AUCTIONING AIRPORT SLOTS

A REPORT FOR HM TREASURY AND THE DEPARTMENT OF THE ENVIRONMENT, TRANSPORT AND THE REGIONS

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Key findings

Market-based allocation systems for slots could result in substantial gains in social welfare.

There is considerable concern that existing allocation procedures for airport slots produce inefficient outcomes and competitive distortions. Transition to a market-based allocation system with appropriate safeguards against concentration of slots would improve efficiency, encourage competition and yield significant benefits for consumers. Adaptations of auction formats used for radio spectrum allocation provide a feasible means of allocating airport slots. This would need to be complemented by a formal secondary market.

These gains would arise even if only a small pool of slots were available for auctioning, but would be greatest if grandfather slots were reclaimed.

Current arrangements give priority to historic users of slots (grandfathering) and, as a result, the pool of slots available for allocation to new users is very small. Nevertheless, a move towards a market-based mechanism for allocating this pool would improve efficiency. These benefits would grow if a greater proportion of slots were regularly allocated through such a mechanism. The greatest social benefits from more efficient use of slots and enhanced competition in air services would be generated by reclaiming grandfathered slots and issuing time-limited usage rights through a market-based system. This might have potentially detrimental effects on investment incentives, which appear to be small, but would need to be assessed in detail.

Slot scarcity

Scarcity creates the potential for inefficient allocation of slots.

Slots are efficiently allocated when used by those carriers that can generate greatest overall social benefit from them. Whenever slots are scarce it is necessary to resolve the competing demands of airlines. Rationing of slots based on administrative procedures, in particular in combination with grandfathering, cannot be expected to produce an efficient slot allocation.

There is currently significant excess demand for slots at major UK airports …

The supply of airport slots is limited by available runway capacity, terminal and stand infrastructure. Of these three constraints, lack of runway capacity is by far the most frequent cause of carriers not being able to schedule air movements at their most preferred times. A number of UK airports currently experience excess demand for slots at peak times, while Heathrow and Gatwick experience excess demand throughout most of the day.

…which is expected to persist indefinitely.

Demand for slots will exceed supply in many instances for the foreseeable future. Demand for air travel is growing rapidly. Investment in new airport capacity is limited by environmental concerns and is subject to long lead times. Even if capacity could be extended to meet overall demand, setting capacity at the optimal level would entail excess demand at peak times. Optimal allocation would require that those carriers most able to switch to off-peak slots do so, leaving peak capacity to those for whom switching would be difficult and costly.

Deficiencies of current slot allocation arrangements

Existing slot allocation procedures perform poorly.

Current slot allocation procedures perform poorly. They do not allocate slots with the objective of generating greatest benefit for consumers and the economy at large.

Inefficiencies are caused by grandfathering…

Allocating slots on the basis of historic precedence is inconsistent with obtaining the greatest possible benefit from available airport capacity. It is possible that a potential user could generate much greater social benefit from a slot than its existing user, but the slot would nevertheless be allocated to the existing user.

…and by the use of administrative allocation procedures.

Those slots that are not grandfathered (i.e. new, returned or unused slots) are placed in a pool and allocated according to administrative criteria that do not reflect the social benefits that could be generated by the potential users. As it is extremely difficult for the co-ordination body (ACL) to judge who has the most valuable and beneficial use for a slot, inefficient allocation is very likely.

Current measures to promote competition are ineffective.

Up to 50% of the pool is reserved for new entrants as defined in the EU regulations. However, this only assists very small carriers offering low frequency services. Such services are unlikely to pose significant competitive challenges to high frequency services operated by established carriers.

Grandfathering and the reservation of slots for new entrants create barriers to expansion and restrict

Effective competition in air service markets depends on the ability of mid-size carriers (and alliances) to expand (both in terms of routes and frequency) to challenge large, established carriers, rather than entry by very small carriers. Where the *competition.*

number of operators on a route is limited by international agreements (e.g. the Bermuda II treaty), in the short run, competition can *only* occur by expansion of existing operators rather than entry of new ones. The small number of slots in the pool available to established operators constitutes a substantial barrier to their expansion and, therefore, a constraint on competition.

'Use it or lose it' inefficiently constrains the flexibility of smaller operators.

The current user of a slot enjoys a perpetual usage right, subject to a 'use it or lose it' obligation. Whilst this may be helpful in making anti-competitive hoarding of unused slots by large, established carriers more difficult and expensive (as they might have to run loss-making services in order to retain slots), it also inefficiently constrains the flexibility of smaller operators who do not exercise any market power. It is not possible for smaller operators without market power to hold unused slots where these may provide a (socially) valuable option to expand services quickly. Again, this acts as a barrier to expansion and constrains competition.

Grandfathering creates perverse incentives.

Under the current system carriers are reluctant to forgo slots they currently hold, as it is likely to be difficult to get them back again later. In extreme cases, carriers may 'baby-sit' slots by running small aircraft offering uneconomic services, which is wasteful of resources.

The allocation process is prone to legal challenge.

It is difficult to make the implementation of administrative allocation criteria objective and verifiable by third parties. As airlines do not pay the economic cost of using a slot, obtaining slots may result in substantial benefits, which in turn provide an incentive to challenge unfavourable slot allocations.

The apparent reliability of the current system stems from inertia.

Although the current allocation mechanism is 'reliable', in the sense that all available slots are rapidly allocated each season in combinations that are general usable by the carriers, this apparent strength is derived from the systematic inflexibility and inertia caused by grandfathering. If this inertia were removed by introducing time-limited usage rights, it is unlikely that the current system could easily cope with (re-)allocating such a large number of slots.

The advantages of auctions

An auction of airport slots could improve

Market-based mechanisms such as auctions have substantial advantages over administrative procedures. An auction *efficiency, promote competition and increase transparency.*

advantages over administrative procedures. An auction would allocate slots to those carriers willing to pay most for the use of scarce capacity. Provided that adequate measures are taken to limit market power and support those that discharge public service obligations, this will normally maximise the social benefit created from limited slot capacity.

Auctioning short-term usage rights would encourage competition.

A move to time-limited usage rights would greatly enhance the benefits from auctions. Usage rights need to be sufficiently short that a significant proportion of slots are regularly reallocated. Ensuring a sufficiently large pool of slots is essential for the promotion of competition, as it would greatly facilitate potential expansion by smaller and mid-sized carriers.

Raising revenue is a consequence of efficiency allocation, not an end in itself…

Any market-based system of allocating slots will raise revenue, as efficient allocation requires that each user of a slot should pay at least the value that the slot could generate in any alternative use. Therefore, raising revenue is a consequence of efficient allocation, rather than an objective in itself.

…and is only possible to the extent that scarcity of slots limits competition.

Any revenues raised from a slot auction reflect excess profits that operators would otherwise earn if allocated a slot for free. To the extent that competition in air services markets will be expected to be vigorous, there will be low willingness to pay for slots and low prices.

Auctions are transparent and robust to legal challenge.

Once auction rules are fixed, running an auction and awarding slots is an entirely objective process. Well-designed and well-organised auctions are transparent and generally immune to legal challenge.

Establishing market prices can aid capacity planning.

Auctions would establish market prices for capacity of different types at different airports. This could be used as a benchmark for assessing whether the costs (including environmental costs) of expansion can be justified.

Designing airport slot auctions

Despite the complexity of the allocation problem and the time constraints it is feasible to design an

Although slot allocation is complex, there are auction designs that could achieve a reasonably efficient allocation within an acceptable time. Auctions have been successfully used for radio spectrum allocation with large numbers of interrelated regional licences. Although modifications would be required *auction for airport slots.*

for slot allocation, this demonstrates the feasibility of using auctions even for complex allocation problems.

The auction design must minimise the risk for bidders of obtaining unusable combinations of lots.

Airlines participating in a slot auction are likely to aim for particular portfolios of slots (and, for each slot, will require a particular combination of runway, stand and terminal capacity). Bidders trying to obtain a particular combination of slots or capacity may face the risk of winning only a subset that may be of relatively little use and value. The auction design must minimise such risks; otherwise, inefficiencies may result.

The auction process must be compatible with international timetables for slot coordination.

UK airport slots need to be matched with corresponding slots at other airports. Hence, any UK auction would need to be compatible with the IATA procedures and timetable for international slot coordination. Realistically, this means an auction must be completed within a period of a few weeks. There are various design features that can be used to ensure a rapid auction, so that it should be possible even to auction the entire stock of slots at once if required. However, auctioning off a proportion of slots each season may be more practical.

There must be rules to limit concentration and gaining of market power.

It may be possible for a carrier to restrict competition and attain market power by purchasing a large number of slots, for example by establishing a strong position at a hub or frustrating expansion by existing competitors on a specific point-to-point route. Increased concentration of slots holding has been observed at US airports that have introduced market mechanisms. An auction system should not be introduced without safeguards against market power, particularly if time-limited usage rights replaced grandfathering.

Simple measures can safeguard routes subject to public service obligations.

Market mechanisms are based on carriers' willingness to pay for slots. Typically, they would not take account of any special social needs for services to UK regions. To protect such routes, the Government would need to reserve slots and/or use subsidies. Allowing local/regional bodies to buy slots themselves or bid with partner airlines is a simple and efficient means of meeting such social objectives whilst minimising economic distortions.

What lots should be auctioned?

The starting point for an auction is to define time windows for

The key requirement for an air movement is access to a runway at a particular time. In order to construct lots for an auction, a typical operating week would need to be divided *access to runways.*

auction, a typical operating week would need to be divided into time windows. As shorter time windows would imply more lots and a more complex auction, these might typically be between 15 and 30 minutes long. A lot would convey the right to schedule a movement within a particular time window for each week in a number of consecutive Summer or Winter operating seasons, where the precise timing of an air movement within the window would be a matter for air traffic control.

However, the design of lots needs to address a number of complications.

Starting from the definition of a time window of access to runway capacity, the definition of lots needs to take account of complications arising from (a) the number of air movements a runway can accommodate depending on the specific traffic mix, and (b) limitations in terminal and stand capacity.

The auction needs to be adapted to take account of runway capacity not being fixed…

The number of possible runway movements within a given time window depends (amongst other factors) on the type of aircraft and, for take-offs, the direction of the flight destination. Thus, the number of lots available for a given time window cannot be predetermined, but should be set in line with the aircraft size and flight direction that operators intend to deploy.

…and the possibility of terminal and stand scarcity.

Although lack of runway capacity is by far the most frequent constraint on scheduling air movements, lack of terminal capacity can be a constraint at peak times. Stands are rarely scarce at present, but this may change with the introduction of super-jumbo sized aircraft. Therefore, any auction system needs to be sufficiently flexible to handle all three possible constraints.

All capacity requirements for an air movement should be bundled in a flexible single lot…

The rights to use runway, stand and terminal capacity required for a particular air movement should be bundled together in a single lot. Establishing separate markets would lead to aggregation risks and unnecessary complexity. The amount of stand and terminal capacity used during a particular air movement depends on the type of aircraft and its typical passenger loading. Therefore, it is not possible to bundle together runway, stand and terminal capacity in fixed amounts.

…reducing risk and complexity for

We propose that a lot should correspond to a particular time window within the week. To deal with the complications *bidders.*

listed above, a 'bid' on a particular lot would, in addition to making a financial offer, nominate intended aircraft size and destination direction, terminal choice and maximum passenger load. These 'usage factors' would be chosen from a small number of categories. The auctioneer would then use an algorithm to determine which bids to select to make highest possible value use of available capacity. The number of bids selected would itself depend on how the mix of aircraft sizes and flight directions affected runway capacity. Although complex for the auctioneer, such a scheme would be relatively simple for bidders.

Usage rights need to be sufficiently short with slots coming up for re-auction on a rolling basis to guarantee sufficient liquidity

Single-season usage rights would provide maximum flexibility, and permit large-scale new entry and rapid expansion by carriers. However, the potential high turnover resulting from re-auctioning all slots each season could make international coordination difficult and cause investment planning uncertainty for airlines. The precise length of usage rights needs to be determined by balancing these two effects, but usage rights running for about 3 to 6 years, meaning that between one third and one sixth of slots would be re-auctioned each season, would appear to be a reasonable starting point.

Short usage rights reduce financing requirements for smaller carriers without significantly affecting investment incentives.

Relatively short tenures on slots have the additional advantage of lowering the likely price of slots and reducing financing requirements. This may provide encouragement to smaller carriers and entrants. Moreover, given that aircraft are often leased and, in any case, are fungible across routes, little investment is predicated on being able to secure particular slots. Therefore, there is little need to give lengthy tenures for slots in order to encourage investment in new or expanded services.

How should an auction be structured?

Our leading option is an adaptation of a simultaneous multiple round auction.

There are a variety of market designs that could be adapted for allocating airport slots. Our leading option is:

- as the primary means of allocating slots each season, a *simultaneous multiple round auction (SMRA)*, similar to that often used for spectrum auctions, adapted to allow bids on combinations of runway, terminal and stand capacity; with
- an effective on-going secondary market to

reduce aggregation risks, rectify any inefficiencies from the auction and permit trading for slots subdivided into part-seasons.

Slots at different times would be auctioned simultaneously...

In an SMRA, all lots are auctioned simultaneously. Bidding proceeds through multiple rounds, with prices rising and bidders building up combinations of lots or switching between lots on the basis of relative prices. An 'activity rule' ensures that bidders do not wait until the end of the auction to make their bids, thus holding up the auction or bringing it to a premature end.

...but runway, terminal and stand capacity would be combined flexibly into lots.

For the purposes of slot allocation, this format would need to be modified to deal with terminal and stand capacity constraints, and the problem of variable runway capacity. Therefore, bids would be for a *combination* of runway, terminal and stand capacity as described above. At the end of each round, the auctioneer would process these bids, identifying the set of bids that are consistent with available capacity and whose total value is highest, and declare these highest bids. There would be a number of 'highest bidders' declared for each type of lot, consistent with the maximum number of runway movements possible with the traffic mix of the highest bidders. Minimum bids would then be set for the following round. The auction would continue until there were no further bids.

There may be a case for allowing combinational bids within this format, but this is not essential.

In principle, the SMRA format may expose bidders to aggregation risks, winning some slots, but failing to acquire synergistic slots at other times. Concerns about such issues have led the US FCC to adopt a modified SMRA for spectrum auctions as of 2001, in which bidders may place bids on combinations of lots, which are either accepted or rejected in their entirety, removing aggregation risks. Our proposed format includes combinational bids in the sense of bundling runways, stands and terminals. The case for allowing bidding for combinations of slots at different times is weaker, as synergies between slots are likely to be much less than those between regional radio spectrum licences. An effective, liquid secondary market for slots would further reduce aggregation risks. Given that combinational bidding can be complex, there would be a strong case for first introducing an SMRA without combination bids and considering bidding for combinations of slots only if, based on the auction results produced by the simpler format, there were reasons to suspect that combinational bids could improve the efficiency of auction outcomes.

An alternative sealed bid format…

Given the tight schedule required to meet international scheduling requirements, there may a case for a one-shot sealed bid auction. Bids would be made in the format as above (a financial bid and a nomination of usage factors. The auctioneer would process these bids, identifying the set of bids that are consistent with meeting capacity constraints and whose total aggregate value is highest, and then declare the winners. As bidders would not have an option to reconsider their bids and respond to what they observe others doing, such a format is likely to expose bidders to significant aggregation risks.

…would require combinational bids…

Therefore, in order to produce reasonably efficient outcomes, bids for combinations of slots should be allowed. This would ensure that carriers did not end up with some slots, but an insufficient number to operate their planned services.

…with prices related to opportunity costs rather than the amount winners bid.

An auction format in which bidders were not required to pay the amount they bid, but a price based on the highest value alternative use of the capacity (analogous to a second-price auction), would improve efficiency. In such a format, bidders would do reasonably well by simply bidding their true value for a combination of slots, reducing the complexity of their decision-making. By contrast, if bidders were required to pay what they bid, considerable complexity would be created as it would be important for bidders to second-guess what others might do.

The adapted SMRA design is probably preferable…

The advantages of the adapted SMRA are greater efficiency, and greater certainty and transparency for bidders. However, because this format allows for a potentially unlimited number of rounds, it can be difficult to guarantee its completion by a fixed date, which would be necessary to integrate with IATA's international scheduling conference. By contrast, the sealed bid format has a guaranteed completion time. It may also be slightly better in constraining the behaviour of strong established carriers with current market power, as exclusionary bidding strategies are more difficult to implement in a sealed bid; it is not possible simply to overbid competitors round after round as in an SMRA. To some extent it is possible to get the best of both by running an adapted SMRA while time allows, but providing for the right to call a last and final round when this would be required to meet the overall time constraint. For this last round, minimum bids would be set at the level of the current highest bids from the curtailed SMRA.

…though empirical testing would be advisable to confirm this.

Given the complexity of these auction designs and the slot allocation problems, empirical testing of any auction format would be necessary to develop detailed rules and test these conclusions.

The role of secondary markets

Even with an auction as the primary means of allocation, there is benefit in establishing a secondary market.

A secondary market is necessary to allow efficient re-allocation of slots in the event that circumstances change mid-tenure or even mid-season. It complements a primary auction by reducing aggregation risks and providing a forum for sale of part-season slot usage rights. We recommend the development of a single exchange with specific rules for slot trading, rather than a series of bilateral deals, in order to maximise transparency and liquidity, and prevent any market power abuse.

A secondary market is beneficial even without an auction.

If it were not possible to implement an auction as the primary means of allocating slots, there would still be substantial benefits to establishing a formal secondary market with rules to constrain market power.

Constraints on market power

Hard quantitative limits on slot holdings are too blunt an instrument to control market power.

The difficulty of using simple quantitative limits on slot holdings to control market power is that the competitive impact of acquiring slots may depend on the identity of the purchaser, the routes for which the slots will be used, and the nature of competition on those routes. Setting a hard quantitative limit may, therefore, be too blunt an instrument and deny potentially beneficial slot acquisitions where simple undertakings to ensure that they were not used anti-competitively would be sufficient to protect consumers.

Concentration of slots beyond a certain point should trigger a presumption of market power and require competition clearance.

Market power issues may be addressed using a similar approach to existing merger control legislation, i.e. by defining a certain proportion of total slots available above which an airline must submit any proposed acquisitions for assessment by an independent authority. Undertakings that alleviate competition concerns could be obtained in exchange for the clearance of further slot acquisitions, thus targeting competition problems where they arise rather than resulting in a blanket prohibition. These provisions should apply to both auction outcomes and secondary market transactions.

'Use it or lose it' should only apply to carriers with sufficiently large shares of slots.

With market-based pricing, there is no reason why a carrier without market power should be prevented from holding unused slots. Holding seldom-used or unused slots to provide operating flexibility is efficient where the value of such flexibility exceeds the market price of the slots. Allowing greater flexibility would reduce barriers to expansion and promote competition. Where slots were unused and provided no flexibility benefits, there would be a strong incentive to sell them on the secondary market. Even where carriers would not want to sell a slot outright in order to retain flexibility, they would have a strong incentive to lease slots to other carriers, retaining the right to recall them on short notice. Therefore, a more discriminating application of the 'use it or lose it' rule in a market-based regime would lead to at most limited (if any) holding of unused slots. Only where carriers have possible anti-competitive reasons for hoarding unused slots should the 'use it or lose it' rule be triggered. This could be conditional on the proportion of slots that a carrier held.

Differential regulation across the EU

There is benefit in moving to a market-based system even without a parallel move in other EU states

There would be benefits for the UK economy in moving to a market-based system of slot allocation even if other EU Member States did not immediately match this move. However, without EU coordination it may not be possible to set fully optimal rules to limit the build up of market power.

1. INTRODUCTION

Airport slots are essential for the provision of airline services to and from congested airports. A slot is defined in UK and EU law as "*… the scheduled time of arrival or departure available or allocated to an aircraft movement on a specific date at an airport coordinated under the terms of the Regulation…*".[1] The number of potential slots at an airport is limited by the availability of runway, terminal and stand capacity.

The two largest UK airports – Heathrow and Gatwick – currently experience significant excess demand for slots from airlines throughout much of the day. A number of other UK airports have excess demand at peak times. The scale of excess demand is expected to grow for the foreseeable future, as demand for air travel is rising and the supply of new slots at UK airports is constrained by long lead times on new infrastructure and environmental concerns.

In this context, the UK Government has indicated concern that current procedures, based on rights of historic precedence ('grandfathering') with the remaining pool of slots allocated by administrative procedure, do not allocate slots efficiently. In its recent White Paper on the Future of Aviation[2], the Government noted that "*… it may be time to consider the benefits that the right of historic precedence offers.*"

The Government has also proposed the introduction of a market in slots:

> "*In order to make the most efficient use of capacity, a market in slots might be created. One element of this could be the auctioning of pool slots. In the absence of time limits on grandfather rights, this would essentially mean newly created slots. But if there was a* ***recycling process****, the pool would be larger and would hold more peak-period slots.*"

[1] Article 2(a) of European Regulation 95/93. This meaning was adopted into UK law by the provisions of the UK Statutory Instrument 1993 No. 1067 (The Airport Slot Allocation Regulation 1993).

[2] 'The Future of Aviation', The Government's Consultation Document on Air Transport Policy, Department of the Environment, Transport and the Regions, 12 December 2000.

Current airport slot allocation procedures are governed by EU Regulation 95/93, which is due for revision. The Commission has formally requested the views of Member States on how this regulation should be revised.

Therefore, HM Treasury, together with the Department of the Environment, Transport and the Regions (DETR), have asked DotEcon to review the allocation methods of airport slots and consider the potential for a radical revision of this regime, including the possibility of reclamation and auctioning of airport slots. The primary objective in any reform of current arrangements would be to ensure that slots are allocated to services that provide the greatest benefits for UK consumers and the UK economy.

The main body of this report is divided into seven sections. In Section 2, we discuss the slot allocation problem, and identify the issues that need to be addressed by an appropriate allocation mechanism. Section 3 provides a brief overview of current allocation procedures and the general conditions under which slot allocation takes place. In Section 4, we analyse the strengths and weaknesses of the current system and identify the potential advantages of adopting an auction mechanism for the primary allocation of slots. In Section 5, we highlight design issues specific to the auctioning of airport slots. In Section 6, we describe a number of candidate designs for slot auctions offering significant advantages over current procedures, whether they are used to allocate all slots or only those from the existing pool. Finally, in Section 7, we discuss the public policy implications of our analysis. An informal introduction to the economic literature on auctions is provided in the annex.

2. THE SLOT ALLOCATION PROBLEM

2.1. OBJECTIVES FOR ALLOCATING SLOTS

No airline can operate at any particular airport without the right to land and take-off. Thus, the allocation of airport slots at congested airports affects the nature of airline services provided to the public in terms of the number of routes served and the frequency of services offered by individual carriers. The distribution of slots amongst carriers affects competition and thereby the pricing of services.

The success of any system for allocating slots should be judged by the benefits that the resulting supply of airline services generate for customers and the economy. An efficient and socially optimal allocation mechanism is one that leads to a supply of airline services that maximises the benefits generated for customers and the economy whilst allowing airlines to make a competitive return on their investments, and providing them with appropriate incentives to compete and to innovate.

Broadly speaking, in order for the supply of airline services to maximise social welfare[3], the allocation of slots must meet the following requirements:

- Available slots are used for services that generate the largest benefits for customers and the economy. This implies that it is impossible to increase social welfare (without creating additional slot capacity) by simply re-allocating available capacity.

- The incremental benefit that could be generated by extending airport capacity and making more slots available is equal to the additional cost of that capacity. This implies that it is impossible to increase social welfare by varying the amount of airport capacity available.

- Where new services could be developed (by the same or another carrier) that generate more benefits than existing ones, it should be possible to re-allocate existing slots or expand slot capacity in order

[3] Unsurprisingly, there is considerable debate about how social welfare should be measured. However, for the purpose of this paper we adopt the standard measure of social welfare used in economics, which is based on the unweighted sum of consumer and producer surplus.

to accommodate such services sufficiently quickly. Otherwise, innovation might be discouraged.

These three conditions define 'economic efficiency', and we will use this term to describe the overall objective of slot allocation procedures in the remainder of this document. As these requirements demonstrate, the key factor in determining efficient slot allocation is the additional *social* benefit that could be generated if (a) a slot were to be re-allocated or (b) an additional slot were to be generated.

To the extent that (at least at the margin) the social benefits of a slot being used in a particular way are equal to the private benefits that accrue to the user (essentially the additional profits that can be made by an airline), this overall objective could be met by a market-based mechanism in which the allocation of slots is determined by the relative willingness of airlines to pay for individual slots. Willingness to pay reflects the private benefits to an airline from being able to use a particular slot and, in a competitive environment, these private benefits should be broadly aligned to the social benefits that would be generated from the particular use of that slot. Therefore, market mechanisms should lead to slots being used for those services where their value is highest, thus satisfying the first of the above requirements. Furthermore, the market price of slots would provide a signal of the value of extending slot capacity. Wherever it is possible to extend capacity at a cost that is lower than the market price, there is an incentive to invest in such capacity extension, and so the second of the above conditions should hold. Finally, if an airline were to develop a new service that makes more valuable use of slots than do their existing users, it should find no difficulty in obtaining the necessary slot capacity for deploying such services, and thus the third condition holds.

