). In these cases it will be necessary to have some mechanism available whereby the allocation of access rights can be reviewed and adjusted, or whereby slot rights can be traded between aircraft operators.

This is necessary for a number of reasons, the most important being:

- to allow for inefficient or unusable allocations to be untangled by the recipients, or for airlines to adjust for changes in their airport access requirements; or
- for the airport authority or government to adjust the allocation of access rights to accommodate changing needs.

The need for an adjustment mechanism is clearly greater the longer the period of time between formal allocations, and the best mechanism to achieve these adjustments for aircraft operators may not be the same as for the airport owner or government.

Adjusting for an inefficient slot distribution or changing requirements

Earlier discussions of demand management techniques identified the likelihood that, irrespective of how slots are initial distributed, inefficient slot allocations might arise. Furthermore, as aviation markets change and airlines respond by modifying flight schedules, slot rights held by individual airlines may become more or less valuable to them.

There may even be some airlines who wish to exit certain markets altogether, and if it is the case that slot rights purchased through an auction are regarded as a legitimate part of their asset base, there must be a secondary market mechanism that allows for disposal of these 'assets'.

The detail of how best to establish and facilitate a secondary market for slots is well beyond the scope of this paper. However, a number of important considerations that would need to be taken into account include:

- what degree of property right or ownership is associated with a slot, and who holds this property right (the government, the airport owner or the aircraft operator);
- whether slots can be traded for money in a secondary market;
- what is the potential for anti-competitive behaviour, and if this potential is present, what regulatory structures would be needed to ensure against it; and
- what form the secondary might take , and to what degree should the government and/or the airport operator be involved in running or monitoring it.

Adjusting for changing needs of airport owners/government

The needs of airport owners or governments to adjust initial allocations of slots are somewhat different to the needs of aircraft operators outlined above.

Again, it is beyond the scope of this paper to suggest the detail of mechanisms which might allow the government and/or airport owners to adjust initial allocations, but in developing these mechanisms one might consider:

- the use of quotas for certain types of movements (perhaps to achieve social objectives) with the rest of the slots being allocated through other mechanisms such as auctions or scheduling committees; and
- the reservation of slot withdrawal rights by the airport operator. Slot withdrawal rights are held by airport authorities at four of the high density rule airports in the United States. Here, each of the domestic and commuter slots allocated to airlines is assigned a random withdrawal number. If new slots are needed for international or essential air services, the commuter or domestic flight with the highest withdrawal number is repossessed by the airport authority.

CHAPTER 3 WHAT IS DONE IN PRACTICE?

The purpose of this chapter is to give a snapshot view of how congestion has, or is, being managed at some of the major airports around the world. Airports of Canada, the United Kingdom and Europe, and the United States of America are examined, although no attempt is made to comment on the *degree of success* of the methods used at these airports.

CANADA

Slot allocation is only an issue at Vancouver and Toronto airports, as the other airports operate well below capacity. In Vancouver, a scheduling committee consisting of the airlines, under the chairmanship of the Airport Authority, allocates slot times on a quarterly basis. There are no formal rules but in practice slots are grandfathered, that is, a carrier occupying a particular slot keeps it as long as it has a flight scheduled. Slots are allocated by day of week *and* time of day. If a carrier drops a flight, it loses its original slot.

At Toronto airport the hourly number of flights are capped. Slots at Toronto are also allocated by a scheduling committee, which works much like Vancouver's.

The allocation of airport access slots does not seem to create any real or temporary 'property rights' in these slots. Although slot trades are allowed between carriers, sales are not. Carriers can be, and have been, forced to give up specific slots.

THE UNITED KINGDOM[17]

Traditionally, scheduling committees comprising resident airlines were responsible for allocating slots at congested United Kingdom (UK) airports, principally Heathrow and Gatwick. The process was implemented by a coordinator supported by specialist staff. The coordinators were traditionally employees of the main resident airline. This practice was similar to the rest of the world.

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17. This section is sourced mainly from CAA (UK) 1993, pp. 207–208.