However, in practice there are a number of reasons why the additional social benefits of using a particular slot in a particular way might not correspond to the additional private benefits. In particular:

- Private benefits might include excessive profits resulting from restrictions or distortions of competition, which would tend to reduce rather than enhance social welfare. For example, the private benefits to a particular airline from increasing its share of slots held at a particular airport may include the potential for price increases as a result of weaker competition, which would be a social cost rather than a social benefit.

- Private benefits may not fully capture the social benefits of serving particular routes to the extent that these are not reflected in the potential customers' ability or willingness to pay. For example, it may be socially beneficial to serve particular routes to remote parts of the country even if the revenue generated from these routes is considerably lower than the revenue that could be generated if a slot were to be deployed for a more profitable route. The ultimate source of such divergences is that the social value of serving that area is not fully reflected in the willingness or ability of passengers to pay for services on this route – in economic terms, there are external benefits that may need to be taken into account.

Thus, a slot allocation mechanism has to address:

- market power (both existing market power and the potential of creating market power through the acquisition of slots), ensuring that the acquisition of slots cannot be used to create or extend market power; and
- any external benefits of serving particular routes, ensuring that there are sufficient safeguards to ensure that slots will be used for routes that should be served for social reasons even if they are not as commercially attractive as other routes.

Finally, it is worth pointing out that the allocation mechanism should provide a sufficiently stable environment to enable airlines to plan ahead and invest in the development of services. Too much volatility and uncertainty about an airline's ability to sustain a portfolio of slots over the time required to recoup an investment in the development of a particular service schedule might undermine the incentive to develop such a schedule in the first place.

2.2. DEMAND FOR SLOTS

Demand for air travel is rising rapidly and driving growth in demand for slots by airlines. In the last 20 years, worldwide airline passenger numbers have more than doubled (see Figure 1).[4] Cargo volumes have also increased substantially. However, at many airports, the expansion of runway, stand and/or terminal capacity has not kept pace with the growth in demand for slots, leading to capacity shortages. A recent report by PriceWaterhouseCoopers found 30 out of 35 Category 1 European Union airports to have some form of capacity constraint.[5]

Depending on the severity of the mismatch between demand and supply, airports are affected in different ways:

- Some airports experience excess demand for slots for significant periods of time during the day. These are typically large hub

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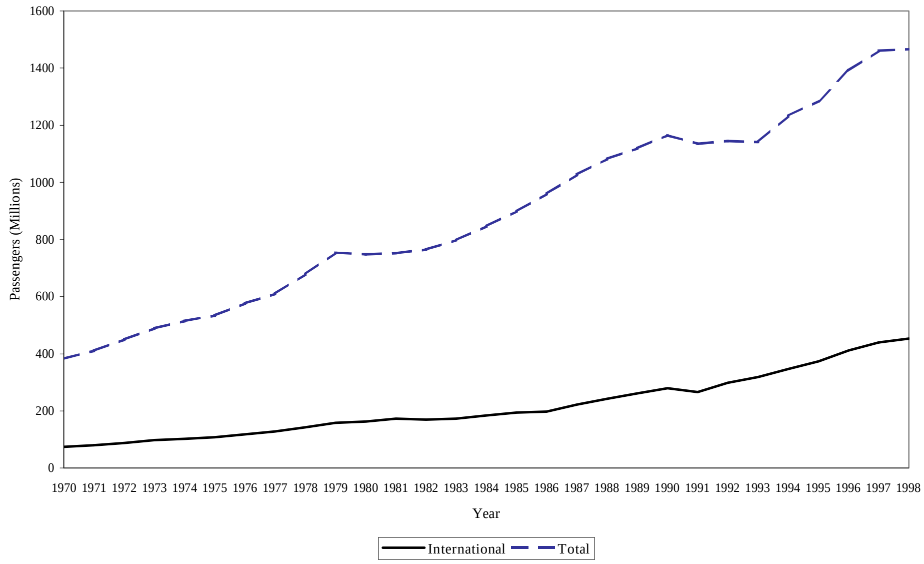
[4] *ICAO Statistical Yearbook*, 1999

[5] PriceWaterhouseCoopers: *Study of certain aspects of Council Regulation 95/93 on common rules for the allocation of slots at Community airports*, prepared for the European Commission, May 2000.

airports, such as Heathrow and Gatwick. It is apparent that there are many airlines that would like to provide services from these airports, but cannot do so because of lack of available slots.

- Many airports experience capacity shortages at peak hours and in peak months, despite having significant excess supply for most of the time. At these airports, it may be possible for the coordinator to accommodate all requests for slots, but not necessarily at the times requested.

Figure 1: Growth in worldwide passenger numbers, 1970-98



Source: *ICAO Statistical Yearbook*, 1999

Wherever there is slot scarcity it is necessary to resolve the competing demands of airlines and, therefore, there is the potential for inefficient allocation. The traditionally advocated response to this problem, as espoused by IATA, is to expand supply through infrastructure development. However, this solution may only be appropriate where current or projected capacity constraints are substantial. Otherwise, the marginal costs of expansion, which may be very lumpy (e.g. the addition of a new runway), are likely to exceed the marginal benefits. This may be particularly true when taking account of the growing opposition to airport expansion on environmental grounds, which indicates that capacity expansion may have considerable social costs. Thus, some level of scarcity may often be socially optimal. Extending capacity to a level at which inefficient demands made at sub-optimal prices can be met is not an economically efficient response to the problem of scarcity.

Even where there is scope to meet demand through new infrastructure, conditions of significant excess demand may still persist for many years while development takes place. In practical terms, this means that simply extending supply and eliminating scarcity cannot address the problem of inefficient allocation of slots. Slot scarcity will (and perhaps should) persist at many airports for the foreseeable future.

Moreover, even where moves are made to increase available capacity at airports, there is still an important role for the use of market-based allocation mechanisms in ensuring efficient utilisation of the assets. Typically, there will be strong peaks in demand at certain times that will justify differential pricing between peak and off-peak times.

2.3. CONSTRAINTS ON SUPPLY: THE PROBLEM OF EXCESS DEMAND

Three resources affect the overall supply of slots: runway, stand and terminal capacity. All of these resources are required, albeit to different degrees, by airlines wishing to take off from or land at a particular airport. The extent to which a particular air movement requires stand and terminal capacity depends on the type of aircraft used and the anticipated load factor, which in turn depends on the route and the type of flight, e.g. scheduled or charter.

Runway capacity. This is primarily determined by the number of runways. However, it also depends on the traffic mix, the hours of operation and the mode (take-off/landing only or mixed mode) in which the runways are used.

Traffic mix is important owing to wake vortices.[6] A large aircraft may closely follow a large or small aircraft, but for safety reasons, a small aircraft requires a greater separation distance. Owing to these distance limitations, the sequence in which various sizes of aircraft follow one another, and the degree of variation in aircraft sizes, causes variations in the total number of movements that are possible within a fixed time period on any one runway.

Environmental restrictions on flight movements, for example on night flights, limit the hours of the day during which airports may be operational. The DETR imposes limits on the number of movements and aggregate noise levels permissible.

[6] A vortex is the turbulence remaining in the air behind the aircraft. The larger and heavier is the aircraft, the larger is its wake vortex.

For example, at Heathrow, Gatwick and Stansted, restrictions exist on flights between 11:30pm and 6am.[7]

Environmental considerations also govern runway usage modes where this can be chosen. At Heathrow, the two runways are used in single-mode (aircraft take-off from one runway and land on the other, with a switch in runway use at 3pm), as this reduces the noise impact of low-flying aircraft on residents under the flight paths.[8]

Although the primary driver of increased supply of runway capacity is investment in new runways, new slots can also be generated through more efficient runway utilisation. Since 1991, the airport authorities at Heathrow and Gatwick have managed to achieve successive incremental increases in the number of slots available per hour (see Table 1). At Heathrow, further expansion could be achieved by switching the two runways to mixed-mode usage. A study by BAA, the International Air Transport Association (IATA) and National Air Traffic Services (NATS) in 1994 concluded that the implementation of mixed-mode, with both runways used for landing and take-off at the same time, could increase the number of hourly movements from 82 to 92.[9] This would add approximately 180 slots per day.

Table 1: Maximum hourly runway capacity in the summer seasons

	1991	1993	1995	1997	1999
Heathrow	74	79	81	82	84
Gatwick	41	45	47	48	48

Source: CAA, taken from Competition Commission: *British Airways Plc and CityFlyer Express Limited*, July 1999.

[7] DETR, Night Restrictions at Heathrow, Gatwick and Stansted (revised restrictions with effect from 31st October 1999). Press Notice 539, 10 June 1999. ACL is responsible for the administration of these quotas (see paragraph 2.26, Competition Commission, *British Airways Plc and CityFlyer Express Limited*, A report on the proposed merger, July 1999).

[8] Clearly, at airports with a single runway this is not an issue, as aircraft take-off and land in sequence on the same runway (mixed mode).

[9] Select Committee on Environment, Transport and Regional Affairs Eight Report. Regional Air Services. 28 July 1998.

However, apart from the switch to mixed mode (which is only an issue at Heathrow) the scope for further expansion of runway capacity at Heathrow and Gatwick airports must be considered uncertain. In any case, incremental gains have not been sufficient to accommodate demand for runway space, which exceeds supply at both airports for much of the day.

Stand capacity. This depends on available ground space and the organisation of the terminals. Amongst the London airports, stand capacity is currently a serious constraint only at City Airport, which has limited ground space.

Terminal capacity. This includes all aspects of airport infrastructure relating to loading aircraft and accommodating passengers and cargo, for example, jetties, conveyor belts, waiting rooms and lavatories. Terminal capacity is based on hourly flows of passengers, which BAA measures as the flow each facility may handle whilst meeting BAA's service standards. Constraints on the expansion of passenger terminal and cargo handling facilities are generally less severe than constraints on the number of runway movements. This is because investments in new runways are extremely 'lumpy', whereas it is often possible to expand terminal capacity by enlarging existing infrastructure.

Over the last decade, infrastructure investment has significantly increased the passenger capacities at Heathrow Terminals 1 and 3, and Gatwick North and South Terminals (see Table 2). Nevertheless, terminal capacity is still scarce at Heathrow's Terminals 3 and 4 during the peak early morning arrival period.

Table 2: Terminal capacity throughput (mppa) at Heathrow and Gatwick

Terminal		1994	2000	Increase
Heathrow	**Terminal 1**			
	- Domestic	8.9	11	24%
	- International	12.5	14	12%
	Terminal 2	8.2	8	-2%
	Terminal 3	10.8	13	20%
	Terminal 4	11.0	11	0%
	Total	**51.4**	**57**	11%
Gatwick	**South Terminal**	12.8	17	33%
	North Terminal	8.3	13	57%
	Total	**21.1**	**30**	42%

Source: BAA, taken from Monopolies and Mergers Commission, *BAA plc*, 1996.

In principle the availability of each of these three resources could constrain the total number of slots. In practice however, it is currently mainly runway capacity that is the major constraint. Table 3 illustrates the capacity constraints on airline slot allocation for the Summer 2000 season at Heathrow and Gatwick. In both cases, total demand for slots exceeded supply by over 15%. At both airports, a large number of requests for slots had to be adjusted or refused in order to address runway limit issues, with a smaller number changed in order to address terminal capacity limits. By comparison, currently there appear to be no major problems regarding a shortage of stands at Heathrow or Gatwick, although this may not continue indefinitely, especially as proposed super-jumbo size aircraft would require dedicated stands. Moreover, stand constraints do apply at City airport, where there is excess runway capacity. In any case, any system for slot allocation should be able to address all three types of constraints in order to be flexible enough to cope with all possible changes in future supply and demand conditions.

Table 3: Demand for slots in Summer 2000

	Heathrow	**Gatwick**
Total demand for slots	335,578	207,910
Total slots allocated	283,681	173,908
Allocated slots where changes had to be made relative to the initial demand because of:		
- runway limits	30,203	26,793
- terminal limits	1,138	51
- stand limits	0	na

Source: ACL.

2.4. THE PEAK/OFF-PEAK PROBLEM

Within the overall demand for slots, there are substantial variations in demand over the day, such that an airport may operate at capacity during 'peak hours' but with many slots unused at 'off-peak' periods. The willingness of airlines to switch between slots at different times depends on a number of factors, including:

- the time sensitivity of their target customers (business travellers are typically very time sensitive and can be charged premium prices, whereas leisure travellers are typically more price sensitive);
- their ability to coordinate landing and departure times with the other airports on the routes they serve, which may also be constrained;
- the need to make efficient use of their assets by optimising aircraft usage;
- the need to coordinate a particular flight with others run on the same route, thus create a frequent service that is attractive to customers; and
- any variation in airport charges for flights at peak and off-peak times.

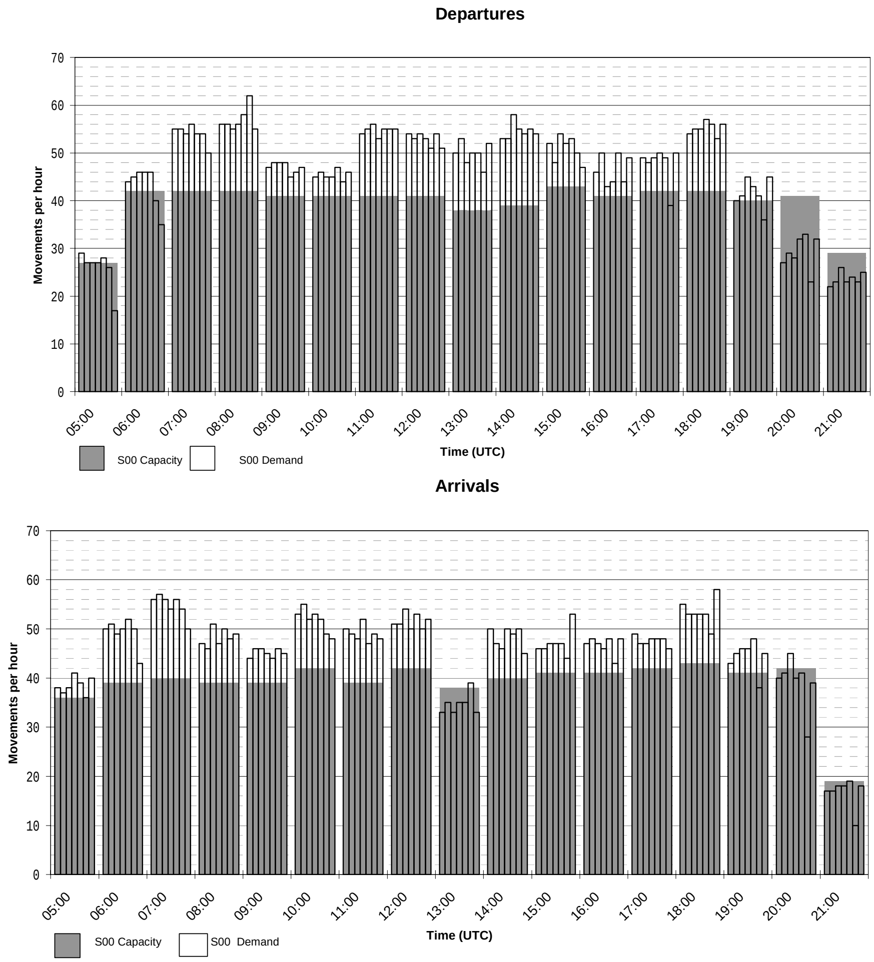
Figure 2 illustrates the spread of capacity and airline requests over the day, divided into hourly periods, for the Summer 2000 season at Heathrow.[10] Unsurprisingly, excess demand is highest at the peak commuter times in the morning and early evening, such as 8-9am and 6-7pm.[11] Demand outstrips supply for most hourly periods, except very early and very late in the day, i.e. at those times that are least attractive to passengers.

Thus, even though there is overall excess demand for slots at Heathrow, capacity is not fully utilised in some periods, showing that there is a limited substitutability of peak and off-peak slots.

[10] The variations in the available hourly capacity shown in Figure 2 can be attributed to the mix of aircraft historically allocated slots during that hour. As described above, vortex considerations require varying distances between aircraft of differing sizes; hence hourly runway capacities are not constant. In addition, the number of movements is restricted during early and late hours owing to noise considerations. There is also a small reduction in movements in the middle of the day in order to create a breathing space to clear backlogs from the morning's operations.

[11] It is likely that these figures significantly under-estimate the true level of demand for slots, especially at peak times. Under current procedures, knowing that their request will be rejected, it may not even be worth an airline's time and effort of applying for slots at certain times.(interview with Peter Morisroe, ACL)

Figure 2: Demand for slots at Heathrow – Summer 2000



Source: ACL.
Note: demand is shown daily, with each of the seven hourly bars representing Monday through Sunday.

2.5. SUBSTITUTION BETWEEN AIRPORTS

In the same way that one particular time slot may at most be a limited substitute for a slot at another time, it appears that for most carriers a slot at one airport is unlikely to be an effective substitute for a slot at another airport, even when these airports serve overlapping catchment areas. Therefore, excess demand may persist at one airport even if additional capacity is available at another, neighbouring airport.

The extent to which the services provided from separate airports within the London airport system[12] - defined as including Heathrow, Gatwick and Stansted - and indeed Luton and City airports too, are substitutable from the perspective of travellers clearly varies according to the type of passenger and particular air services market in question. Therefore, in turn the degree to which carriers will find airports within the London system substitutable will vary according to the type of service they offer. Reaching an overall conclusion about substitutability is a difficult empirical question; a variety of opinions have been expressed. In 1996, the UK Monopolies and Mergers Commission in its analysis of the regulation of BAA[13] found that competition between airports for originating traffic exists only between nearby airports, such as Luton and Stansted. However, a number of other reports provide evidence of a common market for leisure travel between the London airports:

- The 1999 Competition Commission Report into British Airways and CityFlyer's proposed merger[14] stated that, for leisure travel, services from different airports could no longer be considered as different markets.

- A 1993 CAA Report noted that low fares at other airports were not matched by airlines at Heathrow, whereas fare reductions made by airlines at Heathrow affected those offered elsewhere.

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[12] European regulations define an 'airport system' as "two or more airports grouped together serving the same city or conurbation" (Council Regulation (EEC) No 2408/92 on access for Community air carriers to intra-Community air routes, Article 2, Section m, 23 July 1992) and lay down a general principle of freedom of access for EU carriers at EU airports. A decision regarding the Paris airport system underlines the EU Commission's belief that this principle includes the right to choose between airports within an airport system, which would suggest that individual airports within a system are not perfectly substitutable (Decision 95/259/EC: Commission Decision on a procedure relating to the application of Council Regulation (EEC) No 2408/92 (...French traffic distribution rules for the airport system of Paris), 14 March 1995).

[13] Monopolies and Mergers Commission, *BAA plc.*, A report on the economic regulation of the London airports companies (Heathrow Airport Ltd, Gatwick Airport Ltd and Stansted Airport Ltd), 1996.

[14] Competition Commission, *British Airways Plc and CityFlyer Express Limited*, A report on the proposed merger, July 1999.

This implied that airlines operating out of Heathrow face at most limited competition from services at other London airports.

- The CAA position was modified in its evidence presented to the inquiry into the acquisition by British Airways of CityFlyer, which found that low-fare carriers operating out of Heathrow had reduced prices in response to the growth of 'no-frills' services operating out of Stansted and Luton.[15]

There is also evidence of emerging competition between the London airports for business travellers. Although Heathrow continues to take the large majority of business passengers (Table 4 highlights its dominance over Gatwick in this market), low-cost airlines operating out of the smaller London airports are capturing a modest share of the business market. A 1997 international passenger survey carried out by the Office of National Statistics[16] noted that 17% of passengers on easyJet's no-frills service from Luton to Nice and 28% from Luton to Amsterdam were on business travel.

Table 4: Heathrow and Gatwick scheduled passengers, 1997

		Passenger numbers (000's)	**% of business/leisure/ total passengers through Heathrow and Gatwick**
Heathrow	Business	22,245	83%
	Leisure	35,283	75%
	Total	57,528	78%
Gatwick	Business	4,637	17%
	Leisure	11,607	25%
	Total	16,244	22%

Source: CAA Survey figures, taken from Competition Commission, *British Airways Plc and CityFlyer Express Limited*, Table 5.16.

[15] Ibid., paragraph 2.161.

[16] Ibid., paragraph 2.64.

In its report on British Airways and CityFlyer Express, the Competition Commission referred to the possibility of operators switching services between different London airports.[17] It noted that British Airways and Virgin have operations at both airports, and could in theory switch services between them. British Airways has recently announced plans for just such a reorganisation of its slots. It is relocating certain long-haul services from Gatwick to Heathrow, with the aim of concentrating its hub services at Heathrow, in order to capture a greater share of passenger transfers.[18] However, this decision only highlights the importance of Heathrow as a hub for long-haul flights. It is likely that there are many long-haul flights that could only operate profitably out of Heathrow amongst the London airports. Although there may be substitutability across London airports for particular customer segments and particular types of services, this is at present insufficient for capacity added at one London airport to have an appreciable impact on excess demand at another.

2.6. THE PROBLEM OF MARKET POWER

As the allocation of slots determines the ability of airlines to offer services between particular airports, it is the main determinant of the nature of competition in the provision of air services. Access to and control over slots can therefore be used to build or protect a position of market power, and slot allocation needs to take account of the impact it has on the competitiveness of the air transport sector.

Concerns about competition may arise in two dimensions:

- lack of competition on a particular *point-to-point route*; and
- establishment of a strong position with regard to many routes at one particular *airport* (so-called hub dominance[19]).

Competition for a scheduled service on a particular route may be ineffective unless a sufficient number of carriers offer similar flight frequencies on that route. In particular, it is generally difficult for a low-frequency operator on a particular route to compete effectively with a high-frequency operator as:

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[17] Ibid.

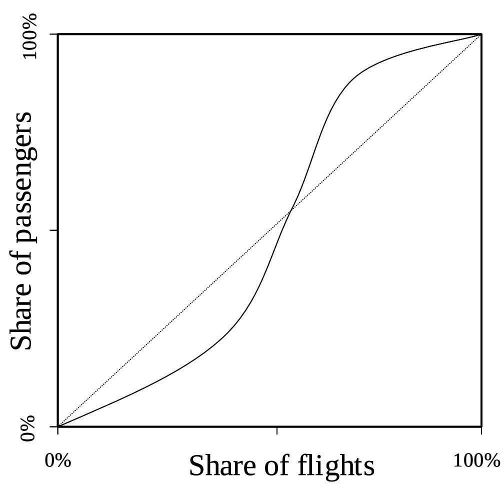
[18] British Airways press release, 6 December 2000, http://press.britishairways.com.

[19] A Kahn, "The Competitive Consequences of Hub Dominance: A Case Study", *Review of Industrial Organization*, Vol. 8, 1993.

- high frequency operators are more likely to operate a service closer to a passenger's preferred time of travel[20]; and
- high frequency operators are more attractive to passengers who want flexibility in their time of travel.

These effects give rise to a so-called 'S-curve' effect[21], shown in Figure 3, where (other factors equal) relatively small operators tend to receive a smaller share of passengers than their share of flights and relatively large operators tend to receive a larger share of passengers than their share of flights. In effect, high and low frequency services can become sufficiently different services that the group of *common* potential customers they compete for is small. In this case, the pricing of the low frequency service may not significantly constrain the pricing of the high frequency service.

Figure 3: Typical frequency - market share relationship on a route



Therefore, for an operator to exercise market power on a particular route, it is necessary that other operators cannot enter that route with a sufficiently high

[20] Simple scheduling models demonstrate a disproportionate effect on market shares. For example, suppose that operator *A* has 2 flights per day and operator *B* has 6 flights per day, each spread evenly though the day. Suppose that passengers run up randomly through the day and take the first flight available; they have no other preference for which operator they use. Operator *A* will receive less than 25% of passengers and operator *B* will receive more than 75%.

[21] See A Kahn, *Change, Challenge, and Competition: A Review of the Airline Commission Report*, CATO Regulation (http://www.cato.org/pubs/regulation/reg16n3d.html).

frequency service in order to be an effective competitive constraint. At present, the grandfathering arrangements mean that it is difficult to gain sufficient slots to be able to start new services quickly at reasonable frequency, unless existing operators reuse slots currently used on other routes. This is clearly only an option for operators who control a sufficient number of slots at a particular airport. Thus an operator can affect competitive conditions by buying a large share of available slots. Even if such a strategy does not blockade individual routes against entry by point-to-point competitors, it necessarily affects the scale and density of competitors' networks.

Airlines that operate on a large proportion of the routes to and from a particular airport enjoy a number of benefits that allow them to differentiate their services from those of other operators with a smaller presence at that hub. From the perspective of consumers, these benefits are that:

- travellers not served by a direct flight can be offered connecting flights provided by the same operator (interlining benefits); and
- loyalty schemes may lead to benefits for frequent travellers from using a single airline (or alliance with a common loyalty scheme) serving a large variety of destinations over using a variety of different operators each serving fewer destinations.

In addition, carriers can gain efficiencies by maintaining all their aircraft, organising all their passengers and performing all their subsidiary activities at a single airport. Airlines with a large portfolio of slots at a particular airport have greater operational flexibility, as these slots can be juggled across many routes.

Although the factors listed above are all potentially efficiency gains of hub-based networks, they also allow carriers with a strong presence at a particular hub to differentiate themselves from smaller operators at that same hub. Therefore, *intra-hub* competition is diminished in order to reap these efficiency gains. Whether these efficiency gains will be passed to consumers or else 'hub dominance' established is a question about the extent to which different hubs compete with each other, that is *inter-hub* competition.[22] If long-haul passengers served by the

[22] For example, British Airways has, "*argued that the hub competition which it faced from the networks of European airlines such as KLM and Lufthansa was a sufficient constraint on its behaviour, as was the competition from hubs at more distant airports, such as hubs operated by Continental Airlines and Delta in the USA*" (Competition Commission, *Air Canada and Canadian Airlines Corporation*, A report on the merger situations, August 2000).

Heathrow hub are not competed for by carriers using the Frankfurt, Paris or Amsterdam hubs, then it is possible for market power to be established at Heathrow by acquiring a sufficient number of slots to prevent other operators from building up their overall Heathrow presence. Clearly, the extent of inter-hub competition requires that long haul passengers are sufficiently indifferent between the hubs at which they interconnect.

However, it is in general the interaction of hub and route dominance that is of concern. Operators with a large presence at a particular hub can gain from this even if they face inter-hub competition because they are much better able to vary frequencies on particular routes than are carriers with a smaller share of slots. This creates an asymmetry between carriers, which may in itself be sufficient to distort competition.

3. THE CURRENT REGIME

3.1. SLOT ALLOCATION PROCEDURES

Slot allocation in the United Kingdom is primarily determined through a system of 'grandfather rights', under which incumbent airlines can normally expect their landing and departure slots to be renewed annually subject to certain conditions. Allocation exercises are conducted twice a year – for the summer and winter seasons – during which grandfather rights are confirmed and remaining slots distributed amongst new airlines and incumbents. The turnover of slots is typically very small; for example, in Summer 2000, 97% of slots at Heathrow and 89% of the slots at Gatwick were grandfathered.[23] The remaining slots are either new slots (created by extending capacity), slots given up by incumbents (returned voluntarily or defaulted under 'use it or lose it' rules) or previously unused slots (e.g. because they were not considered commercially viable).

Airport Coordination Limited (ACL) manages the slot allocation process at twelve leading UK airports[24], including all five London airports. It is a limited company, jointly owned by eleven airlines, but operating independently of its owners on a basis of strict neutrality between airlines. It has no role in policy-making, but provides data collection, schedule coordination and slot allocating services under contract from the airport operators. ACL is 75% funded through its contracts with airport operators, with remaining funds provided by its owners or from small-scale consultancy contracts.

ACL's allocation process operates within a framework of prevailing rules and regulations at the national, EU and international levels covering procedural, competition and environmental issues. The coordination process at all UK airports is consistent with the IATA Scheduling Procedures Guide, which sets the framework for slot allocation for Coordinators worldwide. Although the processes adopted by ACL to resolve scheduling problems at its airports must conform to a common framework, procedures can vary considerably between airports reflecting differences in levels of capacity/demand and local rules. In general, procedures tend to be more rigorous at larger airports with significant

[23] Data provided by ACL.

[24] Heathrow, Gatwick, Stansted, London Luton, London City, Manchester, Birmingham, Newcastle, Glasgow, Edinburgh, Aberdeen and Jersey airports.

capacity constraints than at smaller airports operating with substantial spare capacity.

Although slot allocation is a continuous process throughout the year, much of the activity currently takes place in two intensive periods of about four weeks based around the November and June IATA conferences that coordinate international schedules for the summer and winter seasons respectively. ACL describes the process in six steps.[25]

1 - Data preparation and analysis. Throughout the year, ACL monitors airline activity at the coordinated airports in order to establish historic schedules for the summer and winter seasons. These are released to the airlines for checking in September and April respectively. At about the same time, ACL negotiates scheduling limits (runways, terminals, stands etc.) with the airport operators and airlines.

2 - Preliminary coordination. Airlines submit their schedule requests to ACL by a submission deadline set by IATA. In compiling their requests, the airlines are influenced both by their historic schedules and by negotiations with other airlines through the 'airline scheduling committees' established at each UK airport. The schedule data received from the airlines is then sorted by ACL into four categories:

- *Historic Slots.* Slots used by airlines in the previous session where no changes have been requested that materially effect co-ordination parameters.
- *Changed Historics.* Historic slots for which airlines have requested material changes, such as a change in timing or aircraft size.
- *New Entrants.* Slots requested by airlines new to the airport or new slots requested by incumbents qualifying under the "no more than four slots on a day" or "intra-community route" criteria in the IATA guidelines and EU regulations.
- *New Incumbents.* All new slot requests by existing operators not qualifying as new entrants.

Initially, all Historic Slots and Changed Historics are put into the ACL seasonal database. Changed Historics that breach the scheduling limits are rescheduled as

[25] Memorandum by ACL (RAS 83), Minutes of Evidence taken before the Transport Sub-Committee, 8 April 1998.

close as possible to the requested time but within the scheduling limits. Roughly 10% of airlines' historic schedules are changed each season.

3 - Allocation of the slot pool. Once Historic Slots and Changed Historics have been accommodated, any remaining capacity is allocated to new requests. Up to 50% of the available slots are allocated to 'New Entrants'. The remainder (plus any of the slots not fully subscribed by New Entrants) are distributed amongst the incumbents.

Slots are allocated on a day-by-day and hour-by-hour basis. Airline requests that match hours where there are slots available are progressively entered into ACL's database based upon a number of criteria. These criteria, in order of importance, are:

- *Primary criteria* – historical precedence; schedule change; new entrants; introduction of year-round services; effective period of operation; joint operations.

- *Secondary criteria* – size and type of market served; competitive requirements; worldwide scheduling constraints (e.g. curfews); needs of the travelling public; frequency of operation.

- *Other local criteria specific to UK airports* – night flying restrictions; effect of traffic distribution rules; bilateral issues (e.g. frequencies allowed on specific routes); licensing issues; minimum stand usage; seasonal waiting list (i.e. airlines that have applies for a particular slot in previous seasons); 'sharing out' the limited available capacity between the carriers; ad-hoc requests.

No flights are added that break scheduling limits. The exercise is continued until all requests have been tested and as many as possible fulfilled.

4 - Response to airlines. On the first day of the IATA conference, completed listings are distributed to the airlines. These list all slots offered and requested for the season and explain reasons for any discrepancies between them.

5 - The IATA Conference. The Conference provides an opportunity for airlines and coordinators from airports around the world to meet and agree slot allocations for the coming season. In addition to confirming (and potentially renegotiating some of their slots), the airlines have additional objectives, such as optimising connections and ground handling arrangements. Airlines may engage in slot exchanges with one another in pursuit of such objectives.

6 - Post-IATA activity. The Dialogue between airlines and coordinators continues after the Conference and into the operating season. Airlines may exchange their slots with each other, or add, change or delete their flights as ones released by other airlines become available, subject to ACL approval. This approval is denied or granted only on the basis of whether the resulting air movements compromise capacity constraints.

3.2. REGULATORY FRAMEWORK

3.2.1. EU REGULATION

Slot allocation at EU airports falls within the scope of the EU Single Market, and is subject to a common regulatory framework under European Council Regulation No. 95/93 of 18 January 1993. The relevant legislation is based on the existing IATA scheduling system and embraces the principle of grandfather rights. In theory, the objective of the Regulation is to encourage efficient use of airport capacity through the optimal allocation of slots. Its principles are based on EU policy to "*facilitate competition and to encourage entrance into the market … these objectives require strong support for carriers who intend to start operations on intra-community routes.*"[26]

In addition to enshrining the principle of grandfather rights, the existing regulation addresses the following issues:

1. ***Allocation pool.*** The regulation states that all new and unused slots must be placed in a pool, to be allocated (free of charge) by a slot coordination body. Although slot allocation bodies at applicable airports are typically owned by one or more of the airlines, decisions must be made using "neutral, transparent and non-discriminatory" procedures.

2. ***'New Entrants'.*** Priority access to 50% of pool slots is granted to 'New Entrants', which are defined as airlines:

   - holding fewer than four slots on that day at that airport; or
   - seeking slots for an intra-EU route served by no more than one or two other airlines on that day, and holding fewer than four slots on that day on that route; and
   - holding no more than 3% of total slots available on that day at that airport, or 2% of available slots in that airport system.

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[26] European Council Regulation (EEC) No 2408/92 of 23 July 1992 on access for Community air carriers to intra-community air-routes.

3. ***Slot transfers.*** Slot transfers are permitted under the Regulation. Article 8.4 states that "Slots may be freely exchanged between air carriers or transferred by an air carrier from one route, or type of service, to another, by mutual agreement or as a result of a total or partial takeover or unilaterally. Any such exchanges or transfers shall be transparent and subject to confirmation of feasibility by the coordinator...".

4. ***Regional services.*** Article 9 of the Regulation allows for special provisions for regional services under strict conditions.[27] Fully coordinated airports may have slots reserved for domestic scheduled services, conditional on certain criteria:

   - the route must be considered vital to the economic development of a particular region;
   - the slots must have been being used for that route at the time of implementation of Regulation 95/93; and
   - no more than one carrier is currently operating that route with no other transport offering an adequate service.

   The reservation of such slots must end when a second carrier operates an equally frequent service. Slots may also be reserved on routes where public service obligations (PSOs) have been imposed under EU legislation.

   No slots are reserved under European regulation for services to London airports, although some services to the islands off the UK coast have PSOs. In 1998, the DETR commented that it is "*impossible for the UK to rely with any degree of confidence on the power to reserve slots where no PSO had been imposed*".[28] It pointed out that only flights from Teeside to London would potentially meet the criteria, and even this was uncertain given the availability of the East-coast rail services as a land alternative.

   Within the industry, considerable opposition could be expected to any attempt to set aside a significant number of certain slots for regional routes. BAA has stated that ring-fencing slots in this way can only be done at the expense of

[27] European Council Regulation (EEC) No 95/93 of 18 January 1993.

[28] Select Committee on Environment, Transport and Regional Affairs, *Eighth Report*, 28 July 1998, page 10.

other services that provide greater benefit to the UK economy.[29] This reflects the fact that regional services are typically less profitable than services to more far-flung destinations, as they typically use much smaller aircraft and carry smaller numbers of passengers.

5. ***Airport Coordination.*** Airports may be designated as either fully coordinated or coordinated. Articles 3.3 and 3.4 stipulate that Member States may designate an airport as fully co-ordinated either when capacity is "insufficient for actual or planned operations at certain periods"; when new entrants "encounter serious problems in securing slots"; or when, after a thorough capacity analysis, it becomes evident that capacity problems may not be resolved in the short term.

   The designation of UK airports is the responsibility of the Secretary of State at the DETR. Heathrow, Gatwick, Stansted and Manchester are all designated as fully co-ordinated airports, and Birmingham and Glasgow are classified as co-ordinated.

Regulation No 95/93 was due for revision in 1998 but formal proposals are still to be released. Within the Commission, there has been dissatisfaction with the present system of exemptions, which are viewed as inconsistent with the goals of the EU Single Market. In its Single Market Scoreboard, published in June 1999, the Commission highlighted both 'New rules on allocation of airport slots' and 'Rules on Airport Charges' as areas where progress had been "*disappointing*".[30] At the EU Transport Council on 2 October 2000, the Commission formally requested the views of Member States on the potential for a radical revision of this regime, including the possibility that "*more market-based approaches*" could be used to match supply and demand.[31]

It is also worth pointing out that slot allocation procedures are currently exempt from the restrictions on agreements and practices that restrict or distort competition under Article 81 of the Amsterdam Treaty (previously Article 85 of the Treaty of Rome):

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[29] Ibid, page 15.

[30] Single Market Scoreboard, June 1999, European Commission.

[31] HM Government response to European Commission paper and questionnaire on slot allocation reform, as tabled at the Council of Transport Ministers on 2 October 2000. (obtained from DETR).

> *"…Pursuant to Article 85(3) of the Treaty…Article 85(1) of the Treaty shall not apply to agreements…[including]…slot-allocation and airport scheduling in so far as they concern air services between airports in the Community."* [32]

This very clearly shows that slot allocation procedures and the outcome they generate are acknowledged as having a considerable impact on competition in the airline sector.

3.2.2. UK REGULATION

In the United Kingdom, responsibility for the regulation of civil aviation is with the DETR and the Civil Aviation Authority (CAA). The DETR is responsible for overall civil aviation policy, in consultation with the CAA. The CAA Economic Regulation Group (ERG) regulates UK airlines and airports. The ERG is responsible for the regulation of charges paid by airlines at Heathrow, Gatwick, Stansted and Manchester. It also has powers to investigate allegations of abuse of position by other commercial airports and has responsibilities regarding ground handling at airports. The Economic Policy Unit of the ERG undertakes studies of airline competition, and advises and supports the government on competition matters and aviation negotiations.

The UK government also has bilateral agreements with states outside the EU concerning the level of flight traffic between that country and the United Kingdom. Although such agreements do not directly impact on slot allocation, carriers wishing to offer services must take them into account. The most important bilateral agreement is the *Bermuda II Air Services Agreement* with the United States, which was introduced in 1977, with many subsequent revisions. The agreement places restrictions on the number of airlines operating UK-US flights from particular airports and the frequency of services on those routes. For example, it states that no more than two US and two UK airlines (currently British Airways, Virgin Atlantic, United Airlines and American Airlines) may operate a given UK-US route out of Heathrow.

[32] Commission Regulation (EEC) No 1617/93 of 25 June 1993 on the application of the Treaty to certain categories of agreements and concerted practices concerning joint planning and coordination of schedules, joint operations, consultations on passenger and cargo tariffs on scheduled air services and slot allocation at airports. Note: the Regulation applied until June 1998, but has been extended until June 2001 under Regulation (EC) No 1083/99. This exemption is subject to certain conditions such as neutrality and transparency of the slot allocation process (Article (5) of Commission Regulation (EEC) No 1617/93 of 25 June 1993).

3.3. AIRPORT CHARGE CONTROLS

Under the 1986 UK Airports Act, airport operators are responsible for the provision and maintenance of airport infrastructure, including runways, terminals and equipment, essential passenger search and perimeter security, fire-fighting, cleaning and maintenance. For example, in the case of Heathrow, ACL conducts the allocation exercise under contract from HAL, the subsidiary of BAA that is responsible for operations at Heathrow.[33]

Although airports recoup the costs of allocation indirectly through charges on airlines for runway, stand and terminal facilities, such charges are related to general measures of passenger numbers and infrastructure use and do not reflect the scarcity value of these resources. Moreover, whilst these charges are currently differentiated by time of day, this variation is small and does not reflect the relative economic value of peak and off-peak slots. As a result, these charges do not reflect the relative cost of using capacity, and there is insufficient incentive for operators to move services to off-peak times where it would be economically efficient to do so.

Any move to allow airports to charge airlines for the use of runway, stand and terminal capacity at rates that reflect the scarcity value of the slots that they use could run into problems with the current regulatory system for airports. At present, charges for airport facilities at Heathrow, Gatwick, Stansted and Manchester are price capped in order to prevent airport operators from generating excessive profits.[34]

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[33] BAA plc owns London Airports Ltd (LAL), which controls the operating companies Heathrow Airports Ltd (HAL), Gatwick Airport Ltd (GAL) and Stansted Airport Ltd (STAL). It also owns Airports UK Ltd, which owns Southampton International Airport Ltd, and Scottish Airports Ltd, which owns Glasgow Airport Ltd, Edinburgh Airport Ltd and Aberdeen Airport Ltd.

[34] Under existing regulations set up by the 1986 UK Airports Act, the only tool available to the CAA to control BAA's profits is a cap on the amount per passenger that the airports can charge the airlines. The regulator sets a maximum increase using an RPI-X formula. For example, for Heathrow, the increase in charges was limited to RPI-8% for 1996-98, RPI-4% for 1999 and RPI-1% for 1999-2001. In determining the level of 'X', BAA's return on capital is assessed by the regulator on the basis of a 'single till' approach, which makes no distinction between profits derived from commercial and operational activities. Therefore, in the event that BAA is very successful in generating profits from retail activities, this may perversely be reflected in lower charges on airlines for use of airport facilities. The single till approach has the perverse consequence that airport usage charges are likely to be lower at more congested airports than at less congested ones where returns from retail space will be lower. This is exactly what has happened at Heathrow, where charges to airlines have actually fallen in recent years, as the regulator set 'X' above RPI. This has had the result that charges at Heathrow are less than those charges at Gatwick and Stansted, despite the greater scarcity of slots.

The UK government is bound by international agreements, notably Bermuda II, that require charges levied by airport authorities to be based on the costs of service provision, even if there is excess demand for these services and effective price signals would be required to reflect the degree of scarcity.[35]

Therefore, implementing any system of market-based pricing for slots would raise the question of how to treat any revenue raised within the current regulatory framework. In particular, allowing UK airports to alter their charging structure to reflect the scarcity value of slots would simply result in the transfer of scarcity rents from airlines to airports and increase their current rate of return. This would be inconsistent with the current price cap regime on BAA, as there is currently no regulatory instrument to reduce BAA's return on capital save by reducing charges for the use of slot capacity below those levels that would be required to signal scarcity.

In any case, it would not be desirable to let the entirety of revenue raised from allocating slots to remain with airport operators, even as an incentive to build additional capacity, for the following reasons:

- To the extent that an airport operator enjoys market power in the provision of services, it would have an incentive to restrict capacity to boost revenue.
- To the extent that runway capacity is limited by planning and environmental constraints, it would be inappropriate for the airport operator to enjoy scarcity rents resulting from these limitations.

Rather, scarcity rents associated with limited runway capacity should flow to the government, at least in the first instance, subject to providing airport operators with a reasonable return on the investments it makes in capacity. It is appropriate

[35] For example, a 1994 revision to Article 10 of the UK-US Bermuda II Agreement stated an intention on the part of UK government to maintain regulation of landing, passenger and parking charges at Heathrow: (see Monopolies and Mergers Commission, *BAA plc.*, A report on the economic regulation of the London airports companies (Heathrow Airport Ltd, Gatwick Airport Ltd and Stansted Airport Ltd), 1996, Appendix 3.6). The cost basis for airport charges is laid down in the International Civil Aviation Organization's (ICAO) guidelines, which stipulate that "*the cost to be share is the full cost of providing the airport and its essential ancillary services, including appropriate amounts for interest on capital investment and depreciation of assets, as well as the cost of maintenance and operation and management and administration expenses,...*" (paragraph 14-(i) of the ICAO Statement by the Council on Airport Charges, reproduced in the Monopolies and Mergers Commission report on BAA, *op. cit.*, as Annex 3.3)

to consider an airport operator as a concessionaire who is granted a right to exploit a scarce 'natural' resource - namely runway capacity.

3.4. SECONDARY TRADING

The concept of airport slot 'ownership' is subject to considerable legal uncertainty, which would need to be resolved as part of any decision to move to a new allocation system in which slots were freely tradable.

Under current EU regulations, the sale of slots by any party, whether a government, airline or other, is prohibited. However, airlines are permitted to exchange slots at the same airport between themselves, on a strict one-to-one basis, provided that this does not upset overall coordination. The UK Government has indicated that if favours a shift to a fully tradable system, subject to certain safeguards, in the foreseeable future, and the Commission is certainly interested in the potential extension of the scope of trading.

Although airlines currently enjoy a 'perpetual right of usage' for slots at UK airports, it is the opinion of the UK Government that this does not confer any property rights.[36] This implies that governments have the right to cancel grandfather rights at their discretion, subject to the requirements of European law. This position is consistent with that of the US Department of Transport, which asserted its right to retain ownership of the slots and withdraw slots at any time in the 1986 legislation introducing secondary trading.[37] Airlines, however, have contended that occupancy is more important than ownership.

In the absence of any relevant case law, it is not possible to give a definitive statement on how this dispute will be resolved. However, the need for clarification has arguably been hastened by the emergence of a legal loophole in the current rules relating to exchanges of slots between airlines. In 1999, the UK Court of Appeal rejected a complaint from the States of Guernsey against British Airways following an exchange of slots which had previously been used to provide scheduled services to Guernsey and which British Airways, having acquired the grandfather rights, intended to re-deploy. There was "*no doubt that the slots transferred by Air UK were a more coherent, useful and valuable batch than the ones it*

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[36] UK government response to Questions from the EU Commission, provided by the DETR.

[37] R Poole and V Butler, *Airline Deregulation: The Unfinished Revolution*, Competitive Enterprise Institute, Monograph, December 1998. (http://www.cei.org/MonoReader.asp?ID=473)

received in return,"[38] and the exchange was "*believed to have involved an accompanying payment* [by BA] *of £16 million for four daily pairs of slots."*[39]

This decision has legitimised a 'backdoor' route for airlines to acquire slots without going through the seasonal ACL allocation procedure. This can be done by requesting unallocated slots (i.e. slots previously unwanted owing to their low commercial value) from ACL and then swapping them for more attractive slots, at the same time making a payment to the slots' current user. Although ACL must approve any proposed swap, it looks only at the feasibility of fitting the revised arrangements into the schedule and does not consider any financial component that might be involved. Therefore, the current situation is one where slot trading is, *de facto*, possible even if formally discouraged by the regulator. If this situation continues for the foreseeable future, it is possible that a system of secondary-market trading in airport slots could emerge by default. This may bring advantages in terms of efficiency, as the availability of monetary payments would create gains from trade if an airline currently holding a slot is not the most efficient user.

Evidence from the United States suggests that secondary markets can lead to greater efficiency in the use of slots. In a comparison of two US hubs that utilise a slot market (O'Hare and Washington-National) with two that do not (Atlanta and Los Angeles), Riker and Sened observed greater efficiency (in terms of load factors) and smaller fare increases at the airports using a slot market.[40]

However, the emergence of a secondary market via a back-door route rather than formal regulation could also have a number of undesirable consequences:

- *Market power concerns*. An unregulated secondary market would run the risk that slots could become concentrated amongst relatively few carriers. In contrast, requiring slots to be traded on a formal market means that rules to prevent carriers building strong market positions can be incorporated.

[38] Court of Appeal of England and Wales Decisions, Queen v. Airport Co-ordination Limited Ex parte States of Guernsey Transport Board, Interested Parties: Air UK Ltd British Airways Plc IATA, EWCA 1318, 25 March 1999, Page 2.

[39] Competition Commission, *Air Canada and Canadian Airlines Corporation*, A report on the merger situations, August 2000, paragraph 4.35

[40] I Sened and W H Riker, "Common Property and Private Property: The Case of Air Slots". *The Journal of Theoretical Politics*, Vol 8(4), 1996.

- *Lack of transparency*. Any airline planning to relinquish a desirable slot would need to find a buyer. In the absence of a formal market, it may be difficult to identify potential buyers, especially potential new entrants. In this case, established operators would have the advantage of being natural parties for a seller to approach.

- *Reduced relevance of criteria related to safeguarding particular routes.* ACL's criteria are designed to prioritise slots for particular types of airlines and services over others. Although these criteria may not produce the most efficient outcome, they are designed with public interest goals in mind. Slot trading may enable airlines to bypass these criteria without any alternative mechanisms to ensure that the public interest is considered. Furthermore, because the slots being traded have grandfather rights, undesirable outcomes may persist indefinitely.

- *Uneven burden on incumbents and entrants.* The effective emergence of a secondary market would introduce new costs on expansion, without any corresponding charges on incumbents enjoying grandfather rights.

In summary, while there is a strong case on efficiency grounds for the development of a secondary market in slots, if this is not regulated properly, it could allow carriers to gain market power.

4. THE CURRENT REGIME VERSUS MARKET-BASED ALTERNATIVES

Slot allocation is a complex process that must be completed in a relatively short time to permit international co-ordination. The current system of grandfather rights was designed in an era when there were few if any capacity constraints on airports. It has survived to the present day because it is 'reliable', in the sense that all desired slots are allocated each season in combinations that are generally usable. However, this 'reliability' is derived from systematic inflexibility and inertia, which in a situation of excess demand leads to inefficiencies, distorted incentives and restrictions on competition.

There are also significant problems with the administrative procedures for allocating the small number of pool slots. These necessarily rely on arbitrary and subjective criteria, which make consistently efficient outcomes unlikely and leave the process vulnerable to legal challenge. The current process, although computerised, is also highly dependent on manual intervention. In the event that there was a large increase in the size of the pool, for example because some or all grandfather rights were replaced by time-limited usage rights, it is unlikely that the current system could cope with allocating the resulting number of slots.

Thus, there is considerable scope for the development of an alternative, market-based allocation system for airport slots, such as an auction, that is better suited to addressing efficiency and market power concerns. In order to maximise gains in social welfare through more efficient allocation of resources, this new system would need to replace both grandfather rights and existing administrative procedures for allocating the pool.

4.1. ADVANTAGES OF THE CURRENT SYSTEM

The primary strength of the current system lies in its ability to cap the complexity of the coordination process by limiting the scope for slot changes between seasons. The system of grandfathering, by definition, tends to minimise the number of flight changes from season to season. This, in turn, reduces the scope for clashes between airlines in their scheduling requests, both within and across airports. Put differently, in any one season, the vast majority of flights are simply rolled over from one year to the next, with complications created only by a minority of new or changed services. This built-in inertia reduces the complexity of each season's allocation exercise and may limit the downside from any misallocation of slots, as established operators can continue using slots in established patterns, with schedules evolving gradually over time. It also provides airlines with a maximum degree of certainty over future slot holdings, which may be beneficial for investment decisions.