In 1990, the UK government commissioned independent research into alternative slot allocation methods. The consultants were asked to develop two options: a 'full regulatory' option and an alternative 'market hybrid' option, and compare them with the existing system. Each option had a 'menu' from which a family of allocation methods could be chosen to meet specified policy objectives (CAA (UK) 1993). Both allocation methods required markets to be 'ring fenced' or segmented into distinct classes 'in order to maintain an acceptable balance of traffic'.[18]

The regulatory option was based on the existing IATA system but with confiscation rules to create a pool of slots to allow allocation to new entrants. The confiscation rules would have required the surrender of 5 to 10 per cent of slots at irregular intervals with slots then allocated to new entrants without specifying for which routes they were to be used (SD-Scicon 1991, p. 1).

The market hybrid option proposed sealed bid auctions for a proportion of slot 'leases' each year. Each slot lease would have been set at seven years, with slots re-auctioned when the lease expired. The system required 20 per cent of grandfathered slots to be auctioned each year for the first five years. Trading of slots would be allowed through the controlling agency, which would also charge slot lessors an annual rent 'about the same as the cost of servicing the capital value of the slots'. The proposal would have given existing and future slot holders limited protection, with airlines able to surrender less valuable slots first, but all slots would have to be given up for auction after five years. Airlines could also retain some slots designated as 'core' if they were prepared to match the highest bid. The consultant estimated that, if airlines were to fully pass on the cost of slots to passengers, then this would increase air fares by 5–10 per cent.[19] (SD-Scicon 1991; Avmark 1991).

According to Avmark (1991, p. 7), while the UK Department of Transport had asked the consultants to assume that the proceeds of slot trading would go the Exchequer, the consultants believed that users would find this unacceptable. Avmark notes that while 'tagging' (earmarking) the funds for improving ground and air infrastructure or services seemed sensible, that this would in effect mean that the revenue would go to the (privately owned) BAA Plc, the body responsible for improving London's airport system.

CAA (UK) (1993) states that, after consultation, the UK government decided that neither option would have been workable 'as they stood'. The market hybrid option represented a radical departure for the industry and there were

18. SD-Scicon defined 'fields' as groupings of slots that must be used in a certain way, for example, long or short haul, or certain types of service (bilateral, public service). Their existence is made necessary by international legal constraints on the use of airports. An example of their use is at the United States HDR airports which segment markets into domestic, international, commuter and essential air services.

19. Reflecting the high scarcity value placed on slots at Heathrow.

doubts about its practicability. Although closer to the existing system, the regulatory option was considered overly complex. The government was not convinced that the balance of advantage then lay with changing the existing system. The UK government therefore rejected *both* proposed options, thereby preserving the traditional system of scheduling committees.

However, the slot allocation process *was* changed in 1992. Slot allocation was made the responsibility of Airport Coordination Ltd (ACL), a company owned by a number of UK airlines. An executive committee comprising airlines of both the UK and other countries oversees the conduct of ACL. This committee also decides broad scheduling policy and acts as a mediator in the event of slot disputes.

The European Union slot code gives the airport operator[20] the legal responsibility for setting the hourly scheduling limits. These are set twice a year, for northern summer and northern winter schedules, on the advice of the National Air Traffic Services. Once these limits are established, the coordinator (ACL) asks airlines to submit schedule proposals. These are then satisfied 'as far as possible'.

The major principles used by ACL in determining slot allocation are the same as those traditionally used by scheduling committees. That is, conflicts are resolved on the basis of IATA guidelines, where the most significant principles are *grandfather rights* and *effective use*.[21] This process is also subject to European Union common rules which took effect in February 1993 (see the following section on European airports). (CAA (UK) 1993).

Under the UK slot allocation system, the UK Department of Transportation has no powers to interfere with slot allocation and, according to O'Toole, reportedly has 'little desire to become involved'. It is also not clear who legally owns slots, with airlines trading them on a 'grey' market. Further, the complexity of international scheduling was one reason that the European Commission postponed making radical changes (O'Toole 1993, p. 14).

EUROPE[22]

In February 1993 the European Council Regulation on *common rules for the allocation of slots at community airports* took effect. The main provisions were:

- confirmation of the principle of grandfather rights;

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20. BAA Plc operates Heathrow, Gatwick and Stansted in the London region.

21. IATA guidelines also include, but do not rank, *secondary criteria* such as size of aircraft, the need for a mix of services, competition, curfews at other airports, and economic benefits generally.