In the absence of a recognised alternative system that would offer improved economic efficiency without sacrificing functionality, both the industry and regulators have favoured the preservation of the existing system. From the perspective of established carriers, this system has strong attractions:

- The cost of acquiring and keeping slots does not reflect their scarcity value. To the extent that airlines are able to exploit this scarcity value, there is capacity to make supernormal profits.
- Established airlines may impose a competitive constraint by continuing to use their allocated slots and thus prevent new entrants from acquiring a sufficiently large portfolio.
- Acquiring a perpetual right of usage to a slot provides great certainty in business planning.
- Coordination of next season's slots takes place only as the current equivalent season is coming to an end. This is attractive to airlines, as it enables them to maintain (without exercising) their option to renew existing slots for the forthcoming season until as little as six months before the start of the season. Airlines can thus plan their forthcoming seasonal schedules with maximum knowledge about their performance in the previous comparable season.

However, from the perspective of new entrants or less established airlines wishing to expand their services, these benefits for established carriers with a significant portfolio of grandfathered slots are a clear disadvantage and an obvious source of frustration with the current arrangements.

4.2. DISADVANTAGES OF THE CURRENT SYSTEM

4.2.1. INEFFICIENT ALLOCATION

Judged against the benchmark of economic efficiency in the broadest sense – producing an allocation of slots so that the resulting supply of air services maximises benefits for both UK consumers and the UK economy – the present system is clearly sub-optimal. Put simply, there is no guarantee under the current system that slots will end up being used by those who can generate the greatest benefits from them.

There are three main causes of inefficiency on the current system:

1. Systemic inertia. At a hypothetical airport with no capacity constraints at any time, carriers can take off and land as they wish without interfering with other carriers' scheduling. In this case, grandfather rights are as efficient a form of allocation as any other mechanism. However, once demand exceeds supply at some times of day, one carrier cannot schedule its air movements without conflicting with a rival's plans. With grandfather rights, the historic user of a slot will have precedence regardless of the relative value of the service it offers using this slot compared to the service that cannot be offered. This situation is now common at Heathrow, Gatwick and, to a lesser extent, Stansted. With insufficient capacity, new and expanding airlines may be unable to gain the slots that they want, even if they could use those slots more efficiently than established carriers. Systemic inertia prevents efficient change.

Where capacity shortages are only temporary or limited to short periods, the resulting potential for inefficient allocation may be deemed an 'acceptable' cost. This is the apparent position of IATA, which looks to governments to resolve capacity constraints swiftly through infrastructure development. However, as discussed above, the scope for expanding infrastructure is very limited at many airports, and it is doubtful whether it will ever be possible to provide sufficient capacity for flights to satisfy demand at key airport systems, such as London. If, as is widely projected, demand for slots continues to outgrow supply across London airports for the foreseeable future, the problem of inefficient allocation will only grow worse.

Even if further runway and terminal capacity were to be built, it is inconceivable that we could *ever* reach a position in which there would be sufficient capacity that any airline could schedule air movements whenever it desired without conflicting with other airlines' schedules. Even with sufficient total capacity, there will be excess demand at peak times[41] and at the very least mechanisms are needed to ensure that traffic with flexible timing is scheduled off-peak. Even this limited objective is not achievable by the current system based on historic precedence.

2. Distorted incentives. Investment and scheduling incentives for airlines are distorted because slots are awarded 'free of charge' and with perpetual usage rights. In the absence of a pricing mechanism for slots in which prices reflect the opportunity cost of usage, airline's slot requests and slot usage take no account of the benefit that might be generated if a slot were made available to another airline.

In particular, airlines are able to extract 'scarcity rents', additional revenues that accrue because competition is limited by capacity constraints. The scope for generating rents from slots is a powerful incentive for airlines to hang on to slots,

[41] In general, it is likely to be economically inefficient to extend capacity to a level at which all peak-time demand could be satisfied. Therefore, even if it were technically possible to provide sufficient capacity, this would not necessarily be the optimal course of action.

even if they are not making optimal use out of them. As ownership rights are perpetual, airlines that surrender slots risk losing them forever, thereby relinquishing any potential to develop profitable uses from the slot in the future. Airlines have adopted a number of tactics to hang on to slots, including running very small aircraft on short-haul trips, or 'baby-sitting' slots with code-share airlines or domestic subsidiaries.

These rents also generate substantial incentives for airlines to try to influence the allocation procedure in their favour. This means that allocation procedures might become mired in legal action if there were an increase in the amount of capacity to be allocated on the basis of criteria other than historic precedence.

The lack of a pricing mechanism also means that the economic value of airport capacity needs to be estimated by the individual airport operators, which may often be difficult. Prices established through an appropriate market-based mechanism would enable better and more direct quantification of the benefits that would be created by extending capacity.

3. Arbitrary allocation criteria. In the absence of a pricing mechanism that reveals the true values that airlines place on slots, the current criteria for allocating slots from the pool are necessarily arbitrary. A detailed cost-benefit analysis of each request is neither practical, given the short-time period for decision-making, nor desirable, given the likelihood of legal challenge. As we have already discussed, ACL uses an 'onion layer' approach, prioritising requests on the basis of a hierarchy of criteria. There are many problems with this method:

- *Not all trade-offs are considered.* New requests for slots are only considered once all other requests arising from historic rights have been dealt with. Therefore, the system does not consider all feasible trade-offs between requests for slots and so is far from fully optimised. By way of simple example, it is quite possible that the acceptance of one retiming request may preclude a request for a new slot that could be of greater benefit.

- *There are no objective criteria.* The criteria used by ACL in choosing between competing requests in the same layer of the 'onion skin' are often subjective and difficult to implement. Objectives, such as the promotion of 'new entry' and 'needs of the travelling public' are difficult to make operational. There is no guarantee that decisions based on these loose criteria will promote an efficient allocation.

- *The process is vulnerable to legal challenge.* There are strong incentives for carriers to challenge the process and the lack of objective criteria encourages legal dispute.

A simple example helps to illustrate the inefficiencies in the current allocation system and the potential advantages of an auction. Suppose that there are two airlines, airline A and airline B, who want to offer a service from Heathrow. Airline A wants to fly to Airport X, while airline B wants to fly to Airport Y. Suppose also that there are only two flight slots available at profitable times, one at 8-9am and one at 9-10am. The costs and revenues from running a service at this time are illustrated in Table 5.

Both airlines have a preference for the 8-9am slot, as they would generate higher returns from a flight at this time. However, airline A generates a much larger return than airline B from the earlier slot. There are two potential outcomes:

- ***Outcome I:*** Airline A gets the 8-9am slot, with airline B taking the later one: Combined surplus = £9,000 + £3,000 = £12,000; 210 passengers fly.
- ***Outcome II:*** Airline B gets the 8-9am slot, with airline A taking the later one: Combined surplus = £5,000 + £3,000 = £8,000; 190 passengers fly.

Table 5: Airline surpluses for different times and routes (stylised example)

	Average no. of passengers	Revenue per passengers	Total revenues	Cost per flight	Surplus to airline
8-9am					
Airline A	120	£200	£24,000	£15,000	£9,000
Airline B	100	£200	£20,000	£15,000	£5,000
9-10am					
Airline A	90	£200	£18,000	£15,000	£3,000
Airline B	90	£200	£18,000	£15,000	£3,000

Clearly, in terms of maximising social welfare, Outcome I is preferable: more passenger demand is satisfied and the combined revenue surplus of the airlines is greater. However, under the existing allocation procedures, there are many circumstances under which Outcome II would occur, because airline A would fall behind airline B:

- Airline B already has grandfather rights to the 8-9am slot.

- Airline A is a new entrant whilst Airline B is an incumbent with grandfather rights to a completely different time slot. The application for a switch to the 8-9am slot would have precedence through the 'changed historics' provision. The same result would hold if airline A were an incumbent and the request were for an additional slot.

- Airline B is a new entrant, while airline A is a medium-sized incumbent hoping to increase the frequency of an existing service so as to better compete with another established carrier.

- Both airlines apply for the slot on an equal basis, so the allocation is decided by the coordinator on the basis of 'secondary criteria', such as the size and type of market served, competitive requirements and the needs of the travelling public. With perfect information, the coordinator would select Outcome I. However, in practice, it may be difficult to select the most efficient outcome without access to the detailed valuations of the airlines. Both airlines have incentives to play up the advantages of their proposed service. It is quite possible that the coordinator may erroneously select Outcome II, perhaps because airline B makes ambitious claims that it expects to carry 125 passengers per flight for the 8-9am slot.

Once an inefficient allocation is made, it will be difficult to correct because under the system of grandfather rights the coordinator cannot change it. Under the existing system, the only way in which the allocation could be adjusted is through exchanges of slots between the airlines. However, there are a number of problems with such an exchange:

- Airline B could expect to extract an 'under-the-table' monetary payment from Airline A in return for swapping slots. As Airline A could generate an increase in surplus of £6,000 per flight, it would be willing to pay up to this amount in return for swapping slots. In effect, Airline B would be able to appropriate much of the increased surplus of Airline A from running the earlier service.

- Airline B may not be willing to swap flights for anti-competitive reasons. For example, imagine that it was already running a service to Airport X and did not want increased competition from airline A.

The likelihood of an inefficient outcome under the existing system increases with the number of airlines that wish to acquire a slot. For example, imagine that there is an airline C, which would also like one of the two slots, and has valuations that are different to those of airlines A and B. With 3 airlines, there are six different combinations of successful bidders, only one of which is optimal. Under the existing system, any of the combinations is possible for the reasons outlined above.

4.2.2. COMPETITIVE DISTORTIONS

In addition to generating an inefficient allocation of slots, the provisions in the Slot Regulation that are intended to stimulate competition are misguided. Although there is provision for the reservation of pool slots for new entrants, the definition of a new entrant does not reflect the commercial reality of competition between airlines. As a consequence, these provisions are only of benefit to very small carriers offering low frequency services. Established mid-sized carriers or entrants wishing to offer high frequency services (i.e. more than 4 movements per day) do not benefit. Such airlines have three ways of obtaining slots, all of which are uncertain:

- *The pool.* New entrants have first choice for up to 50% of pool slots. Other airlines may apply for slots through the remaining pool. However, it is unlikely that there will be a significant number of slots available at attractive peak times as these are oversubscribed and existing holders have grandfather rights.

- *The secondary market.* Obtaining slots on the secondary market is difficult as the market is informal and illiquid, such that it is hard to identify potential sellers. In any case, established carriers may be unwilling to concede slots to new entrants. This is not a situation in which competition law is likely to be of any benefit to entrants and small operators. Provided that a large, established operator keeps using its existing slots, it can maintain its historic usage rights. Slot divestment by operators with actual or potential market power has generally been required only as an undertaking in the contexts of mergers, not as a response to a complaint by competitor.

- *Changed historics.* An airline unable to obtain a slot at the time it wants could apply for a slot at a different time where there is little or no excess demand. If successful, it could later apply to switch its service to the desired time. As its slot would be subject to grandfather rights, it would have precedence over new entrants. However, this approach has considerable risks. Owing to ‘use it or lose it’ rules, the airline must utilise the undesirable slot until such time as a better slot becomes available. This may mean accepting a low or even negative return on capital for a period of uncertain duration, making this a very unattractive method of obtaining a slot at an over-subscribed time.

New entrants trying to set up frequent services may be in a position to use alternative, less congested airports (for example, easyJet’s operation out of Luton).

However, if new entrants cannot obtain a sufficiently large number of slots at substitutable airports, there are little or no competitive constraints on the abuse of market power on a particular point-to-point route under the current system.

As a result, although there are currently measures to encourage *small-scale entry*, there are very substantial *barriers to expansion* by existing operators. This is a matter for very considerable concern, as the nature of competition in the airline market suggests that expansion by existing operators (especially mid-sized operators) is often of much greater importance in ensuring effective competition than small-scale entry. As we have discussed above in Section 2.6, the following factors need to be taken into account:

- Frequency of operation on routes is of considerable importance in attracting customers. The principal competitive constraint on the pricing decisions of high frequency operators is other high frequency operators. Low frequency operators on the same route offer a differentiated service that may not compete directly with high frequency services. Therefore, small-scale entry on a particular route may not enable a service of sufficient frequency to act as a competitive discipline on established operators.

- Established operators such as British Airways operate hub systems. They enjoy both demand- and supply-side advantages from operating a large number of routes from their hub. Small carriers operating few routes may form only a weak competitive constraint on established operators with dense networks.

- On routes outside the EU, bilateral agreements may restrict the number of operators on that route (e.g. between the United States and United Kingdom). In this case, there is an absolute barrier to the entry of new operators and competition relies on expansion by those operators already active on that route.

For these reasons, expansion by existing mid-size operators may often be much more important for competition than small-scale entry. However, expansion is hindered by:

- the small proportion of the stock of slots that becomes available in the pool each season;

- the lack of a formal, liquid secondary market; and

- the ability of established operators to discriminate against entrants or expanding rivals in any swaps of slots.

Furthermore, the combination of the current 'use it or lose it' obligations and the lack of an effective secondary market compounds these barriers to expansion. Although the 'use it or lose it' rule is intended to prevent the hoarding of slots by operators with market power to blockade entry, it is applied uniformly to all operators. Entrants and small operators do not enjoy market power and so do not have any anti-competitive incentive to hoard unused slots to block entry by others. Despite this, entrants and smaller operators cannot acquire slots with the potential of leaving them unused to maintain an option for subsequent expansion even in those cases (which may be very rare in practice) where there might be considerable benefits from doing so. Rather, if the need for expansion arises it would be necessary to apply for slots from the pool or seek them on the secondary market, both uncertain and lengthy processes. In contrast, large established carriers have considerable commercial flexibility as a result of maintaining large portfolios of slots, which they can reallocate across routes.[42]

Relaxing ‘use it or lose it’ rules for carriers without market power would not lead to a situation in which significant numbers of slots would remain unused. Where a carrier acquires a slot in order to gain the option of expanding its services at a future date, it would have any incentive to make this slot available to other carriers on a short-term basis where feasible, e.g. through a revocable lease which might be attractive to an operator wishing to run a charger service. The extent to which such a usage right is interruptible would obviously be reflected in the payment received by the carrier using the slot (in a similar way as prices are lower, for example, for interruptible gas supply contracts), and the terms and conditions of such a lease would reflect the optimal balance between the option value of the slot to the lessor and the usage value to the lessee.

4.3. WHY AUCTIONS ARE MORE EFFICIENT

We have seen that the current system for allocating slots leads to inefficient outcomes and competitive distortions. Furthermore, carriers may enjoy scarcity rents resulting from competition being hindered by lack of slots, which in turn may create incentives for challenges to the allocation process.

Simply changing the criteria used in the allocation process is not a remedy. Many of the shortcomings of the existing allocation procedures identified above are generic and would arise in any administrative allocation procedure. Indeed, the growing popularity of auctions stems from the fact that they generally avoid many of the problems associated with administrative procedures.

[42] Although the ‘use it or lose it’ rule is a source of potential inflexibility and a barrier to expansion, it is important to remember that the need for a ‘use it or lose it’ rule derives from the current system of perpetual usage rights. Removal of the ‘use it or lose it’ obligation even for small carriers would be a dangerous step as long as perpetual usage rights remain.

4.3.1. EFFICIENCY PROPERTIES OF AUCTION OUTCOMES

Efficient allocation requires that a resource should be assigned to whoever values it most. There would be little difficulty in achieving this even with an administrative procedure if the administrator had reliable information about the value placed on the resource by its potential alternative users. However, such information is not usually available. The criteria used by ACL in assessing how to allocate pooled slots are intended to act as a proxy for social welfare. However, these criteria are at best a guide to determining an allocation in a situation where the decision-maker has very imperfect information.

Without full knowledge of the value of a resource to different potential users, no administrative allocation procedure can guarantee an efficient allocation. Consider our simple example in Section 4.2 above, where airline A and airline B were each competing for one of two slots at 8-9am and 9-10am. In this example, we showed that there were many circumstances under which the existing allocation system would not produce an efficient outcome. More generally, we can say that it is not possible to guarantee the efficient allocation of these resources under any non-market based allocation procedure, as the provider of the resource does not know its value to potential users:

- If the government allocated the two slots without charge on the basis of its own estimates of respective value to the two users, there is a risk that these estimates may be incorrect and the slots would be allocated to the wrong user.

- Efficiency cannot be achieved simply by setting a charge for using each of the slots, as the government does not have sufficient information to determine either the absolute or relative levels. For example, if the absolute charge for the 8-9am slot were set too high (above £9,000), it would not be allocated at all. Conversely, if the charge were set too low, then the provider would still get applications for the 8-9am slot from both users. The relative level of charges for the two slots is also very important. Unless the charge for the 9-10am slot is set at least £2,000 less than the charge for the 8-9am slot, then both airlines would still prefer the 8-9am slot to the exclusion of the 9-10am slot. If the differential were set at more than £6,000, then both airlines would prefer the later slot.

- If the government asked the two bidders to provide information about their valuations and allocated the resource without charge to whoever had the highest stated value (which is loosely analogous to the current slot allocation process for the pool), there would be an incentive for each bidder to overstate their value. There would still be no guarantee of efficient allocation.

Now, suppose that instead of the existing allocation procedures, the government conducts a simultaneous, multiple-round ascending bid auction for the rights to the two time slots. Each bidder wants just one slot. The most efficient Outcome I is necessarily the final outcome of the auction for the following reasons:

- Whenever the price of the 9-10am slot is no more than £2,000 higher than the price of the 8-9am slot, both bidders will prefer the 8-9am slot. Therefore, both bidders will bid on this slot, increasing its price relative to the 9-10am slot. In this case the auction will continue.

- Once the price difference exceeds £2,000, airline B will prefer the 9-10am slot and airline A will prefer the 8-9am slot. In this case there is just one bid on each lot and the auction will finish.

Thus, the auction process ensures an efficient outcome by revealing the fact that airline B has a lower valuation than airline A for the 8-9am slot.

The benefits of using a market-based mechanism to reveal information about bidders' absolute and relative valuations of resources applies in much more complicated settings than the example above, for example when there are large numbers of related lots. More complex allocation problems often require much more complex auction designs (and may not necessarily produce fully efficient outcomes). Nevertheless, carefully designed auctions can realise outcomes that are close to fully efficient, and certainly much more efficient that any administrative allocation procedure. Using appropriate experimental techniques, it is possible both to optimise auction designs and to demonstrate these high levels of efficiency. We discuss some of the general principles of optimal auction design in Annex 1.

4.3.2. TRANSPARENCY AND LEGAL CERTAINTY

By its very nature, administrative procedures require subjective judgments to be made about whom can best use a scarce resource under conditions of partial information. Therefore, such procedures are generally not transparent. Even if it is possible to codify the objectives for an administrative allocation procedure, and this process is open to public scrutiny, it may nevertheless be very difficult for a third party (e.g. a court) to verify whether these objectives have been pursued or not. This lack of objective verifiability creates opportunities for participants who are not satisfied by the outcome of an administrative allocation process to question or challenge it.

In general, auctions are more transparent and less open to challenge than administrative procedures, as it is possible largely to codify clear rules that deal with most eventualities prior to the auction. However, auctions and market mechanisms also dramatically reduce the *incentive* for parties to engage in activities aimed at influencing the outcome of the process, such as disputing the outcome after the event. Market mechanisms establish prices at which demand matches available supply. At these prices, unsuccessful parties would not wish to win.

In contrast, administrative allocation procedures generally set charges below opportunity cost leading to excess demand. The value to a party allocated the resource is likely significantly to exceed the cost, giving rise to a significant surplus if awarded the resource. This surplus can act as a strong incentive to engage in activities aimed at influencing the result of the allocation process, either ex-ante (e.g. lobbying activities) or ex-post (e.g. legal dispute of the result). Not only may such influence activities lead to disruption of the allocation process, but also they may be socially wasteful in themselves. In effect, there may be many parties 'competing' with each other to win a resource by means of influence activities, thereby dissipating any surplus they may enjoy from being granted the resource.[43]

4.3.3. EFFICIENCY AND REVENUE RAISING

Whilst the efficiency properties of auctions are generally acknowledged, the use of auction mechanisms is often criticised because it is regarded as an easy way for governments to raise revenues. However, we believe that such criticism is unfounded. More specifically, efficiency cannot be achieved without raising revenues, and the revenues raised are no more than the reflection of the market value associated with a scarce resource.

Efficient allocation requires setting prices such that there is no longer excess demand, thereby resolving conflicting demands on the use of resources. Market-based allocation systems generally produce efficient outcomes because prices reflect opportunity costs – i.e. the costs caused by using a resource in a particular way that precludes the other uses. In our hypothetical simultaneous, ascending bid auction, the 8-9am slot would sell to airline A for £2,000, while the 9-10am slot would be allocated to airline B without charge, as it is the only bidder. This is the opportunity cost of airline A acquiring the 8-9am slot, as B has to settle for the 9-10am slot and as a result has to give up £2,000 in profits.

This observation applies equally in the event that there is excess demand for both slots. For example, imagine that airline A and B each wanted both slots but with values unchanged from those in the original example (see Table 6). It this case,

[43] There are many examples of disputes over the outcome of administrative allocation procedures. We understand that ACL has faced repeated judicial reviews over its slot allocation decisions. Other notable examples are the award of the third mobile phone licence in Ireland, which was significantly delayed owing to legal action, and the recent award of the UK national lottery franchise.

there is no way of achieving a market-based allocation unless the price of the 8-9am slot is at least £5,000, as otherwise *both* users would want to use the slot. Whoever is the original owner of the resource will earn some revenues in a market-based system.

This does not imply that striving for efficiency is the same as maximising revenue. In our revised example, any market price between £5,000 and £9,000 for the 8-9am slot will yield an efficient allocation, but generate vastly different amounts of revenue. Our hypothetical auction would yield revenue of £5,000 – the smallest amount consistent with achieving efficient allocation. Although it is possible design auctions that extract more revenue under certain conditions (see our discussion in Annex 1), by and large achieving economic efficiency and maximising revenue are closely related.[44]

Following the recent series of auctions of third generation mobile telephony spectrum across Europe, some industry commentators have objected that auctions have been used a means of raising revenue for governments. However, this is to miss the point that spectrum auctions have largely been designed to achieve efficient allocations, of which revenue raising is a necessary consequence. EU governments generally did *not* use auction formats designed to extract maximum revenue from high value bidders (such as incumbent mobile phone operators), even though recent theoretical and experimental research has identified such auction designs.

Therefore, it is reasonable to conclude that, at least to date, the motivation behind the use of auctions by governments to allocate resources has been largely to ensure efficient allocation rather than to maximise revenues. Provided that economic efficiency is maintained as the overriding objective in the design of auction mechanisms, it is not reasonable to criticise the use of an auction because of the revenue it raises; this revenue is the minimum necessary to ensure efficient allocation.

Furthermore, where resources are scarce and support only a limited number of competitors in any downstream activity (i.e. any activity in which the use of the

[44] This is a highly technical issue. In simple theoretical models of auctions, there is often no distinction at all between economic efficiency and revenue maximisation - all efficient auction designs yield the maximum possible revenue (the so-called revenue equivalence theorem discussed in Annex 1) and so these two objectives are one and the same. However, in many practical examples the assumptions behind these theoretical conclusions are unreasonable, and there is distinction (or even a conflict) between economic efficiency and revenue maximisation.

resource is an input), the value placed by bidders on access to the resource is based on the supernormal profits they expect to earn. Even though the extent of retail competition will depend on the precise circumstances of the market,[45] it is possible that unavoidable scarcity of key inputs may result in muted competition. In this case, the revenue raised in an auction merely extracts supernormal profits that would otherwise accrue to the firms operating in the market. Competition *for* the market limits excess profits where competition *in* the market may be ineffective. If bidders anticipate that retail competition will be vigorous, they may expect not to earn any significant excess returns even without having to pay for the underlying resource. In this case, bidders' valuations of the resource in the auction (and thus prices) will be low.

Provided that economic efficiency remains the paramount goal when designing allocation mechanisms, there is little sense in which revenue raised can be seen as a 'tax'.

[45] For example, in some markets, competition may be vigorous even with a small number of players provided that each can expand their operations easily and gain customers at their competitors' expense (i.e. there are few barriers to expansion). In other situations, a small number of players could lead to oligopolistic outcomes, where market power is exercised and prices significantly exceed average cost. This is entirely dependent on the nature of competition and will vary from market to market.

5. DESIGN ISSUES FOR AIRPORT SLOT AUCTIONS

As we have discussed above, the allocation of airport slots is a complex problem that raises a number of specific challenges for auction design:

- *Multiple characteristics and endogenous capacity.* Airport slots comprise the right to use different resources (runway, terminal and stand capacity) in varying combinations. As each of the capacity constraints can bite, it is difficult to establish the number of available slots without knowing how particular slots will be used. For example, if all slots during a particular time period were to be used for large aircraft on busy routes, it may well be that terminal or stand capacity limits the number of slots available, but if some users were to deploy smaller aircraft, then runway capacity may be the binding constraint. This poses problems for the design of lots and the determination of highest bidders.

- *Interdependent valuations and synergies*. As the value of slots will ultimately depend on the revenues an airline can generate, and these in turn may depend on the airline's overall schedule, the value of any particular portfolio of slots may significantly exceed the sum of the individual valuations. Indeed, airlines may require a potentially large number of slots in order to be able to offer a commercially viable service.[46] This gives rise to aggregation risks: an airline may bid for a slot expecting to be able to acquire complementary slots, but may ultimately fail to do so. In this case, it may have bid too much for the slots it manages to acquire. Therefore, a key challenge in slot auction design is to ensure that airlines are able to win efficient combinations of slots and that the willingness of all airlines to participate in the auction is not compromised by aggregation risks.

- *International coordination requirements*. Airport slot allocation procedures need to take account of international coordination requirements. Airlines bidding for UK airport slots must be able to match these with corresponding slots at foreign airports, and for this reason, the design of any UK auction must be compatible with the IATA timetable for slot allocation.

[46] At a very basic level, an airline would require corresponding take-off and landing slots at a particular airport as there would otherwise be a problem with aircraft scheduling.

- *Promoting efficiency and social welfare.* As with spectrum auctions, the primary objective of an airport slot auction would be to promote social welfare by facilitating the most efficient use of a scarce resource. In both cases, there may be requirements for special rules to prevent companies from acquiring market power and to protect regional services.

In this section, we highlight issues that are specific to the allocation of airport slots and which would need to be addressed in the development of a bespoke auction process. The issues raised influence our suggestions for candidate auction designs for slots, which are developed in the next section.

5.1. MULTIPLE DIMENSIONS AND ENDOGENOUS CAPACITY

The multi-dimensionality of slots poses problems for the design of lots and the determination of highest bidders. This is perhaps best illustrated with a simple example. Assume that there are three bidders for slots in a particular time window. Assume further that these bidders want to operate different aircraft, which is reflected in the amount of terminal capacity that would be required by each bidder. Bids and capacity requirements for runway and terminal capacity are summarised in Table 6.

Table 6: Bids for multi-dimensional lots – a stylised example

	Bid amount	Runway capacity requirement	Terminal capacity requirement
Bidder A	200	1 unit	3 units
Bidder B	150	1 unit	2 units
Bidder C	100	1 unit	2 units

Assume that runway and terminal capacity available for this period is 2 units and 4 units respectively. This implies that, if bidder A were to win the auction, no further slot would be available for this period as terminal capacity would bind. On the other hand, both bidder B and C could be accommodated within the limits given by the available runway and terminal capacity. Moreover, the sum of bids offered by bidder B and C exceeds the sum offered by bidder A, and therefore B and C should be declared highest bidders even though neither of them has offered the highest amount. If, by contrast, bidder A were to bid 300, then it should be deemed to be highest bidder as the value it can generate exceeds the value that can be generated by B and C together, even if this implies that existing capacity is not fully utilised.

This example shows that:

- the available slot capacity is determined by the eventual use. If bidder A were to win the auction, only one slot could be offered. By contrast, if bidders B and C were to win, then two slots would be available.

- the notion of 'highest bids' has to be modified. Highest bids are those mutually consistent bids (i.e. those bids that could be satisfied within the given capacity limits) whose aggregate value is highest.

In practice, the issues resulting from the multi-dimensionality of the characteristics of slots and the endogeneity of available capacity will be much more complex than in this simple example. Nevertheless, it is possible to define an algorithm that selects the set of mutually consistent bids whose aggregate value is highest at any particular point in the auction, provided that each bid contains information about the specific capacity requirements associated with the intended use of the slot the bidder wishes to acquire. Moreover, in the current situation at UK airports, the algorithm would in most cases only need to address the issue of runway capacity, making the problem relatively simple. In any case, the burden of complexity would lie with the auctioneer rather than the bidders.

5.2. INTERDEPENDENT VALUATIONS AND SYNERGIES

Clearly runway, terminal and stand capacity are highly synergistic: if a carrier has rights to use only two of these three types of capacity at a particular time, it will be unable to make a traffic movement. If these three types of capacity were sold separately, this could create some risks for carriers. In particular, an offer for terminal capacity could be made on the basis of the expectation of obtaining a runway slot at a certain price. If that runway slot becomes more expensive than expected, the carrier could either find itself paying more than intended to get the combination of runway, stand and terminal, or else getting one or two but not all three usage rights. Synergies generate potentially significant risks for bidders and can sometimes lead to inefficient outcomes.

Synergies can also occur across slots. In order to provide frequent services on busy routes, airlines require multiple slots on the same day and/or in the same week. This creates possible aggregation risks across slots, as the price they are willing to pay for one particular slot may depend on whether or not they will succeed in acquiring other, complementary slots. For example, an airline may be able to target the lucrative business travellers only if it can offer services with a sufficient frequency to appeal to such time-sensitive passengers. Thus, the value that can be extracted from a portfolio of slots distributed across the day (and covering peak times) may be higher than the sum of the values that could be generated if this portfolio were split across a number of airlines, each of which could attract only more price-sensitive leisure travellers because of the reduced frequency.

However, if an airline fails to get one particular slot there are often many other slots that would be reasonable substitutes (e.g. in immediately adjacent time windows). Therefore, winning or losing one *particular* slot is unlikely to affect the value of other slots greatly providing there is an opportunity to purchase substitutes. Therefore, even though airlines may face economies of scale in terms of the number of slots they acquire and prefer a certain distribution through the week, there are unlikely to be strong synergies between *particular* slots.

For larger airlines, such as British Airways at Heathrow, any such aggregation risks across slots may be largely managed by swapping slots between routes. However, airlines with smaller operations at an airport may lack this degree of flexibility and may therefore be more exposed to aggregation risks across slots. Given that such airlines are important to the promotion of competition, it is important to ensure that their opportunity to expand onto new routes and innovate is not curtailed by such risks.

Auctions can be designed to reduce aggregation risks:

- ***Simultaneous, multi-round auctions rather than separate auctions.*** By auctioning related blocks simultaneously over multiple rounds in a unified process, it is possible for airlines to monitor aggregation risks and adjust their bidding strategy accordingly. By being able to pursue back-up strategies, aggregation risks across slots may be dramatically reduced. In contrast, running a sequence of auctions over time can lead to very substantial aggregation risks as bids must be made in one auction on the basis of expectations about what might happen in future auctions.

- ***Combinational bidding.*** Under this system, bidders submit bids for multiple combinations of lots rather than just individual lots. An algorithm is used by the auctioneer to determine which particular bids are accepted. Combinational bids are either accepted or rejected in their entirety, thus eliminating aggregation risk. This system will shortly be put into use by the US Federal Communications Commission for spectrum auctions. We consider the relative merits of such auctions in detail in section 6.2.3.

In addition, establishing an efficient and liquid secondary market will mitigate aggregation risks, as airlines may be able to rectify any situation in which they failed to acquire all of a set of synergistic slots, by appropriate selling or buying.

5.3. INTER-AIRPORT COORDINATION

5.3.1. FURTHER RISKS

An additional source of risks for airlines is the need to coordinate landing and departure slots between the airports at each end of the route. Risks of inefficient outcomes are particularly acute if both airports have substantial capacity constraints. For example:

- a carrier may obtain one slot without a matching slot at the other airport;
- slots may remain unsold if carriers are unsure of obtaining matching slots after the auction; or
- bidders may purchase several slots (if prices allow) to ensure that at least one matches.

It appears that the problem of coordinating slots at both ends of a route is common, as "*[m]ore than 90 per cent of all inter-continental air services originating or ending in Europe are concentrated in the continent's 33 largest airports*".[47] Many of Europe's largest airports are considered congested in some form.[48] Table 7 shows the percentage of flights to and from London airports that have a 'severely congested' airport at the other end of the route. For the purposes of this table, we define a severely congested airport as one where individual slot coordinators reported runway capacity to be fully or nearly fully subscribed over most of the operating day. A 1998 CAA report placed Barcelona, Brussels, Dusseldorf, Frankfurt, Madrid (Linate), and Paris (CDG) in this category.[49] On this basis, nearly one-third of flights from Heathrow arrive from or are destined for a severely congested airport.

[47] P Butterworth-Hayes, "The European Airport Maze", *Skyway*, Volume 3, Number 9, Spring 1998.

[48] See PriceWaterhouseCoopers, *Study of certain aspects of Council Regulation 95/93 on common rules for the allocation of slots at Community airports*, prepared for the European Commission, May 2000. Airports considered to have some form of constraint on slot availability are listed in Annex XVII of the report.

[49] Civil Aviation Authority, *The Single European Aviation Market: the first five years*, CAP685, June 1998. Paragraph 177.

Table 7: Proportion of flights between London and EU Congested Airports, Summer 1999

	Heathrow	Gatwick	Stansted	All
EU	30.6%	13.2%	16.7%	22.2%

Source: CAA Airport Statistics, reported by UK airports.
Airports considered constrained are based on the classification in CAA, *The Single European Aviation Market: the first five years*, CAP685, June 1998.

Using a looser definition of congestion and looking at flights to and from airports identified in a May 2000 PriceWaterhouseCoopers report as having some form of constraint (runway, terminal or stand)[50], the figure for such flights in or out of Heathrow rises to around 70 per cent.

At present, the use of grandfather rights in existing allocation systems worldwide tends to limit the amount of change from season to season, thereby simplifying the process of international coordination. Although this process is very inefficient, inertia is effective in facilitating international coordination. One risk created by using auctions, especially if grandfather rights were curtailed and the size of the pool of available slots in each period were substantially increased, is that the increased scope for changed patterns of slot holdings could undermine the ability of airlines to coordinate their schedules across airports within the existing IATA timetable. The complexity of coordination procedures and the scale of aggregation risks would be increased further if capacity-constrained airports outside the United Kingdom also decided to move to an auction system and curtailed grandfather rights.

As with aggregation risks between slots within airports, the potential coordination problems described above may be minimised through careful auction design. The use of simultaneous multi-round auctions, combinational bids, staggering slot allocation over a number of years and the development of efficient secondary markets could all help in this regard. Moreover, it should be noted that current allocation procedures are not themselves particularly sophisticated. The existing international system may well be able to cope with a greater rate of change by making use of computer-based optimisation techniques.

[50] PricewaterhouseCoopers, *Study of certain aspects of Council Regulation 95/93 on common rules for the allocation of slots at Community airports*, prepared for the European Commission, May 2000.

5.3.2. TIME CONSTRAINTS AND AUCTION COMPLEXITY

Under the current procedures, slot allocation is largely undertaken within a short time window between the completion of the previous season and the subsequent IATA conference. The current timetables are shown in Table 8.

Table 8: Current IATA schedules for slot allocation

Summer season (7 months, April – October)		Winter season (5 months, November - March)	
Discussions with airlines begin:	September	Discussions with airlines begin:	April
Deadline for requests from airlines:	Mid-October	Deadline for requests from airlines:	Mid-May
IATA Conference:	Early November	IATA Conference:	Early June

Changes to the date of the IATA conference would require international agreement, and may be viewed as undesirable by many airlines and airport authorities. Therefore, for the purposes of this study, we treat the conference date as an immovable deadline. Consequently, any revised allocation procedure must be capable of producing a fully coordinated timetable for the following season prior to the relevant IATA conference, without risk of delay.

IATA also sets separate deadlines in mid-October and mid-May for the receipt of requests by airlines for new slots and changed historics to their coordinators. However, in the event that an auction system was introduced, it is not clear that this deadline would necessarily have any continued relevance. Rather, we would propose that any auction be commenced at a date that allows sufficient time for the process to be completed before the relevant IATA conference.

This clearly raises the question how long an auction would take. The most important factor determining length is the type of auction being used. One-shot sealed bid auctions are typically much faster than multiple-round, ascending bid formats. An appeal by the coordinator for sealed bids would be the direct equivalent of the current system for seeking requests from airlines. It should therefore be possible to operate a sealed bid system without altering the existing deadline for requests.

With a multiple-round format, auction length is much less certain. Rather than a single deadline for bids, bidders must submit bids in successive rounds, with the likelihood that their bids will be successful increasing as the auction progresses. The auction would end when there are no new bids made.

It is difficult to predict exactly how many rounds it may take to complete a multi-round auction, as this depends largely on the number of lots available and the strategies deployed by bidders. Nevertheless, there is considerable scope for developing the rules of the auction to influence length. The following factors play a critical role in determining auction length:

- ***Reserve prices and minimum bid increments.*** The higher the initial level of reserve prices and larger the minimum bid increments, the sooner the auction is likely to be completed. For example, one reason why the Italian 3G auction was much shorter than the UK 3G auction (see Table 9) was the fact that reserve prices were set around 13 times higher. However, there is a potential trade off between the use of high reserve prices and/or large bid increments and the efficiency of the auction outcome. Reserve prices and bid increments must not be set so high that they constrain the ability of bidders to express their demands.

- ***Activity rules.*** In auctions where there are multiple lots and bidders can buy more than one lot, it is usual to set 'activity rules', in order to ensure a certain level of bid activity in every round. For example, activity rules have been used in US and Canadian spectrum auctions. To maintain eligibility to bid for an initially requested number of lots, bidders are required to make a number of bids equivalent to a proportion of this number. This percentage is increased in stages to 100% by the end of the auction. The higher the level that the percentage activity requirement is set and the earlier in the auction that it is tightened, the shorter the auction is likely to be. The main reason for not setting the activity level at 100% from the start of the auction is to reduce aggregation risks for bidders buying multiple lots.

- ***The length and frequency of rounds***. The shorter the length of rounds and the greater the number of rounds per day the faster the auction will be. The main limiting factors on minimising round length and maximising frequency are the need to give bidders sufficient time to make decisions and the auctioneer sufficient time to run the auction smoothly. In general, most auctions start with relatively long rounds but steadily increase the pace as bidders become more familiar with the auction format and declining bid activity reduces the complexity of decision making. Extensive bidder training would obviously reduce the need for a slow start, and the repeated use of the same auction format would eliminate this need over time.

- ***Provision for a final round.*** Some auctions – for example the forthcoming Canadian PCS auction – include provision for the auctioneer to declare a final round, using sealed bids, in exceptional circumstances. There is no expectation that this option would need to be exercised. However, by including a similar provision in the design of an auction for airport slots, the risk that an auction could overrun the IATA deadline could be eliminated.

Table 9 provides examples of average round lengths and frequencies for recent spectrum auctions. Even complex auctions involving many lots, such as those for US PCS spectrum, have worked with round lengths reduced to as little as 15 minutes and eight or more rounds per day.

It should, therefore, be possible to run an effective auction even for *all* slots at a single airport within a timescale of a few weeks. However, for practical purposes, it may be desirable to phase in an auction format gradually, starting initially with only those slots that form part of the existing pool. In the event that it is decided to reclaim grandfather rights, these need not necessarily be added to the auction pool in one go, but could be introduced in proportionate chunks over a number of years. On the assumption that auctions for airline slots would be regular events, perhaps taking place twice a year under a consistent format, it is reasonable to suppose that bidders would quickly become quite sophisticated and capable of handling a fast-paced auction.

Table 9: Auction and average round length for selected spectrum auctions worldwide, 1999-2000

Auction	Length of auction	No. of lots	No. of rounds	Average no. of rounds per day	Length of rounds (decision time only)
Canadian 24 & 38GHz Oct 1999	24 days	354	117	5 (peak 8)	30-120 mins
Dutch 3G July 2000	13 days	5	305	23 (peak 30)	Often 20 mins
German 3G August 2000	14 days	12	173	6 (peak 15)	20-45 mins
Italian 3G Oct 2000	3 days	5	11	4 (peak 6)	30 mins
New Zealand 3G July 2000	129 days	1,036	415	4 (peak 4)	30 mins
UK 3G March 2000	39 days	42	150	4 (peak 6)	20-60 mins
UK WLL Nov 2000	7 days	5	21	3 (peak 7)	5-70 mins
US PCS (C, D, E & F blocks) March 1999	18 days	347	78	4 (peak 8)	15-60 mins
US PCS (C & F blocks) Dec 2000	20 days (still going)*	422	67*	4 (peak 6)	15-60 mins

*as at 18 January 2001.

5.4. MARKET POWER

Where competition in air services markets is effective, a particular airline's willingness to pay for a slot will reflect the net social benefit that can be derived from its use. In this case, market-based mechanisms will lead to efficient allocation of slots. However, where competition is currently not fully effective, an airline's valuation of slots may include the private benefit of protecting current market power. Even if competition is *currently* effective, it is possible that by buying a sufficient number of slots at certain times of day an operator might anticipate gaining some market power, and any anticipated excess profits from this would be reflected in the amount that operator an would be prepared to pay for those slots.

In particular, because the supply of slots is limited, there is a risk that any allocation mechanism that is based exclusively on the airlines' willingness to pay for slots will allow operators to create or protect a position of market power. This would be done by using expected excess profits from a restriction of competition to acquire slots so as to keep out or disadvantage competitors. Therefore, an unrestricted market mechanism may lead to increased concentration, ineffective retail competition and inefficient allocation of slots as operators with current or anticipated market power will be prepared to pay more for slots than will similarly efficient operators who do not have or anticipate having market power. This is a problem for both the use of auctions and with secondary markets, irrespective of whether air services markets are *currently* competitive or not.

Regarding route-by-route dominance, under a market-based system, even if one operator buys a large share of the available slots, this does not necessarily eliminate competition on *any particular route*. In particular, as a slot can be used for any route (subject to international agreements on the numbers of operators and flights permitted on certain routes), it may still be possible for competitors to switch resources (including slots) from other routes in response to excessive pricing on one particular route. In this case, buying surplus slots cannot be used as a means of blockading *individual* routes to entry.

However, in other cases, international agreements may provide a limit on the number of operators on a route (e.g. between the United Kingdom and the United States).[51] As a result, it may not be possible for further new operators to enter a route. In this case, competitive conditions are determined *entirely* by the ability of existing operators on the route to expand and win passengers from other operators. However, their expansion prospects may be limited by the availability of slots at appropriate times, for example as with Virgin Atlantic between the United States and United Kingdom. In these circumstances, a large carrier buying slots to prevent expansion by an existing competitor could diminish competition even on a specific point-to-point route.

[51] This issue only arises where the origin or destination of the flight lies outside the EU.

A carrier with hub dominance may be able to attain route dominance for the more valuable business travellers because, "[they] *are likely to be more time and destination sensitive, but not as price sensitive as leisure passengers*".[52] Furthermore, for frequent travellers, the existence of loyalty schemes may lead to a preference for the largest carrier at that hub even for non-connecting flights.

In conclusion, there are mechanisms by which a carrier could diminish competition and attain market power by purchasing slots, including:

- establishing a strong position at a hub, leading to reduced intra-hub competition and differentiation from weaker rivals at the same hub; and

- where new entry on a specific point-to-point route is prohibited by international treaty, frustrating expansion by existing competitors on that route.

Furthermore, where a carrier has existing market power at a hub (even if short of dominance in the strict sense of competition law) this may distort the efficient allocation of slots, especially if some slots are to remain grandfathered and it is feasible to frustrate entry by purchasing a relatively small number of slots.

In Annex 2, we show the current shares of passengers at all the London airports for the summer season 1999. It can be seen that a significant proportion of passenger volumes are concentrated amongst just a few airlines at each airport. Although these statistics are not sufficient in themselves to conclude that substantial market power or even dominance is *currently* being exercised, they do indicate that there are a number of airlines whose current positions are sufficiently strong that without appropriate constraints there is a concern that they might be able to concentrate holdings of slots to the potential detriment of competition.[53]

In the case study below, we examine the US experience of allowing trading in slots at four major hub airports. Care must be taken as the US market is more analogous to the European market as a whole rather than just the UK market in

[52] Competition Commission, *British Airways Plc and CityFlyer Express Limited*, A report on the proposed merger, July 1999.

[53] A number of airline mergers and alliances have been blocked on competition grounds as this would lead to an unacceptable concentration of slots. Therefore, there is little doubt that there are commercial incentives for concentration that would be expressed in any market for slots and, on the basis of these blocked mergers, be detrimental for consumers.

isolation.[54] It is observed that trading has been associated with a marked increase in concentration in slot ownership, which in turn has raised concern that new entrants have been disadvantaged. This evidence supports the conclusion that a slot allocation mechanism that is purely based on the willingness to pay may not result in an optimal outcome unless incentives to protect and gain market power are addressed as an integral part of the market design. This applies to both the primary allocation of slots by auction and any mechanism of secondary trading.

Case Study: Using secondary trading to extend market power – the US experience

The experience of the United States, where a secondary market for airport slots has existed since 1986 for four 'high-density' airports – O'Hare, National, JFK and La Guardia – confirms that introducing market mechanisms for slots can lead to increases in concentration unless appropriate regulatory steps are taken. Market power held by the largest airlines increased to such an extent that legislation to protect new entrants was introduced.

The US Buy-Sell rule allows the sale, purchase and trading of airport slots by both airlines and other parties at designated airports. Upon implementation in 1986, airlines were allocated their existing slot holdings with grandfather rights. Since then, slot trading has resulted in a significant increase in the proportion of slots held by the largest 2-3 airline operators at each airport. For example, by 1994, the number of airlines holding commuter slots had fallen to three, down from eight in 1986.[55] There has also been a rapid rise in the prices paid for slots. A 1990 US

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[54] The scope for comparisons between the US and UK markets is constrained owing to the very different sizes of the markets, their different orientations towards domestic and international traffic and the fact that neither country permits cabotage (the right of an airline to carry traffic between two points within the territory of a foreign state). In general, comparisons between the US and EU market are more valid, although these too are complicated by the very different degrees of liberalisation and types of regulation. The US domestic market was liberalised in the mid-1970s, with all economic regulation of airlines overseen by the Civil Aeronautics Board. Liberalisation of the EU air transport market began much later and has taken place more gradually [November 1990: Regulation 2343/90 on market access and air fares; January 1993: Regulation 2407/92 on the licensing of air carriers, market access and fares; and January 1998: Regulation 3975/87 on the application competition rules to air transport (see Button, K, Haynes, K and Stough, R, Flying into the Future – Air Transport Policy in the European Union, 1998 for more information)]. In addition, there is no EU equivalent of the US single regulatory body; the development of new EU-wide regulations on airlines tends to take longer than in the United States and the pace of implementation may be uneven.

[55] P S Dempsey, *Airport Monopolization: Barriers to Entry and Impediments to Competition*, Testimony before The US House of Representatives Committee on the Judiciary, Hearings on The State of Competition in the Airline Industry, June 14, 2000.

Department of Transport report found that the average value of a slot across the four airports was US$850,000.[56] By 1996, slots were being traded for up to US$2 million each.[57]

Table 10 illustrates the substantial increase in concentration of airport slots under the control of various groups for O'Hare and La Guardia airports. Similar trends have been observed at JFK and Washington National.[58]

Table 10: Percentage of domestic air carrier slots held by selected groups at two US airports

Airport/holding entity	Jan 1986	June 1996
O'Hare (Chicago)		
American and United	66%	87%
Other established airlines	28%	9%
Other owners	6%	3%
La Guardia		
American, Delta, and USAir	27%	64%
Other established airlines	58%	14%
Other owners	15%	22%

Source: GAO's analysis of data from FAA's Slot Administration Office, GAO Report, Airline Deregulation: Barriers to Entry Continue to Limit Competition in Several Key Domestic Markets, (Letter Report, 18 October 1996, GAO/RCED-97-4).

In 1996, a report to Congress by the General Accounting Office (GAO) found that the system of slot trading deterred entry at key airports to such an extent that they recommended the withdrawal of slots from incumbents to create a pool of slots for new entrants.[59] Another unofficial report noted that large carriers were reluctant

[56] Secretary's Task Force on Competition in the U.S. Domestic Airline Industry, Airports, Air Traffic Control, and Related Concerns, 1990 (quoted in Dempsay, *op. cit.*, footnote 42).

[57] Ibid.

[58] GAO Report, *Airline Deregulation: Barriers to Entry Continue to Limit Competition in Several Key Domestic Markets*, (Letter Report, 18 October 1996, GAO/RCED-97-4).

[59] Ibid.

to sell slots to new entrants, and often parked their excess slots with affiliated airlines or code-sharers in order to keep them from being confiscated owing to lack of usage and passed to their competitors.[60]

New legislation – the AIR-21 Act – was introduced in April 2000, with the eventual aim of phasing out slot controls, increasing airline competition and enhancing service provision to smaller communities. However, new rules at La Guardia proved unworkable, as the extra slots needed to accommodate new entry alongside existing grandfather rights led to unacceptable congestion and delays. At the time of writing, a permanent regulatory solution is yet to be agreed.

5.5. SAFEGUARDING REGIONAL ROUTES

At present there is no formal reservation of capacity for UK flight services with social priority at the London airports. The intrinsic inertia of the current allocation system may to some extent protect marginal services to UK regions from being displaced by higher value commercial services to the extent that carriers who have little opportunity to re-deploy their slots on commercially more attractive routes provide them. Auctioning slots may expose some of these routes to competition that is at present suppressed by the grandfathering system. However, the main threat to regional routes at present may result from the fact that operators serving such routes are unable to acquire additional slots to launch new services and may therefore decide to cease serving those routes. A fully functioning market may make it easier for operators to expand their portfolio by extending their slot holdings, and hence may reduce pressure on domestic feeder routes.