22. This section sourced mainly from CAA (UK) 1993, p. 208.

- creation of slot pools comprising newly created, unused and returned slots, of which 50 per cent would be made available to 'new entrants' — a new entrant was defined by the number, and proportion of slots held by the airline at the airport or airport system;
- slots would be lost if they were not used for at least 80 per cent of the time for which they were allocated;
- slots may be freely exchanged between airlines or transferred between routes and types of service; and
- slots for domestic services may be protected by government action in certain circumstances.

However, the regulation did not include a mechanism whereby incumbents would surrender slots to new entrants.

CAA (UK) (1993) indicates that the main effect of the regulation was to reinforce the existing system but at the same time make some provision for new entry. It notes that airlines were releasing unwanted slots sooner in order to avoid formal withdrawal under the 'use it or lose it' condition, and that some new entrants at Heathrow had been able to start services using slots from the newly created pool. However, these new services had tended to be on thinner routes where competition was absent. CAA (UK) (1993) goes on to suggest that the regulation does not provide a means for airlines with a small proportion of slots at congested airports to start new competitive services on major routes.

THE UNITED STATES OF AMERICA

Langner (1995) provides a detailed description of the development of slot allocation methods in the United States. In 1968, slot quotas were introduced at the High Density Rule (HDR) airports of Washington National, La Guardia, Kennedy, Chicago and Newark, and were allocated on a half yearly basis by scheduling committees until the early eighties.[23]

User classes for quota purposes are certified air carriers, scheduled air taxi/commuter services, and other. Trading of slots as well as other forms of explicit bargaining were prohibited.

The scheduling committees consisted of the airlines serving an airport or intending to do so. Unlike scheduling committees in other countries, these committees did not operate using IATA principles; rather, slot allocation was discussed within the scheduling committee and had to be agreed upon unanimously.

If there were disagreements and a deadlock could not be resolved, the Federal Aviation Authority (FAA) had to choose a method for slot allocation according

23. All other airports typically operated on the basis of first-come-first-served (Pickrell 1984, p. 174)

to *its* priority rules. Uncertainty as to the allocation method the FAA would choose played an important role as a threat for the committee to reach agreement. Possible methods for use by the FAA were: first-come-first-served (likely to result in higher system delay costs); arbitrary administrative allocation (introducing a political dimension); lotteries (with the possibility of incumbents losing substantial numbers of slots), auctions (with the potential for higher costs) and grandfathering of slot rights (Charles Plott, preface in Grether, Isaac and Plott 1989, p. xiv).

Following the Airline Deregulation Act in 1978, new airlines entered the industry, air fares decreased and demand for air travel increased. In August 1981, air traffic controllers went on strike, significantly reducing airport capacity. Slots were then allocated administratively by the FAA. In September 1981, all carriers serving the 22 controlled airports were required to reduce operations by a percentage equal to the reduction in air traffic control capacity at that airport. New carriers were prevented from starting operations without first being assigned slot privileges. Overall, aircraft operations were about 15 per cent[24] below the September 1980 level. However, by January 1982 total operations at these airports were restored to a level about 4 per cent below that of the previous year, with ten of the twenty-two airports recording an increase in flight frequencies (Pickrell 1984).

An interim system of 'slot exchanges' was implemented in March 1982 to deal with the allocation problem caused by the air traffic controllers strike, effectively replacing the scheduling committees at individual airports. Airlines were designated as having slots which could be exchanged. Allocation decisions were made simultaneously for all controlled airports at meetings in which trading took place (Plott in Grether et al. 1989).

In May 1982 the FAA approved the exchange, sale, and rental of take-off and landing slots (at the 22 controlled airports). However, sales and rentals were prohibited after about seven weeks 'amid widespread protests about their propriety', although exchanges continued to be permitted (Pickrell 1984).

By the winter of 1983, attention had returned to devising ways of solving scheduling committee deadlocks. Based on the idea that the key to agreement was the rules that would apply to allocate slots in the event of deadlock, the carriers created a 'fail safe' sub-committee charged with the task of devising these rules.

Plott (in Grether et al. 1989) states that airlines then became aware that the Reagan Administration supported a policy of grandfathering slots to existing carriers followed by the opening up of a secondary market in slots. In the event of a deadlock the airlines had feared the government would either confiscate slots or impose slot auctions to capture the economic rents embodied in slots

24. Flight reductions ranged up to 30 per cent at Pittsburgh and Chicago-O'Hare.

and enjoyed by carriers. Grether et al. believe that this revelation removed the need for airlines to compromise in scheduling negotiations. Subsequently, the fail safe committee did not agree on rules and the system of 'slot exchanges' ended in March 1984 with the recommencement of scheduling committees. However, the committees remained largely deadlocked (Plott in Grether et al. 1989).