In any case, although from an airport efficiency perspective, it may be optimal to allow some of these services to be discontinued (or relocated to less capacity constrained airports, e.g. from Heathrow to Luton), this may be undesirable for social welfare or political reasons.

The typical methods employed by governments worldwide to support marginal regional routes are a combination of reserved slots and subsidies. The use of reserved slots is the most distorting in terms of economic efficiency. This is especially true in relation to an auction format where the number of slots is not pre-established but determined by the auction. In this case, introducing pre-

[60] See E Gleimer, “Slot Regulation At High Density Airports; How Did We Get Here and Where Are We Going?” *Journal of Air Law and Commerce*, Vol. 61, 1996.

determined reserved slots can introduce rigidities in the auction process that may result in an inefficient combination of flights over the relevant time period.

Subsidies are much less disruptive, as they create greater flexibility to fit regional flights into reasonably efficient slots in relation to capacity constraints. However, it is very difficult for central governments to estimate what level of subsidies may be required to enable a particular service. An alternative way of encouraging regional services may be to allow local/regional bodies to buy slots themselves or to bid in cooperation with partner airlines. This method has the advantage of forcing regions to face the true cost of their access and the differential in cost between access to Heathrow, Gatwick and any other London airport.

6. PROPOSALS FOR AN AIRPORT SLOT AUCTION

Despite the complexity of allocating runway slots, there are workable auction designs that could yield significant efficiency benefits compared with existing procedures. In this section, we consider a number of candidate auction designs that can address the issues of:

- inter-related types of capacity (runways, stands and terminals);
- the need of airlines to manage portfolios of slots that may substitute or complement one another;
- current and potential market power;
- complexity; and
- the need to integrate with international arrangements for scheduling.

Throughout we assume that the primary objective of an auction would be to produce an efficient allocation rather than raising revenue per se. Slots should be allocated to the carrier prepared to pay most, provided that this is consistent with effective competition in the various air services markets.

Given that a large number of slots may need to be allocated simultaneously, it is important to ensure that the auction design is not overly complex. This would be particularly important if grandfather rights were curtailed, and therefore the number of slots in play at each biannual scheduling round increased considerably. In this case, it is important to try to make the auction as simple as possible for *bidders*, even if this raises complications for the body charged with running the auction.

Even if there is a well-designed auction system running biannually, there is an important role for a formal secondary market. Any such market would also require rules to prevent the establishment or reinforcement of market power.

6.1. DESIGN OF LOTS

The first step in designing any market mechanism is to consider how rights to use airport capacity should be defined. Within an auction, these packages of usage rights would form the lots on which bids would be made.

6.1.1. TIME WINDOWS

Under the current slot allocation system run by ACL, each slot is allocated a 15-minute 'on-off stand time' – a 'time window' during which the aircraft is scheduled to leave or arrive at its stand.[61] Once off the stand, takeoff time is determined by air traffic control. In practice, an actual air movement may not occur within its slot owing to delays or unforeseen circumstances. However, operators who frequently fail to make air movements within their allotted time window face penalties, including ultimately confiscation of the slot. ACL considers the feasibility of air movements with regard to available runway, stand and terminal capacity on the basis of these 15-minute time windows. Multiple traffic movements are possible within each window.

Given that runway availability is by far the most frequent constraint on scheduling air movements, 'time windows' for runway use should be the primary mechanism for differentiating between lots in an auction. As the number of available air movements is not predetermined but varies according to the capacity requirements and flight routes requested by airlines, it is not appropriate to treat each individual air movement as a lot in an auction. Moreover, this would lead to a very great number of lots. Rather, we recommend defining each 'time window' as the basic unit of a lot. For any one lot (i.e. time window), there would be multiple winners of slots corresponding to the number of traffic movements possible within the time window.

Within any particular time window, the scheduling of air traffic would be a matter for air traffic controllers and airport authorities in order to optimise the use of runways in a non-discriminatory manner without particular favour or disfavour to any particular operator. Therefore, all slots available for a particular time window would be *identical* for the purposes of the auction.

In order to limit the potential complexity of the auction, it is desirable not to generate too many lots. Too large a number of lots could create difficulties for bidders in formulating and executing a bid strategy and could possibly even make it difficult to complete an auction within a reasonable time. The number of lots based on time windows can be controlled in two ways:

- *Altering the length of time window.* Using existing 15-minute time windows, there would be 68 lots per day at Heathrow, based on

[61] Interview with Peter Morrisroe, ACL.

the current hours of operation from 5am to 10pm GMT. By extending the length of a time window to 30 minutes and giving air traffic control greater discretion to schedule within those time windows, the number of lots per day could be halved. The relationships between the length of time windows and number of lots for Heathrow's summer season is illustrated in Table 11.

- *Defining repeat usage rights.* A time window could define the right to use a slot on a specific day or on more than one day. Auctioning slots for specific days for a whole season may be impractical, as it would require too many lots. For example, using 30 minute, day specific time windows, there would be over 14,500 lots for Heathrow's summer season. By contrast, if each time window implied usage rights for every day of a season, there would be only 34 lots. More realistically, auctioning slots with usage rights specific to a day of the week throughout a season would result in 238 lots at Heathrow, based on 30-minute time windows. Although this is a substantial number of lots, auctions have been run with similar or greater numbers of lots.[62]

At present, operators can request a slot for a particular time and day of the week from ACL for just part of a scheduling season. A system of auctioning only whole season rights could, therefore, disadvantage operators wanting slots for part-seasons. A solution would be for the primary biannual auction to allocate rights to use slots for whole seasons, with part-season usage being traded on the secondary market. However, this would still involve risk for part-season operators: they would either need to secure a slot for a whole season in the auction and sell unused weeks in the secondary market, or else rely on being able to buy slots for part of a season in the secondary market. Nevertheless, given that ACL already gives priority to requests for slots for a whole season, it is unlikely that part season operators – who will typically be smaller airlines or charter operators – would be significantly disadvantaged relative to the current system.

Moreover, auctioning only whole seasons does not raise any material competition concerns. As we have already discussed, the primary competitive constraint on large airline operators with market power is not small entrants, but rather medium-size operators who can offer similar flight frequencies. Expansion or entry by such medium-size operators is unlikely to be hampered by slots only

[62] For example, in spectrum auctions in both the United States and New Zealand.

being available in whole season packages. Rather, the priority for auction design should be workable allocation of whole season rights.

Changing the number of *slots* to be allocated would not affect the number of *lots*.[63] For example, even if short-term usage rights with staggered starting dates replaced grandfather rights, only a proportion of slots would be available each season. This would mean that, in any particular year, only a fraction of the available stock of slots in each time window would come up for auction. The shorter the time period used and/or the lower the proportion of slots auctioned at any one time, the lower the number of slots per lot available in that auction. In Table 11, we show the impact of moving from an auction of all slots at Heathrow to one with only one-third or one-quarter of slots for different time windows. A substantial advantage of this arrangement is that it allows the same auction system to be used regardless of the size of the pool of slots to be allocated. There would be no need to change the structure of the auction or the number of lots available if at some later date either new airport capacity or the ending of grandfather rights increased the size of the pool. Therefore, this lot design would allow phased implementation of a variety of possible slot allocation reforms.

[63] This is true unless no slots at all were available for a particular time window, in which case the corresponding lot could be dropped from the auction.

Table 11: Number of slots available and number of lots, for various lengths of time window and usage right combinations at Heathrow

			All slots in a season			
Length of time window	**Time windows per day**	**Time windows per week**	**Total number of daily slots sold**	**Av. no. of slots sold per lot**	**Max. no. of slots per time window**	**Min. no. of slots per time window**
1 hour	17	119	1,334	78.5	85	48
30 mins	34	238	1,334	39.3	43	24
20 mins	51	357	1,334	26.2	28	16
15 mins	68	476	1,334	19.7	22	12

	One-third of slots in a season					One-quarter of slots in a season				
Length of time window	**No. of different lots**	**Total number of daily slots sold**	**Av. no. of slots sold per lot**	**Max. no. of slots per time window**	**Min. no. of slots per time window**	**No. of different lots**	**Total number of daily slots sold**	**Av. no. of slots sold per lot**	**Max. no. of slots per time window**	**Min. no. of slots per time window**
1 hour	119	445	26.2	27-28	16	119	334	19.6	21-22	12
30 mins	238	445	13.1	14-15	8	238	334	9.8	10-11	6
20 mins	357	445	8.7	9-10	5-6	357	334	6.6	7	4

15 mins	476	445	6.6	7-8	4	476	334	4.9	5-6	3

Note: Based on actual data provided by ACL on capacity for Heathrow Summer season 2000 for the 17-hour period 06:00 to 23:00.

6.1.2. WHAT CAPACITY USAGE RIGHTS SHOULD BE INCLUDED WITHIN A LOT?

Any air movement requires access to three types of capacity: runways, stands and terminals. Although not of primary importance at present, these terminal and stand constraints are considered by ACL's current allocation procedures and to omit them from an auction mechanism would arguably be a retrograde step, leading to some inefficiency. Stand capacity bites at London City airport, and terminal capacity can act as a constraint during peak hours. Moreover, it is conceivable that stand and terminal constraints could become more important – such as on the introduction of larger aircraft. For this reason, we consider auction mechanisms that are able to deal with the most difficult case of all three types of capacity being potentially scarce; these mechanisms could be simplified if terminal capacity or stand scarcity were unimportant. Conversely, the auction mechanism could be extended to deal with the issue of noise emission, which may become increasingly important as constraints on the size of noise contours may begin to bite at a number of UK airports.

Unfortunately, it is not possible to bundle a right to use a stand and a *fixed* amount of terminal capacity along with a landing or take-off slot, as different sizes of aircraft and types of service will have different stand and passenger handling requirements associated with a landing or take-off movement. There are two main approaches to solving this problem:

- ***Separate markets for terminal and stand capacity.*** A slot could provide a *minimum* entitlement to use capacity, with an operator required to purchase additional terminal capacity or the right to use a stand in separate *ancillary services* markets. These ancillary services could be sold either alongside the main auction of slots, or else subsequent to the main auction.

- ***A single market for flexible bundles.*** An auction format could be used where an airline would make a bid that specified not only what it would be prepared to pay to use a particular runway slot at a particular time, but also provided information that could be used to determine its stand and terminal capacity requirements. In essence, any bid for a runway slot would have multiple dimensions that would need to be considered by the auctioneer when

> determining which bids for a particular runway slot were the winning bids.[64]
>
> For example, suppose that five slots were available within a particular half-hour window. Bids had been received for this time slot, but the five highest bids had total terminal and stand requirements that could not be met. Then, rather than simply taking the highest five bids, the auctioneer would select five feasible bids that met the terminal and stand capacity constraints and had the *greatest* possible value amongst all such feasible bids. We explain this procedure in more detail in section 6.2.2.

The principal benefit of using separate ancillary services markets is that the auction of slots can be simplified *for the auctioneer* in the sense that a 'bid' is simply a statement of willingness to pay for the right to take-off or land at a particular time. In this case, the auctioneer need only select the highest bids. In contrast, using an auction format in which bids had multiple dimensions (financial, and intended use) is somewhat less transparent and more complex for the auctioneer, as winners are determined by an algorithm used by the auctioneer, rather than by simply taking highest bids.

However, using separate ancillary services markets is more complex and riskier for bidders. It would be necessary for bidders to bid not just for slots, but also for matching ancillary services. If auctions for slots and ancillary services were run in parallel, there would be a very large number of lots. Bidders would also face the risk of acquiring either a slot or ancillary services but not both (which would be even more severe if auctions for ancillary services were held after the primary slot auction). This could lead to bidders either not being able to use as large an aircraft as they might wish, or else holding a scarce right to use stand or terminal capacity without any matching right to land or take-off. This is particularly concerning for economic efficiency, as slots where terminals or stands are also scarce will fall primarily at peak times and have high value; failing to use such slots efficiently will entail significant social losses.

This form of inefficiency can be entirely avoided by combining bids for runway, terminal and stand capacity, and using an algorithm within the auction mechanism to ensure that terminal and stand capacity constraints are respected where they are relevant. Operators would only be allocated usable combinations of runway,

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[64] Here we use the term 'winning' loosely, as algorithms such as this could be used in a multiple round auction to determine the current highest bidders at the end of each intermediate round.

terminal and stand capacity.[65] For this reason, we strongly recommend a single integrated auction mechanism with flexible bundling of all necessary capacity. Although this complicates implementation of the auction, it simplifies construction and execution of bid strategies and should lead to more economically efficient outcomes.

In order to implement such as system, carriers would need to provide with their bid sufficient information to allow the auctioneer to determine the demands they would make on terminal and stand capacity. In addition, information would also be needed to allow the auctioneer to determine the demands that particular planned usage of a slot would make on runway capacity. Given this information, the auctioneer can determine whether available capacity can offer an acceptable quality of service.

Runway capacity is not a constant, as the number of feasible movements depends on aircraft separations required by the traffic mix. As we have already discussed, the current slot allocation system is one in which there is considerable inertia and therefore the traffic mix at a particular time remains similar from season to season. Therefore, it is sufficient to adjust estimates of available runway capacity from hour to hour on the basis of historic traffic patterns. By doing this, it is possible to ensure that maximum utilisation is made of runways.

However, in an auction system, there is a much greater possibility of the traffic mix in any given hour changing appreciably from the previous season, particularly if a significant proportion of the entire stock of slots is auctioned in one go. Therefore, the current method of estimating runway capacity hour-by-hour given the historic traffic mix is unlikely to be successful. Instead, it would be necessary to determine available runway capacity endogenously within the auction system. In particular, if operators are required to nominate how they intend to use a given slot, it is possible to calculate a runway's maximum throughput given that implied traffic mix. Rather than necessarily making a fixed number of identical slots available at a given time, the auctioneer can vary the number of winners of a lot to optimise the use of runway capacity. We discuss this in further detail below when considering possible auction designs.

[65] In effect, we are proposing a form of combinational auction in which bidders submit combined bids for a runway slot, stand and terminal capacity. In general, combinational auctions are considered to have some advantages in auctioning items where there are strong synergies, as bidders need not face the risk of bidding for a synergistic combination of items, but failing to get all of them. This issue is discussed in more detail in the annex on auction design.

To operate such a system, a bid for a particular lot (i.e. time window) would need to consist of both a financial offer and a nomination of various *usage factors* that would effect how the carriers proposed usage of a slot impacted on runway, terminal and stand capacity. These nominated usage factors could include:

- whether the time would be used for take-off or landing[66];
- the size category of aircraft, which is important for ensuring sufficient separation of landing aircraft and determining stand requirements. At present, National Air Traffic Services (NATS) uses five main aircraft weight categories for arrivals, and both weight and route categories for departures.[67] Such category nomination might remain appropriate for the purposes of an auction.[68] NATS would then, as now, determine the order of departures based on the aircraft mix waiting to take off;
- the routing direction for taking-off aircraft, which affects runway capacity for take-offs;
- preference for terminal (if any); and
- a maximum passenger load factor, which affects use of terminal facilities and would be chosen from a small number of categories. Load factors vary significantly between charter and scheduled services and, to a lesser degree, between national, short-haul and long-haul routes. Again, this could be done by means of choosing one of a small number of bands.

[66] At airports with single mode runways we could equally well have one set of lots for take-offs and another for landings. However, by taking take-off or landing as a 'usage factor' we can deal with possibility that at a mixed-mode airport, it may be optimal to forgo some of the benefits of mixed-mode operation and switch to landing only or take-off only for short periods if carriers' willingness to pay for such an arrangement is sufficient to outweigh any loss in runway efficiency.

[67] NATS provides air traffic control at Heathrow, Gatwick and Stansted airports, as well as some regional UK airports. NATS uses categories based on aircraft weight to determine the separation distance of *arrivals*, measured in nautical miles. *Departure* separations are based primarily on the route taken – a northerly or southerly departure – with weight being of secondary importance. Departure separations are expressed in terms of time (minutes).

[68] To the extent that these categories do not capture differences in the size of the aircrafts' wingspan, which is a main determinant of stand requirements, modifications to the classification may be necessary.

If a carrier wins a lot, this would convey the right to make an air movement within a particular time window for a number of consecutive summer or winter seasons, within the usage limits established by its bid. As we discuss later, it would be possible for a carrier to nominate multiple usage categories, thereby giving itself the right to use a lot flexibly if it won it.

Given that stand and terminal capacity are currently often not scarce, it is possible that the winners of a particular lot (i.e. the carriers permitted to make movements within that time window) might be able to change aircraft size or increase passenger loading without exhausting available capacity. In this case, any surplus capacity (of whatever) type would remain available to carriers on a first come first served basis after the auction. When a change of use request did not lead to capacity limits being exceeding, it would be permitted.

6.1.3. USE IT OR LOSE IT

At present, operators are under a 'use it or lose it' obligation. The current grandfathering regime creates strong incentives for operators to try to retain slots where possible, even to the extent of 'babysitting' them by using the slot to fly loss-making small aircraft. Under an auction system, the incentives to retain unnecessary slots are much reduced, as:

- there is a financial cost to acquiring that slot; and
- even if a slot is given up, it may be possible to regain it later either in an auction or on the secondary market.

These factors reduce the need for a 'use it or lose it' obligation. In particular, if competition in air services is effective, there is *no* need for such an obligation at all as an operator who had no use for a slot would have an incentive to sell it in the secondary market or lease it on a short-term basis. As discussed in Section 4.2.2, strict 'use it or lose it' may prevent smaller operators from acquiring slots to maintain options to expand services and thus constitute a barrier to expansion.

However, this conclusion may change if competition is not effective. In particular, an operator with market power may have an incentive to hoard unused slots in order to deter entry through two possible means:

- Hoarding attractive slots may blockade an entrant who may then be unable to operate a sufficiently frequent and attractive timetable.
- An operator with market power may hold unused slots to provide the option of responding rapidly to any entry by cutting prices and/or boosting frequency. The threat of such a response may act as an entry deterrent in its own right.

Thus, there may still be value in maintaining such an obligation for the purpose of limiting any possible abuse of market power. However, this is best achieved by triggering the obligation *only* for operators who have a sufficiently large share of slots. Applying such an obligation indiscriminately could actual undermine, rather than enhance, competition.

6.1.4. PENALITIES FOR SLOT MISUSE

Under any system with economic pricing of slots, there may be significant price differentials between peak and off-peak slots. This may give rise to financial incentives to misuse slots by systematically and repeatedly:

- landing or taking off at a time other than allotted by the lot; or
- using the slot other than as nominated in the winning bid, for example by flying a larger aircraft than applied for.

Exceeding the rights to use capacity implied by a particular slot may be considered by airlines as an alternative to acquiring a more expensive peak-time slot, or paying more for a different aircraft type or a higher passenger number limit. Therefore, it is essential that such misuse is monitored and there are appropriate penalties to provide sufficient disincentive for such behaviour. For example, the penalty for using a slot other than at the scheduled time needs to be sufficiently large relative to the differential between the prices of peak and off-peak slots.

In practice there may be occasional exceptional circumstances that mean that operators cannot use a slot in the planned manner. Therefore, penalties should only be triggered once slot misuse reaches a certain frequency. Under the present system, airlines face the prospect of a slot being confiscated if they repeatedly fail to use it at the allotted time. However, this is unlikely to be a credible threat for minor infractions. Therefore, in order to maintain strong incentives for proper use of slots, there would need to be a proportionate and credible escalation path for fines depending on the frequency and severity of misuse.

6.1.5. DURATION OF USAGE RIGHTS

The number of seasons over which the winner of a lot would have a usage right is an important design parameter. The main effect of the duration of a slot is on the size of the pool of slots to be allocated. In order to give carriers sufficient opportunity to expand and rearrange their services without undue delay, it is important that a sufficient number of slots be allocated each year. This could be achieved by using relative short durations.

It is neither necessary nor desirable to auction off all slots at the same time. Rather, some form of rolling auction process, in which a substantial proportion of slots are auctioned off each season, is preferable. This would ensure that there is always scope for new entry and expansion, while also making coordination easier by limiting the need to change all schedules each season. For example, a duration of 3 to 5 years would lead to 20% to 33% of the total stock of available slots being reallocated each season, which would permit extensive changes.

Duration has other important effects. Longer durations will increase the value of slots. A very long duration may be a concern if it leads to prices at a level at which new entrants could face difficulties or disadvantages in raising finance to fund slot acquisition. Furthermore, longer durations make the value of slots considerably more uncertain, as it is necessary to make longer-range forecasts of market conditions in order to estimate their value. As we discuss in section 6.2.1, there are adverse consequences that follow from bidders being very uncertain about the value of slots and the efficiency of an auction may as a result be reduced.[69] This also increases the risk of carriers overpaying for slots, which could affect the potential viability of small carriers. These reasons suggest that short durations are likely to be more appropriate.

Some carriers have argued that short-term usage rights for slots could reduce investment incentives, leading to fewer new services. However, there is little reason to expect this. Consider the contrasting example of radio spectrum licences. These are typically long licences (15-20 years) in order to give operators sufficient incentive to invest in telecommunications networks, as clearly it is not possible to continue operating a network without a corresponding radio spectrum licence. However, the situation in the airline sector is entirely different:

- Any particular slot is fungible across many routes, and so continued operations do not depend on continued usage of a particular slot. In the event that a usage right terminates, a carrier would have a wide choice of alternative slots it could acquire to maintain a similar service.

- Very little investment is predicated on having the right to use *particular* slots. The only investment that is obviously slot-specific is marketing associated with timetables.

- In any case, a much smaller proportion of investment is sunk (i.e. its value unrecoverable if operations cease) than in the telecoms example. Aircraft are often leased and there are alternative users of

[69] In auction theory, this is known as the 'winner's curse'. For further explanation of this concept, see Annex 1.

other infrastructure. Thus, the minimum time period for profitable operation of a route is relatively short.

Therefore, there is little apparent need to give lengthy tenures for slots in order to encourage investment in new or expanded services.

It is beyond the scope of this report to suggest an exact duration for slot usage rights. From a practical perspective, a duration of 3-6 years would ensure that a sufficient number of slots would be reallocated each season to promote competition and give flexibility for operators to expand and change their routes, and might therefore be an appropriate starting point. It would also appear to be a sufficient period for operators to earn a reasonable return on new routes, though this should not be an overriding concern given that it would be relatively easy for carriers to continue similar operations on a route by replacing expiring slots with new ones. Further work would be required in order to determine the optimal duration for slot usage rights.

6.2. THE AUCTION MECHANISM

There are a number of auction designs that are feasible for use in allocating airport slots. In this section, we describe these designs and consider their relative merits. Overall, we find that the most preferable system is likely to be a modification of the simultaneous multiple round auction (SMRA) that has frequently been used for spectrum auctions. The leading alternative is a form of one-shot sealed bid auction.

6.2.1. SIMULTANEOUS MULTIPLE ROUND AUCTIONS

We first describe how a relatively simple SMRA of the type often used for spectrum auctions would work, and then consider modifications for auctioning airport slots. In an SMRA, bidding proceeds through multiple rounds. At the first round, bidders can submit bids on all lots (providing that they exceed a minimum bid set for each lot). The highest bidder on each lot is declared at the end of the round.

In the following rounds, new minimum bids are set for each lot, equal to the current highest bid on that lot plus some increment set by the auctioneer. Bidders can now make further bids, overbidding the current highest bidders from the end of the previous round if they wish. The auction proceeds in this manner through multiple rounds, with the price of each lot rising if there are further bids. Bidders can switch back and forth between lots from round to round as prices develop, bidding on whichever lots they consider best value.

The auction closes across *all* lots simultaneously when there is no further bidding activity. Until the end of the auction, it is possible for bidders to switch between lots. Therefore, this is a *single* auction for many lots, rather than a number of separate auctions, one for each lot.

In this auction format there would be an incentive for bidders to wait as late as possible to make their bids in order not to give away any information about their intentions to other bidders. For this reason, there are so-called *activity rules* that force bidders to make bids at each round in order to keep their options open for later in the auction. A typical set of activity rules might work in the following way:

- Before the auction each lot is assigned a number of 'eligibility points' in proportion to a rough estimate of its value.
- Each bidder applies for a certain number of eligibility points prior to the auction. This is typically determined by the size of deposit a bidder puts down. The eligibility points held by a bidder limits the number of bids it may make. The total number of eligibility points associated with lots on which a bid has been submitted and with lots on which a bidder has been highest in the previous round must not exceed the number of eligibility points held by the bidder.
- At each round, in order to maintain its stock of eligibility points, a bidder must exceed an *activity requirement* set by the auctioneer. For example, a bidder might be required to make bids (including standing highest bids from the previous round) whose points sum to 70% or more of the bidder's eligibility points.
- If a bidder fails to meet its activity requirement, its eligibility points are scaled down in proportion.
- As the auction progresses, the activity requirement is increased. Typically this is done by having a number of stages, with the activity requirement increasing from one stage to the next. In the final stage of the auction, bidders would need to bid all of their eligibility points to maintain them.

Such activity rules prevent bidders from delaying and making bids only towards the end of auction. In order to maintain the option to bid on all the lots that a bidder might ultimately want, it is necessary to bid on a sufficient number of lots throughout the auction.

Being an open auction, an SMRA allows bidders to observe the bidding behaviour of other bidders. This allows bidders to benchmark their own estimates of the value of lots against the bidding behaviour of others, thus reducing the potential uncertainty[70] about the value of lots they may face. Such uncertainty over valuations has two effects:

- It may lead to ex-post inefficiencies, in the sense that a bidder may win a lot as a result of overestimating its value, denying the lot to someone else with an ultimately more profitable use of it.
- Rational bidders will tend to bid cautiously for fear of suffering 'winner's curse', which arises where the winner bids its full value estimate. As the winner is the bidder with the most optimistic view of the lot's value, this is very likely to be an over-estimate of the true value (for a more detailed discussion see Annex 1).

Open auctions such as SMRAs reduce this valuation uncertainty, in essence constructing a market in which the prices of lots emerge. As prices are established, bidders can refine their own valuations and strategies, for example moving between lots depending on relative prices or modifying the combinations of lots sought. For this reason, activity rules are very important, as price information will only emerge when bidders actively bid for the lots rather than wait for others to reveal their valuations.

6.2.2. A MODIFIED SMRA FOR AIRPORT SLOTS

The simple SMRA described above would need to be adapted to deal with airport slot allocation, in particular to allow for:

- the possibility of terminal and stand scarcity; and
- the different number of air movements possible on a runway depending on the mix of traffic using it.

The process we describe here is an SMRA for *combinations* of runway, terminal and slot capacity. The combinational nature of bids is reflected in the design of lots as dscribed above. A bid for a particular lot – a time window - would consist

[70] Formally, we mean so-called 'common value' uncertainty. At least in part, a lot has an objective value to all bidders that is uncertain.

of both a financial offer and a nomination of usage factors, of the type described in section 6.1.2, which affect the utilisation of runway, terminal and stand capacity.[71]

The auctioneer would then process these bids and select current highest bidders at the end of the round. For any given lot, there would be *multiple* current highest bidders, as multiple traffic movements are possible within a given time window. The number of highest bidders cannot be predetermined, as runway capacity depends on the traffic mix.

In selecting the current highest bidders, the auctioneer would maximise the total value of the selected bids, subject to these being feasible given available capacity and declared usage factors. The selected current highest bidders would often, but not necessarily, be those who made the highest monetary offers for that lot. Sometimes it would be necessary to select a bidder making a lower monetary offer in favour of one making a higher monetary offer as the former would make lesser demands on terminal capacity or stands, or use the runway more efficiently given other traffic movements scheduled within the same time window.

This selection process would need to be achieved by means of a computer algorithm. To implement this, to would be necessary to quantify the impact of particular usage factors on capacity requirements, thereby identifying those allocations of slots to bidders that are feasible given available capacity. The algorithm would then search over all feasible allocations of slots to find the one with the greatest total value of accepted bids.[72] Although this process would be complex for the auctioneer, it is relatively simple for bidders, who need to state their intended usage of a slot and make a monetary offer.

[71] If desired, a bidder could nominate multiple choices of usage factors with its bid for a lot. In this way a bidder could either choose to buy a relatively restricted right to use a slot, for example where the aircraft size must be of the nominated type, or a relatively unrestricted right to use a slot, for example by nominating multiple types of aircraft, providing the option to substitute aircraft later.

[72] In practice it probably not feasible to search over all possible allocations of slots to bidders as the number of such allocations is astronomic and would require excessive time to compute. Given that terminal and stand capacity constraints are only infrequently of relevance, it would be more efficient first to compute the optimal allocation ignoring such constraints, which reduces largely to selecting highest bidders. From that starting point, search algorithms can be used to see if modifications of the allocation are feasible and would increase the total value of accepted bids. Given the complexity of this problem, it may be necessary to use statistical optimisation techniques such as simulated annealing to solve the problem within a reasonable time. Such techniques are also robust to the presence of multiple local optima. This would produce a solution that is close to optimal and, to the limited extent to which it was not the fully optimal solution, did not favour or disfavour any particular bidder.

Having declared current highest bidders for each lot, the auctioneer would then need to set a minimum bid for the subsequent round. This would be set as some increment over the lowest of the multiple current highest bids on any particular lot. A slight complication would be that where terminal or stand constraints were important, it might be necessary to set minimum bids differentiated according to the intended usage of the lot.

Having set these minimum bids, the next round would be started. Bidding would proceed through multiple rounds until there was no further bid activity. As described in the previous section, activity rules would be necessary to ensure that bidders did not unduly delay in making bids.

6.2.3. COMBINATIONAL BIDDING

In SMRAs, bidders often must assemble combinations of lots. However, this means that bidders may face aggregation risks.[73] In particular, they may bid for a combination of licences, only to lose some of them whilst remaining highest bidder on others. In auctions where there are strong synergies across lots, such a fragmentation of lots may not just expose bidders to risk, but also lead to inefficient outcomes.

As a response to this problem, a modification of the standard SMRA format has been developed in which bids can be made not just for single lots, but also for combinations of lots. For example, suppose that a bidder had a strong synergy between two lots, call them *A* and *B*. If the bidder must make two independent bids, one for *A* and one for *B*, there is a risk that the bidder may win one, but not both, of the lots. With combinational bidding, the bid may submit one single offer for *A* and *B*. This bid would either be accepted or rejected in its entirety by the auctioneer.

Although combinational bidding solves the problem of aggregation risk, it does introduce some new problems. In particular, it can produce inefficient outcomes in which a bidder with strong synergies across lots displaces a number of bidders who each only want one lot, even if the later group of bidders place greater value in total on the lots than the former single bidder. Despite this problem, combinational bidding is generally thought to produce more efficient outcomes where there are strong synergies across lots.

[73] This is often referred to as an 'exposure risk', though we use the term 'aggregation risk' throughout.

The US Federal Communications Commission has run a large number of spectrum auctions using the SMRA format. It has recently been experimenting with the use of combinational bidding and has decided to move to this system for allocating regional spectrum licences as of 2001. In this case the lots relate to the use of spectrum in particular geographical areas, and there are potentially strong synergies between lots. For example, if a number of lots are geographically contiguous, then it may be efficient for a bidder to acquire all or none of them. Obtaining only some of these lots would lead to a 'hole' in geographical coverage. Clearly there would be no substitute to acquiring the lot required to fill the hole.

With regard to airport slots, there are strong synergies with regard to the different types of resources required for any particular air movement – runway, stand and terminal capacity. This would suggest the use of combinational bids. Indeed, the modified SMRA for slots discussed in the previous section is, *in effect*, an auction with combinational bids for different types of resources. In particular, by nominating how a slot will be used, an appropriate bundle of runway, terminal and stand capacity that will allow this usage is assembled automatically by the auction mechanism. Any need for carriers to bid separately for runway, terminal and stand capacity is avoided. This removes a major source of potential inefficiency that could result from having separate markets for runway, terminal and stand capacity, which are highly synergistic.

By contrast, synergies between different slots are significantly weaker. Even though there are competitive advantages from operating more routes and more frequent services, giving rise to some synergies across slots, the impact of failing to acquire one *particular* slot on the value of other slots is likely to be limited. Carriers have flexibility with regard to using slots for different services and other slots will be reasonable substitutes. Within an SMRA, if an operator needs to acquire additional slots to reap synergy benefits, there will typically be a variety of acceptable alternatives. Therefore, there is no particular reason to expect inefficiencies to result from bidders failing to achieve *particular* combinations of slots. Therefore, we do not see a strong case for introducing additional provisions for combinational bidding across slots.

The only strong synergy across airline slots is between take-off and landing slots. Even if an airline deploys slots flexibly across different routes, it still needs an equal number of take-off and landing slots at a particular airport. For example, if a carrier had more take-off than landing slots, as there would eventually be no aircraft available to use them. Therefore, any allocation system that produced outcomes in which the number of take-off and landing slots won by a carrier were significantly different would lead to inefficiencies. In an SMRA, bidders have opportunity to adjust their bids from round to round and so there is little reason to expect a significant mismatch between the total number of landing and take-off slots. Small mismatches could be corrected through post-auction requests to change a slot from landing to take-off (or vice-versa) where this did not affect capacity or by using the secondary market. Although combinational bidding would entirely remove this problem, as bids for landing and take-off slots could be paired, the additional complexity introduced for bidders appears unjustified by the scale of the problem.

6.2.4. SEALED BID AUCTIONS

An alternative to an SMRA is some form of one-shot sealed bid auction, in which bidders simultaneously submit one set of bids. These bids would be similar in format to those discussed above: a financial offer and nominated usage factors. These bids would be processed by the auctioneer and winners declared without running multiple rounds.

This process has the advantage over SMRAs of not being open-ended and, therefore, guaranteed to achieve an outcome within a fixed time, as would be required for completion before the IATA international scheduling conference. However, as we have already discussed, SMRAs have the advantage of allowing bidders with uncertain valuations to benchmark these against the bidding behaviour of other bidders, reducing uncertainty and improving efficiency.

Also, SMRAs allow bidders to switch between different lots and assemble combinations of lots as relative prices emerge, thereby limiting aggregation risks. This feature cannot be replicated in a one-off sealed bid auction other than through allowing combinational bidding across slots. Without such provisions there would be substantial risks of carriers making bids for particular slots in order to operate a service of a particular frequency on a particular route, but failing to get all of the slots they required. This would be a particular problem for small operators who may have relatively little ability to juggle portfolios of slots across different routes. With combinational bidding, bidders would submit bids for acceptable combinations of slots. It would be possible to pursue back-up strategies by submitting bids for other acceptable combinations, on the basis that at most one of the acceptable alternatives could be won.

These bids would be processed by the auctioneer, who would allocate lots to bidders in a manner that:

- respected combinational bids;
- did not exceed capacity constraints; and
- subject the two conditions above, maximised the total value of all winning bids.

This is analogous to the process of determining current highest bidders at the end of a round in an SMRA discussed in section 6.2.2.

Having determined winners, the auctioneer would then determine the prices to be paid. Here there are three main options, which have very different effects on bidders' incentives:

- a *discriminatory* auction, in which each winner of a lot paid the amount of its bid;
- a *uniform* auction, in which all winners paid the same price, determined by the *weakest* winning bidder, possibly with some adjustments for differences between bidders in their nominated usage factors; or
- winners pay prices equal to the *opportunity cost* of their bids, which is, roughly speaking, based on the valuation of the *strongest losing* bidder for each lot.[74]

There has been much debate in the academic literature about which of these variants is most desirable. For example, this issue has arisen in the design of government debt auctions in both the United Kingdom and the United States. The key difference between these auction formats is the extent to which they force bidders to have to take account of the likely bids of others when deciding about their own bids.

This can most clearly be seen in the case of a discriminatory auction. If a bidder considers that it is likely to have a much higher value than other bidders, it would not be rational to enter a bid equal to its value: although such a bid would surely win, the bidder would enjoy no surplus. Therefore, a rational bidder would bid less than its valuation, depending on what it expected other bidders to do. In contrast, if winners pay only the opportunity cost of their bids, the amount that a winner bids determines whether or not it wins, but not how much it pays. This depends only on the bids of *other* bidders. Therefore, in this case, bidders have an incentive simply to bid their valuation, as they would like to win the lot in any case where they pay less than this. The uniform auction is an intermediate case, as the amount that the winner pays may depend on what it bids itself, but to a lesser extent than in a discriminatory auction.

This has two consequences:

[74] This is the lowest possible amount which, had the bidder in question bid this amount given their nominated usage factors, and given the bids of other winning bidders, that bidder would have still won a given licence.

- Discriminatory auctions are the most strategically complex and, therefore, run some risk of inefficiencies being caused simply by bidders misjudging what they expect others to do. In contrast, opportunity cost pricing permits simple bid strategies to be used that do not require 'second-guessing' of what other bidders may do.

- Discriminatory auctions often lead to strong bidders paying more than would uniform auctions or those with opportunity cost pricing. Where bidders may be strong relative to others owing to existing market power, this may be a desirable feature as it tends to level the playing field between strong and weak bidders.

Given these conflicting effects of discriminatory auctions, it is unsurprising that there have been mixed empirical findings on the desirability of these different formats. General conclusions cannot be drawn, as they depend on the nature of the allocation problem in question and the extent of asymmetries between bidders.

Nevertheless, there would appear to be a reasonable case against the use of discriminatory auctions for slot allocation. Given the enormous complexity of the allocation problem, there may be a considerable risk of inefficiencies if bidders have to second-guess what others may do. Thus, a uniform auction or opportunity cost pricing would be preferable. In practice, particularly if many winners are declared for each lot, there may be little difference between a uniform auction and the use of opportunity cost pricing as in neither case will the amount a winner bids have much effect on what it pays.

Therefore, if a one-shot sealed bid process were adopted, achieving reasonably efficient outcomes is likely to require:

- the use of bids with a financial offer and a usage factor nomination, as with the SMRA;

- allowing combinational bidding to permit bidders to obtain efficient combinations of lots and pursue backup strategies; and

- use of a uniform price auction, or prices based on opportunity costs, to reduce strategic complexity.

However, we have serious concerns about the practicability of such an auction design. In order for bidders to express their preferences for particular combinations of slots and alternative combinations, it may be necessary to make large numbers of mutually exclusive combination bids, essentially listing out every possible combination of lots that would allow an airline to offer its planned services. Even where airlines knew exactly what combinations of lots they require and how much they were prepared to pay for them, this would be a major undertaking owing to the very large number of combinations possible. For this reason, we consider the SMRA format is strictly preferable.

6.2.5. HYBRID DESIGNS

It is possible to hybridise SMRA and sealed bid formats. Such hybrid formats have been proposed as a means of providing many of the efficiency and information revealing characteristics of the SMRA, whilst at the same time reducing the advantages of strong bidders where this strength results from existing market power. This issue is discussed at length in Annex 1.

In any case, an important benefit of a hybrid auction for slot allocation would be that it provides a safeguard measure for completing the auction within a given timeframe. A hybrid auction would work in the following way:

- an SMRA of the type described in section 6.2.2 would be started and run round-by round; and
- in the event of the SMRA not being completed by the backstop date, the auctioneer would declare a last and final round.

This last and final round would essentially be a sealed bid. Each lot would have a minimum bid established by the last completed round of the SMRA. These sealed bids would take the same format as the SMRA, with a financial offer and a nomination of usage factors. The auctioneer would process these bids (as described above) and declare winners.

As a result of running this sealed bid after multiple rounds of open bidding, the need to allow combinational bidding to achieve reasonable efficiency is likely to be much reduced. In particular, bidders would have seen which lots competitors were bidding on and may be able to form reasonable expectations of which combinations of licences they could reasonable expect to win. Those carriers who had sets of slots other than those they wanted could then use the secondary market.

Nevertheless, the use of sealed bid to curtail an SMRA is a somewhat drastic step and may reduce efficiency relative to letting the SMRA conclude naturally. Therefore, it would be important to ensure that all reasonable steps were taken to ensure that the SMRA ran rapidly, including:

- appropriate activity rules;
- rules of setting minimum bid increments.
- the use of a comprehensive software-based implementation of the auction to facilitate rapid bidding and analysis of round-by-round outcomes; and
- sufficiently harsh penalties on bidders who delay the auction.

It would probably not be practical to introduce combinational bidding into any such a sealed bid, even though this might create some efficiency benefits. Secondary market trading would be necessary to eliminate any inefficiencies resulting from the sealed bid.

6.2.6. REVISED TIMETABLE

Depending on the auction design parameters adopted, we anticipate that a sealed bid auction could be completed within one week, whereas an SMRA could take between two and four weeks. Prior to the auction, it would be necessary to set aside time for an approval process for bidders, in order to ensure that only suitable parties can compete in the auction.

In the case of SMRA's, procedures for receiving deposits from bidders prior to the auction may also be required (with sealed bid auction, deposits could be submitted with the bids). Using these assumptions, Table 12 and Table 13 illustrate potential revised timetables for the summer and winter seasons using sealed bid and multiple-round, ascending bid auction formats respectively. The main difference is that it may be necessary to start an SMRA earlier in order to maximise the likelihood of completion of the process within the deadline of the IATA Conference.

Table 12: Potential schedule for slot allocation with sealed bid auction

Summer season (7 months, April – October)		Winter season (5 months, November - March)	
Approval process for bidders:	September	Approval process for bidders:	April
List of approved bidders finalised:	End-September	List of approved bidders finalised:	End-April
Submission of sealed bids (with deposits) by airlines:	Mid-October	Submission of sealed bids (with deposits) by airlines:	Mid-May
Announcement of successful bidders:	Late October	Announcement of successful bidders:	Late May
IATA Conference:	Early November	IATA Conference:	Early June

Table 13: Potential schedule for slot allocation with SMRA

Summer season (7 months, April – October)		Winter season (5 months, November - March)	
Approval process for bidders:	September	Approval process for bidders:	April
List of approved bidders finalised:	Last week of September	List of approved bidders finalised:	Last week of April
Approved bidders submit deposits*	End-September	Approved bidders submit deposits*	End-April
Auction begins:	First or second week of October	Auction begins:	First or second week of May
Auction concludes, announcement of successful bidders:	Late October	Auction concludes, announcement of successful bidders:	Late May
IATA Conference:	Early November	IATA Conference:	Early June

*based on maximum number of lots an airline wishes to bid for.

6.2.7. AUCTION MECHANISMS – A COMPARISON

Table 14 provides a summary of the pros and cons associated with the different proposals. In summary, it is unlikely that the use of a one-shot sealed bid process could provide an effective alternative to the use of an SMRA.

Table 14: Pros and cons of various possible auction designs

Auction format	Advantages	Disadvantages
A. SMRA with separate lots for runway, terminal and stand capacity	Simple to implement	Aggregation risks and complexity for bidders Inefficient outcomes Strong bidders not constrained
B. SMRA with flexible bundling of runway, terminal and stand capacity (discussed in section 6.2.2)	High efficiency Aggregation risks small Simplest option for bidders	No guaranteed completion date Strong bidders not constrained
C. (Preferred option) As B, but hybridised with provision for last and final round. This would be a sealed bid *without* combinational bidding.	Efficiency close to option B Aggregation risks small Simple for bidders (except sealed bid)	Strong bidders not constrained unless final round declared
D. As C, but with combinational bids across different lots	Possibly greater efficiency even that option B	Complexity for bidders Strong bidders not constrained
E: One-shot sealed bid with combinational bids. A discriminatory auction with bidders paying what they bid.	Guaranteed completion date Strong bidders constrained - cannot pursue simple exclusionary strategies through repeated overbidding, and likely to pay more than in option F.	Strategic complexity - bidders need to second guess others Inefficiency relative to F, A, B, C and D. Complexity for bidders - must submit many combinational bids to pursue backup strategies
F. As D, except uniform auction (pay weakest loser's bid) or opportunity cost pricing (pay strongest loser's bid)	Guaranteed completion date Strong bidders constrained - cannot pursue simple exclusionary strategies through repeated	Inefficiency relative to A, B, C and D. Complexity for bidders - must submit many combinational bids to pursue backup strategies

	overbidding.

6.3. EFFECTIVE SECONDARY MARKETS COMPLEMENT AN AUCTION

Effective secondary markets in which slots can be re-allocated through trading would bring about considerable benefits regardless of the method used for the initial allocation of slots every season. Any inefficient allocations would give rise to potential gains from trade in a secondary market, and exploiting these gains from trade would improve efficiency. A secondary market would allow efficient re-allocation in the event that circumstances change mid-tenure or even mid-season. For example, demand for particular route could increase or decrease considerably and the airline might wish to adjust the slots it held.

Whilst an effective secondary market would in any case improve the allocation of slots, there are *additional* benefits from well-functioning secondary markets in the case where the primary method of allocation is through an auction. Secondary markets considerably reduce the aggregation risks faced by bidders because they would provide an opportunity to off-load unwanted slots (e.g. in the case where an airline has not been able to assemble the slot portfolio it wanted) and/or acquire the slots needed to complete a particularly valuable portfolio. As these aggregation risks are particularly severe for new entrants, therefore, we would expect that a well-functioning secondary market would help new entrants to bid more aggressively, thus increasing their chances of winning slots in an auction. Constructing an effective secondary market is a much more workable alternative to other solutions for aggregation risk, such as combinational bidding across lots.

We also envisage the secondary market as being the primary means of trading slots for part-seasons, as the seasonal auctions would allocate rights to use particular time slots for entire seasons. An airline, having acquired a slot for the entire season would be able to offer part-season use of this slot to another airline. This would greatly reduce the need to specify part-season slots in the main auction, thus significantly reducing the number of lots and the complexity of the auction.

Overall, an effective secondary market may allow considerable simplification of the main auction procedures, as it would be able to resolve inefficiencies that might result from a simpler auction, and reduces the extent to which the auction design has to address the problem of aggregation risk. However, the secondary market may need to be carefully designed to ensure that it cannot be abused in order to gain a position of dominance through the acquisition of slots. Evidence from the United States shows that this is a real concern: the growth of secondary market trading in airport slots has been accompanied by a marked increase in market share of the a few large airlines at the major US hub airports.

Nevertheless, it should be possible to design an effective secondary market mechanism by attaching conditions on the way in which slots allocated through an auction can be traded. The main conditions for an effective secondary market would be as follows:

- In order to maximise transparency and liquidity, airlines may be *required* to *trade* slots through a single exchange rather than bilaterally. This exchange could be organised similarly to a stock exchange with buy and sell orders posted electronically, and the order book being cleared at pre-determined intervals (e.g. daily, weekly).

- In addition, airlines may be allowed to post swap orders in order to be able to buy or sell a certain slot conditional upon being able to off-load or purchase another slot. We would expect this to be the primary method of retiming slots.

- In order to prevent airlines from selling selectively to carriers that do not impose a competitive threat rather than strong competitors, sales offers would have to be unconditional, i.e. an airline offering a slot for sale should be required to sell to anyone who is willing to pay the asking price regardless of the identity of the buyer.[75]

- To prevent airlines from creating a dominant position through the acquisition of slots in the secondary market, the safeguards discussed in 6.4 below should apply.

Airlines should be able to attach conditions to slots they acquire which may be necessary in order to alleviate competition concerns. For example, an airline may need to give undertakings not to use slots acquired in a secondary market for services on certain routes where this would cause competition concerns.

6.4. METHODS OF CONSTRAINING MARKET POWER

US experience clearly shows that moving to the greater use of market mechanisms has the potential to lead to increased concentration. Therefore, rules to prevent the build-up of market power are an essential aspect of any move to increased use of market-based mechanisms. Unfortunately, no simple mapping can be made from concentration in holdings of slots to market power on particular routes. The market power enjoyed by any particular airline depends on the competitive responses it faces from other airlines.

For this reason we would propose that market power issues are addressed in the following way, which is similar to the approach taken under merger control legislation:

- Define a certain proportion of slots which provides a safe haven. Any acquisition of slots that would not breach this limit should be permitted. The definition of a threshold below which slot acquisition should not be in any way restricted might alternatively be based on some concentration index (such as, for example, the Herfindahl-Hirschmann Index) based on slot shares rather than any fixed proportion of slots, and it may be possible to combine limits on the level of concentration with limits in the level of change of concentration;

- Any acquisition of slots that would lead to a breach of this limit would only be allowed after an independent authority has assessed the competitive effects of such an acquisition and had authorised the airline to purchase additional slots. This clearance could be given subject to certain undertakings (e.g. an undertaking not to deploy more than a certain number of slots for a particular route where otherwise competition concerns might arise). Obviously, there would need to be a tight timetable for obtaining such clearance, similar in nature (although not in detail) to the strict timetable imposed on the authorities under the current EU merger regulation. It is beyond the scope of this report to assess the most appropriate procedure for such an assessment.

- As even with a tight timetable it will not be possible to obtain such clearance within the tight timeframe of the auction, airlines may seek to obtain clearance of proposed acquisitions in advance where their intended slot acquisition could potentially breach the safeguard threshold.

[75] To the extent that, for reasons of flexibility, slot swaps (rather than trades) are permitted to take place through bilateral exchanges rather than a centralised trading system, there may need to be safeguard mechanisms in order to prevent airlines from circumventing this requirement by using the exchange of a commercially valuable slot for a commercially unattractive slot with some side payment rather than a straightforward sale. For example, the co-ordinator may be required to ensure that bilaterally negotiated slot exchanges do not involve slots of considerably different commercial value.

- Any such limits limit could easily be applied throughout an SMRA by means of the activity rules and constraints on eligibility.
- In the secondary market, the requirement that all trades go through a central clearing house would make monitoring of these rules straightforward.

Whilst it is beyond the scope of this report to make recommendations on the details of such a mechanism and the precise threshold levels that should be applied, introducing this type of regulation would have a number of advantages:

- It is flexible but provides reasonable legal certainty to make auctions and trading in secondary markets feasible.
- Undertakings that alleviate competition concerns can be obtained in exchange for the clearance of further slot acquisitions, thus targeting competition problems where they arise rather than resulting in a blanket prohibition.

7. POLICY CONCLUSIONS

In this section we summarise our conclusions about what changes to existing slot allocation arrangements would be desirable.