In April 1986, slot trading was introduced at four of the HDR airports, Washington National, La Guardia, Kennedy and Chicago, as scheduling committees had been unable to reach unanimous allocation decisions in previous years (Doganis 1992). Slots could be bought, sold or leased for any consideration and any time period, and could be traded in any combination for slots at the same airport or other high density traffic airport. Ninety-five per cent of slots were allocated to existing users in four categories: essential air services, commuter, domestic, and international. The remaining five per cent were allocated through slot lotteries, with preference being given to new entrants. Slots were designated by the hour.

Each of the domestic and commuter slots allocated are assigned a random withdrawal number. If new slots are needed for international or essential air services, the commuter or domestic flight with the highest withdrawal number is repossessed by the airport authority.

Buying and selling, short-term leasing or swapping of domestic or commuter slots has been allowed, including swaps between HDR airports, but slots cannot be changed from one category to another. With some exceptions[25], the initial slot allocation rules specified that slots not used for at least 65 per cent of the time (since raised to 80 per cent) in a two month period are forfeited.

Slots regulations[26] specify that slots are *not* a property right but a privilege subject to FAA control. Slots may be withdrawn by the FAA at any time to fulfil 'operational needs' such as providing slots for international or essential air service operations or simply for reducing aircraft movements.[27]

Slots are traded through a clearing house and the FAA is notified of slot transfers, although financial terms are generally not made public. However, few slots have been surrendered and those that have are generally at off-peak times. Airlines are able to swap flights between their slots and some airlines allow others access to their slots so as to avoid 'use it or lose it' provisions (referred to

25. Federal Aviation Regulation, Section 93.227 — A variety of exemptions apply, although broadly it allows for: new entrants, strikes, some public holidays, slots allocated for international operations, and protection under bankruptcy law.

26. Federal Aviation Regulation, Section 93.223.

27. Federal Aviation Regulation, Section 93.217 — Allocation of slots for international operations and applicable limitations; Section 93.210 — Allocation of slots to essential air service operations and applicable limitations.

in the industry as 'babysitting'). Of the 145 slots forfeited up until January 1990, less than 10 remain in use by new entrants or small airlines, the rest having being sold on or acquired by incumbent airlines through mergers and takeovers (Avmark 1992).

Slots for international or essential air services may not be bought, sold, leased or otherwise transferred, and are withdrawn if unused for more than two weeks.

CHAPTER 4 SUMMARY

The preceding chapters have provided an overview of the different techniques available to governments and airport authorities to manage the congestion that arises when demand for access to airport runways exceeds their capacity.

The techniques fall broadly into two categories — administrative based methods, and price (market) based methods. Administrative methods include: restricting aircraft movements (often taking the form of quotas or bans on certain categories of flights); allocating airport access rights (slots) by scheduling committees; and allocating access rights by lottery. Price based methods include: pricing the congested 'peak' periods; and auctioning off airport access slots.

Each of these methods has its own advantages and disadvantages, but none appears to stand out as universally superior to the others in achieving outcomes that will optimally balance the raft of potential considerations of airport authorities (such as the achievement of allocative efficiency, promotion of market contestability, or ensuring equity of access). Furthermore, the potentially promising technique of slot auctioning does not appear to have been tried in practice, and hence is theoretical only.

An investigation of the techniques used by airport authorities around the world to manage congestion yielded some informative insights into the evolution of their ideas, but failed to find hard evidence of a preferred, or most appropriate, model. It is possible that a more detailed investigation might reveal political or airport operational issues underlying this finding.

It is beyond the brief of this paper to conclude with anything akin to a recommendation of how to proceed in managing access at Australian airports. However, it is likely that to achieve an optimal solution to current and emerging problems of airport congestion it might be necessary to make use of a number of demand management techniques in conjunction with each other. Furthermore, the set of techniques chosen for any one airport may not necessarily be the best for all other airports.

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PSA	Prices Surveillance Authority

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ABBREVIATIONS

ACL	Airport Coordination Ltd
FAA	Federal Aviation Authority
GA	general aviation
HDR	United States High Density Rule
IATA	International Air Transport Association
RPT	regular public transport
UK	United Kingdom
US	United States