7.1. IMPLEMENTING AUCTIONS

As we have shown, it is possible to design an auction that can cope with the complexity of slot allocation within a reasonable timeframe. Our preferred option for an auction design for allocating airport capacity consists of the following:

- runway, terminal and stand capacity being bundled together flexibly into a single lot;
- lots being differentiated by time windows over an operating week, but running for a whole season, with multiple winners of each lot, the number depending on the number of slots available;
- these lots being auctioned within an adapted simultaneous multiple round auction, with bidders able to switch between lots and build up aggregations round by round;
- bids consisting of both an financial offer and a nomination of a number of simple usage factors relating to how the slot would be used and the likely demands made on runway, terminal and stand capacity;
- an algorithm employed by the auctioneer to select the highest value bids each round that are consistent with available capacity; and
- provision for last and final offers to be made in the event that the auction would otherwise overrun the backstop date needed for coordination with the IATA scheduling conference.

This design could be able to used without modification for allocating the existing pool, new capacity or slots released by curtailment of grandfathering. Therefore, this provides considerable flexibility for implementation.

The timetable for running the auction would be tight. Therefore, it would be very important to provide an easy-to-use software implementation of the auction. In particular, well-constructed software that provides all information required by bidders in a digestible format would be essential.

Clearly we have not articulated the full details of how such an auction would run. Given its complexity, it would be essential to refine these rules and test the format by means of experimental techniques.

7.2. THE POTENTIAL BENEFITS OF DIFFERENT COMBINATIONS OF INTERVENTION

Regardless of whether grandfather rights are curtailed, there is a strong case for moving to a system of market-based allocation for airport capacity. However, ending grandfathering and moving to market-based allocation mechanisms are strongly complementary measures, in that:

- it is unlikely that the existing allocation system could cope with the vastly greater number of slots that would need to be allocated if grandfathering were ended; and
- although a market-based allocation system would improve allocation even if used for the current small pool of slots, its benefit (especially its pro-competitive benefit) would be much greater if grandfathering were ended.

We consider the potential benefits of different combinations of intervention in turn below.

Case 1: Formal secondary market only whilst grandfather rights remain

Moving to a formal secondary market would bring some efficiency gains even if no other reforms were adopted. This measure would increase the liquidity of the current grey market and allow greater regulatory scrutiny of potentially concentrative trades. However, continued grandfathering would create substantial incentives for existing users to retain slots wherever possible, limiting the liquidity of the secondary market. It would be necessary to maintain 'use or it lose it' obligations probably even for small operators in order to generate liquidity on the secondary market. Barriers to expansion by mid-sized carriers would remain.

Case 2: Auction existing pool of slots with formal secondary market whilst grandfather rights remain

This would generate greater efficiency gains than the use of a secondary market alone. However, barriers to expansion by carriers would remain, and the small volume of slots auctioned would limit efficiency gains.

Case 3: Auction a major increase in capacity whilst grandfather rights remain

Auctioning slots generated by a major increase in capacity would generate greater improvements in efficiency than Case 2. In particular, this could bring significant pro-competitive benefits, as barriers to expansion for existing operators would be temporarily lifted. However, measures would need to be in place to ensure that concentration of slot holdings did not increase.

In the case of a major capacity increase, it may be difficult for the existing allocation procedures to cope with allocating a greatly increased volume of slots in one go. Therefore, it may be necessary to move to a different system prior to making such new capacity available. Furthermore, current arrangements for protecting competition (reservation of slots for entrants) may be insufficient to prevent additional concentration in this case.

Case 4: Remove grandfathering but retain existing allocation arrangements

Similar concerns arise as in Case 3, except in this case they would be more severe as there would be a greatly increased volume of slots in the pool each season, rather than just a one-off increase. Existing arrangements may have trouble allocating such a large number of slots quickly and may not have adequate safeguards against concentration. It is possible that removing grandfathering but continuing to use existing administrative allocation procedures could make the situation worse, not better, as it may lead to further concentration.

Case 5: Remove grandfathering, auction slots with formal secondary market

This case has the greatest potential for improvements in the efficiency of competition and the promotion of competition. However, in this case it would be essential to have adequate measures in place to prevent the build-up of market power. The use of an auction as the primary means of allocation would be strongly complementary to establishing a formal secondary market, as the presence of the later would allow simplification of the former.

7.3. CURTAILING GRANDFATHER RIGHTS

There is a strong case for curtailing existing grandfather rights, on grounds of efficient allocation and promotion of competition. Efficient allocation is hindered by existing users having priority over potential users regardless of the relative value each places on a slot. Grandfather rights act as a barrier to expansion, particularly by mid-sized carriers. On the other hand, grandfather rights generate maximum certainty for airlines over future slot holdings, and may thus create benefits in terms of investment planning. Curtailing grandfather rights may increase volatility in the slot holdings of individual airlines and thereby make investment planning more difficult. Although the potential detrimental effects from this would appear to be small, a full assessment of the extent to which investment planning benefits would be lost if grandfather rights were curtailed is beyond the scope of this study.

If grandfather rights are reclaimed, there are a number of ways this could be done:

- All slots could be taken back in one go. This method would ensure equal treatment of all airlines. It would also give maximum flexibility for reallocation of slots in the most efficient way.

However, the scale of potential changes to slot usage rights could pose problems for international coordination.

- Slots could be taken back gradually, with a fixed proportion reclaimed for auction each season until grandfather rights have been eliminated. In this case, the size of the seasonal pool could be expanded gradually until it covers 100% of slots. This gradual reclamation would provide a simple means of moving to a system of rolling auctions, in which a proportion of rights come up each season as tenures expire. A rolling system would result in less complex auctions and may fit better with existing procedures for international coordination. However, there are equity issues with regards to reclamation.

A formula would need to be found for reclaiming grandfather rights. There are several potential ways of doing this, for example, randomly selecting a proportion of rights to be reclaimed each season, reclaiming slots proportionally from airlines, or taking more slots from larger airlines by using graduating bands based on their number of existing slots. Care would need to be taken to ensure that no airline is excessively favoured or victimised during the period in which grandfather rights are reclaimed.

7.4. USE IT OR LOSE IT

At present, all carriers are subject to a 'use it or lose it' provision when allocated slots. However, if grandfathering were curtailed and market mechanisms established, there would no rationale for a blanket prohibition on carriers controlling unused slots. Allowing smaller carriers to hold unused slots where they judged that the benefit of the flexibility this provided exceeded the cost the slots would promote competition. In practice, this should not result in slots remaining unused, in particular if the option of offering slots on the basis of a revocable lease is taken into account. However, a prohibition on slot hoarding by large established carriers who may have market power should remain.

If grandfathering were not curtailed, it would be difficult to modify the 'use it or lose it' rule in this way. Grandfathering creates incentives to hold on to slots that undermine the liquidity of any secondary market. 'Use it or lose it' acts as a counterbalance to this.

7.5. ABUSE OF MARKET POWER

Any market based system for the allocation of scarce resources poses the risk that acquisitions are made to create or strengthen market power. Therefore, appropriate safeguards are required to prevent airlines from buying up slots in order to restrict or distort competition. This includes packages as modest as formalising secondary market trading whilst leaving existing grandfather rights untouched.

Unfortunately, no simple mapping can be made from concentration in holdings of slots to market power on particular routes. Therefore, a flexible scheme for identifying anticompetitive concentration of slots would be best. Whilst competition law has an important rule in constraining an abuse of market power, this would need to backed up by a competition test on slot holdings above a threshold. It is beyond the scope of this study to suggest at what level such limits would be optimally set.

7.6. PAN EUROPEAN COORDINATION

Obtaining benefits from moving to a market-based allocation system for slots does not depend on pan-EU coordination of such a move. This is equally true of curtailing grandfather rights. Given the scope for inefficiencies in the current system, any inefficiencies that could result from moving to a market-based system with misaligned incentives and inefficient slot allocations in other Member States are of at most second-order importance. Nevertheless, there would be further efficiency benefits for the UK economy and consumers from the increased use of market mechanisms at other congested EU airports.

One area where EU coordination may be relatively important is in the setting of uniform rules against concentration of slots and the build-up of market power. Given that there is competition not just at airports, but also between congested hubs, care would need to be taken to ensure that rules against concentration applied just to the UK did not significantly distort intra-hub competition. However, EU-wide coordination on this issue would remove this concern.

ANNEX 1: OPTIMAL AUCTION DESIGN – AN INTRODUCTION

INTRODUCTION

This annex presents an informal introduction to the economic literature on auctions. Technical details are left aside, instead we provide the non-specialist with an introduction centred on examples and intuition. Excellent - and more complete - surveys of this field can be found in the works of Klemperer and Milgrom.[76]

We discuss the theoretical implications of a number of common auction formats, which – except under a set of unrealistic and restrictive assumptions – produce different outcomes. This implies that, depending on the specifics of the allocation problem that has to be solved, there are reasons to prefer one auction format to others. This is the problem of optimal auction design.

We begin with the simplest possible case of single lot auctions. Auctions of single lots are conceptually much simpler than those of multiple lots, and are useful in discussing issues that are also important in more complex cases. In this simple framework we introduce the assumptions, under which different auction designs yield the same outcome, in terms of efficiency and revenue. By gradually relaxing these assumptions, thus making the theoretical environment more realistic, we show that "auction design matters."

Both academic researchers and governments agree that market-based mechanisms, such as auctions, can be a very effective means of allocating scarce resources in the most efficient manner. However, auctions need to be well designed in order to achieve these objectives. As Klemperer[77] puts it, in applied economics "[auction] design is a matter of 'horses for courses', *not* 'one size fits all". Optimal auction decision depends not just on the resource being allocated, by also the nature and extent of likely competition for the resource.

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[76] P Klemperer, *The Economic Theory of Auctions*, Cheltenham, UK, Edwar Elgar, 2000. For an overview of the evolution of auction theory see Klemperer's review article: "Auction Theory: A Guide to the Literature", *Journal of Economic Surveys*, forthcoming. See also P Milgrom, *Putting Auction Theory at Work*, forthcoming, Cambridge, Cambridge University Press.

[77] P. Klemperer: "What Really Matters in Auction Design", *University of Oxford Discussion Paper*, 2000.

SINGLE LOT AUCTIONS

A simple example for a single lot auction is the sale of a painting for which bids are invited. There are three common formats for auctions of this type:

- ***English auction.*** This is the familiar format of art auctions. Bidders cry out successively higher prices (or respond to an auctioneer crying out successively high prices) until a single bidder remains. This bidder will obtain the painting at the value of her last bid.

- ***First-price sealed bid auction.*** This is the format used in most sealed tender processes. Each bidder submits a sealed bid without knowledge of the behaviour of other bidders. The highest bid wins and the winning bidder pays a price equal to their bid. An example of this type of auction was the allocation of the Channel 5 TV franchise.

- ***Second-price sealed bid auction.*** Again sealed bids are submitted and no information is available about the bidding behaviour of others. The highest bid wins, but the winning bidder pays the *second* highest bid, rather than their own bid. This format was used, for example, in New Zealand for radio spectrum auctions.

There has been much theoretical and empirical research by economists into how rational bidders should behave in each of these auctions, and the corresponding outcomes (i.e. who obtains the lot auctioned, and at what price). The main findings are:

- In an English auction, the optimal bidding strategy is to stay in the bidding as long as the current price is lower than a bidder's value of the lot, and to drop out as soon as the price exceeds that value. This results in the lot being sold to the bidder with the highest valuation at a price equal to the valuation of the second highest bidder (subject to small differences that may result from the requirement that bids have to be raised in discrete steps).

- The optimal bidding strategy for a *first-price* sealed bid is determined by a trade-off. If a bidder bids more, she increases the probability of winning, but will have to pay more in case she succeeds. If a bidder were to bid her true value, she would not enjoy any surplus in the case of winning the lot. By contrast, if she bid less than her true valuation, she will enjoy such a surplus, but somewhat reduce the probability of winning the lot. In general, bidders will bid somewhat *less* than the value they put on the lot, depending on what they expect others to bid. This means that bidders have to take a view about the behaviour of other bidders when deciding what to bid themselves – each bidder is 'second guessing' what the other bidders are going to do.

- The optimal bidding strategy for a *second-price* sealed bid auction is to submit a bid equal to the bidder's true valuation of the lot. The intuition behind this conclusion is as follows.[78] The price a successful bidder has to pay is independent of the value of its own bid. Therefore, she should only be concerned about maximising the probability of winning the lot at any price that is below her true valuation. This can be achieved by bidding the true value. If she wins, the price she has to pay will be no higher than her true valuation. If she does not win with a bid equal to her true valuation, the second highest bid must exceed her valuation, and she would not gain any surplus from winning. There is no incentive to exaggerate her true valuation, as this only creates the risk of winning the lot and having to pay more than it is worth to her.

Perhaps surprisingly, under each of these auction formats the bidder with the highest value is expected to win the lot at a price that is equal *on average* to the second highest bidder's valuation, provided certain rather restrictive assumptions hold. This outcome is economically efficient in the sense that the lot ends up with whoever values it most. Moreover, as the revenue a seller can expect to obtain from the auction is the same on average under each of these auction formats, the seller should be indifferent between choosing one or the other. However, the result that all of these auction formats lead to efficient outcomes and, on average, the same revenue for the seller holds *only* if *all* of the following assumptions hold:

- *Risk-neutrality.* Bidders are assumed to care only about expected value. If bidders are risk-averse, they will tend to wish to avoid the risk of losing an auction, and will therefore bid more in first-price sealed-bid auctions, trading off some of their expected surplus against an increased chance of winning.

- *Independent private values.* Different bidders' valuations are independent of each other, implying that they must be totally subjective and individual to the bidders. If bidders' valuations partly depend on objective common factors (for example, the 'market value' of a painting,), but bidders differ with regard to their specific estimate of this common value, sealed bid auctions may raise less revenue and result in inefficient outcomes because

[78] See P Klemperer, *The Economic Theory of Auctions*, Cheltenham, UK, Edwar Elgar, 2000

bidders wish to avoid the 'winner's curse'. We discuss this problem in more detail below.

- *No ex-ante asymmetries.* Bidders do not have any systematically different perceptions about other bidders' valuations[79]. If some bidders are commonly perceived to be stronger than others, this might have a differential impact on the behaviour of strong and weak bidders depending on the auction format.

- *No collusion.* Bidders are assumed to compete against each other in the bidding process rather than colluding in order to affect the outcome and reduce the price. If there is a danger of collusion, then different auction formats may make it more or less difficult for bidders to collude and may therefore produce different outcomes.

In practice, these assumptions will not be satisfied and so one format may be better than another, depending on the specific circumstances.

COMMON VALUES: THE WINNER'S CURSE

In most practical cases, the 'independent private values' assumption is untenable. Bidders are often uncertain about the value to place on an object and would be influenced in their valuation by knowing the value that others place on it. In this case, there are 'common values'. A pure common value setting refers to a situation in which the value of the lot is objectively the same for all bidders, even though each bidder may have a different *estimate* of what this value might be. A very simple example is auctioning a jam jar full of pennies. The value of this item is determined by the amount of money in the jar, which is the same for all bidders. However, each bidder may have a different estimate of the amount of money that is in the jar, and consequently the maximum amount it would be willing to bid. In practice, virtually all auctions of resources have a strong common value element, even if bidders may differ somewhat in their ability to exploit those resources.

This uncertainty about the common value can lead to a phenomenon known as the 'winner's curse'. In the example of the jam jar full of pennies, the bidder most likely to win the auction is the bidder who has the most optimistic estimate of the amount of money in the jar. If the estimates of bidders are on average correct, and

[79] Technically, this means that all bidders' valuations, while different, are drawn from the same distribution. Taking any two bidders, they each perceive a 50-50 chance that they have the highest valuation.

each bidder were to bid up to its estimated value, then the winning bidder is very likely to have overestimated the value of the lot – it will have bid more than the amount of money in the jar. This problem has been claimed as the reason for massive overbidding in early auctions of exploration rights for offshore oil fields.

The rational response to the threat posed by the winner's curse is to shade down one's bid and bid less than one's own estimate. This results in a loss of revenue to the seller. More specifically, the amount by which a rational bidder should shade down its bid depends on the extent of uncertainty about the common value. The more uncertain the estimate, the more the bid should be shaded down.

This is the reason why, in common value settings, open auction formats in which bidders can observe each other's behaviour generate more revenue than sealed bid auctions. By observing what other bidders do, and assuming that estimates are on average correct, a bidder can re-evaluate its own estimate as the auction proceeds. If a bidder observes other bidders to continue bidding way beyond its own estimate, it may want to re-assess this estimate upwards. By contrast, if other bidders are seen to be dropping out at relatively low prices, a bidder may wish to revise its estimate downwards. In either case, however, a bidder will face reduced uncertainty and will therefore have less reason to be cautious and shade down its bid.

Moreover, in the case where the value to a bidder is made up of a combination of common and private values, i.e. where there are some factors that affect the value in the same way for all bidders (e.g. demand for oil) whilst others are specific to individual bidders (e.g. the efficiency with which a bidder can run the operation of extracting oil from an oilfield), the common value uncertainty can lead to inefficiencies. The winning bidder may not be the one with the highest private value (who should win, given that the common value element is identical for all bidders), but perhaps the most optimistic bidder. Thus, differences in the estimate of the common value can swamp differences in private values. Again, an auction format that reduces common value uncertainty is less likely to be susceptible to such inefficiencies than a sealed-bid process in which little or no information about other bidders' valuation is revealed.

The case of airport slots is one where the value of slots is likely to depend on both common and private value factors. Some factors, such a likely demand for flights on a particular route, will affect all potential bidders and give a common component to valuations. But also, each bidder will have rather different plans for the sort of service to be offered, which affect only the valuation of that particular bidder and so form a private component of the valuation. A 'no frills' airline's valuation of a route is unlikely to be affected by the fact that a traditional flag-carrier may be able to integrate the route into its network and produce some synergistic cost savings. On the other hand, both airlines' valuations would be both low if demand on the route were low.

Therefore, all other things being equal, an open English auction is preferable to the other formats as it allows bidders to gather information about the common component of the value of the lot simply by observing each other's bids. By allowing bidders to base their bidding on more information, an open auction improves both efficiency and revenue. Bidding will be less conservative if, by observing what others are prepared to bid, bidders have some reassurance that they are not grossly overestimating the value of a lot.

ASYMMETRIC BIDDERS

Thus far, we have assumed that bidders were ex-ante *symmetric* in the sense that none of the bidders could be singled out as being particularly strong or weak.[80] However, there are many circumstances in which there are systematic and commonly known differences between bidders. For example, incumbent operators have in general been perceived to be stronger than new entrants in the European auctions for third generation mobile licences because of their established customer base and their experience. Similarly, in the case of airport slots, each potential buyer may have commonly known characteristics that suggest a difference in valuation that is known ex ante.[81]

Such commonly known asymmetries between bidders affect the outcome of auctions, but the extent of the impact depends on the auction format. There are two cases that have been considered in the literature: common and private values.

- **Private value.** Even with private independent valuations, ex-ante asymmetries affect the likely revenue that can be expected from the auction.[82] For example, assume that competitors differ just in the range of possible profit levels obtainable from the resource, such that a 'strong' participant can make profits within the interval £100 - £200, whereas the weak one only within £50 - £100. In an English open auction, where participants successively call out their bids,

[80] In technical terms, that their valuations were drawn from the same publicly known distribution.

[81] For example, consider two airlines: *A*, a traditional carrier, and *B* a 'no frills' carrier. *A*'s fleet consists of both small and large aircraft, and *B*'s fleet is made up of smaller planes. Additionally, *A*'s routes are spread worldwide, whereas *B* operates only regionally. Suppose they are both interested in a particular slot, which is available only to a smaller aircraft. It is likely that *B* will attach a higher expected profitability, as such a slot would represent a core asset for *B*, whilst *A* could still manage its route network by slightly changing its schedule.

[82] The case of private values and ex-ante asymmetries are studied in great detail in E Maskin and J Riley: "Asymmetric Auctions", *Review of Economic Studies*, forthcoming.

the strongest competitor will win, and pay an amount of money equal to the second-strongest participant's *average* valuation (£75), by successively bidding slightly above the weakest bidder's last bid. By contrast, in a first price sealed bid auction, the stronger bidder may rationally wish to place a bid at a level that guarantees a win given the possible range of the weaker bidder's valuation. This suggests that open auction formats will generate less revenues than sealed bid formats.[83]

- **Common value.** In the case of valuations with common value components, the impact of ex-ante differences may be even more dramatic, as the relative impact of winner's curse on different bidders is affected. To see this, suppose that two participants bidding for a single lot have only slightly different valuations, but with strong common value component[84]. The strong player, will bid a little more aggressively than in the symmetric case, as his winner's curse is ameliorated by the small advantage he enjoys. However, this increases the size of the winner's curse for the weaker bidder. Winning against a bidder who is known to have an advantage not only implies a likelihood of having overestimated the common value, but having overestimated the common value by more than the private value difference. Therefore, the weaker bidder will be even more cautious, which in turn increases the advantage of the strong bidder. The presence of small ex-ante differences between participants may translate into possibly huge ex-post differences, in terms of the bids that are ultimately relevant for the outcome of the auction. In this case the use of an ascending open auction is again likely to result in lower revenues and inefficiency.[85]

[83] However, this property is not general. It is very sensitive to the type of asymmetry – when the differences are no longer in the ranges of possible valuations, owing to variations in the likelihoods of bidder's outcomes, results could be very different. In terms of optimal strategies, the weak bidder would have an incentive to bid more aggressively, and the strong one more conservatively. If some particular conditions are satisfied (see Maskin and Riley, *op. cit.*), then the English auction may have a higher expected value than the second price auction.

[84] Technically, the literature refers to this as the "almost common-value" case, in contrast to the 'pure' private-value and the common-value ones. See P Klemperer, "Auctions with Almost Common Value", *European Economic Review*, 1998, which provides an illuminating analysis of this and other related points.

[85] In case of entry or bidding costs, an almost common-value environment would generate even more extreme results. The disadvantaged bidder may not participate in the allocating process at all (see Klemperer, *op. cit.*).

In both the private and the common value cases, we see that small differences between bidders may substantially influence the outcome of an auction and gives the possibility of inefficient outcomes. However conclusions are very sensitive to how competitors differ and the type of auction.

Nevertheless in the case of common values, an open auction may see a strong bidder winning at a low price, with a small chance of a weak participant winning. This may favour strong bidders at the expense of weak bidders and introduce some inefficiency. Where 'strength' and 'weakness' of bidders partly depends on their established market position (or lack thereof), and there is a social benefit from entry which is not capture in the willingness to pay of bidders, it may be desirable to opt for a sealed bid process in order to give new entrants a chance of succeeding.

MULTIPLE LOT AUCTIONS

So far we have considered only auctions of single, well-defined lots. However, many auctions are for a number of lots which, from the perspective of the bidders, can be substitutes for each other (e.g. the different blocks of radio spectrum auctioned in the recent auctions for third generation licences in the UK) or complements (e.g. the individual spectrum blocks auctioned in the German 3G auction, or regional spectrum blocks auctioned in the US). The case of airport slots is itself an example of a particularly complicated auction in which there may be a great number of related lots sold together that could be substitutes or complements.

To a large extent, the considerations that apply to the single-lot case can be generalised to the multiple lot environment[86]. In particular, problems resulting from common value settings and known asymmetries between bidders arise in very much the same way in multiple lot auctions. However, in addition there are complications that arise from the extent to which there are complementarities between lots and therefore the value to a bidder depends on the number and nature of lots it will eventually acquire. In the case of airport slots, frequency effects mean that an airline may value a portfolio of slots much more highly than the sum of the values it would put on each individual slot if valued on a stand-alone basis, giving rise to such complementarities.

[86] For the details see the work of E Maskin and J Riley, "Optimal Multi-Unit Auctions", in F Hahn (ed), *The Economics of Missing Markets, Information, and Games*, 1989.

Such complementarities give rise to additional exposure and aggregation risks. A simple example may help to illustrate the risks faced in a situation where bidders can combine lots, and there are synergy benefits across lots. For example, suppose that there are two lots (call them *X* and *Y*) that are, on their own worth 2 to a bidder, but together worth 6.

It would not be rational simply to bid up to 3 on each lot. How much it is rational to bid for *X* depends on the probability of getting *Y* and the likely price that the bidder will have to pay for *Y*.

For example, suppose that the bidder in question expects to win *Y* with probability ½, and in the event of winning *Y* to pay an expected price of 3. In this case, on buying *X*, the bidder would expect to gain a surplus of:

½ x (Combined value of *X* and *Y* – Expected price of *Y*) + ½ x Standalone value of *X* – Price of *X*
= ½ x (6-3) + ½ x 2 – Price of *X*
= 2½ - Price of *X*.

Therefore, a bidder *expecting* to pay 3 for *Y* would rationally pay up to 2½ for *X*.

However, once *X* has been acquired, the bidder should pay up to 4, which is the incremental value of *Y* as a result of synergies. On the other hand, if the bidder did not buy *X*, then it would not be worth paying more than the standalone value of *Y* (in this case 2).

This example illustrates the two sources of risk faced by the successful bidder for *X*:

- the risk of acquiring *X* and failing to acquire *Y*; and
- the risk of making a loss on the overall transaction, even if the bidder buys both *X* and *Y*.

The second risk arises if the price of *Y* rises above 3½. In this situation, it is still rational to bid up to 4 if *X* has already been acquired, even though the bidder would expect to make an overall loss. In effect, the bidder must pay to avoid losing synergies between *X* and *Y*.

These problems are most severe in the case where lots are sold off sequentially, and where a bidder effectively has to make a commitment to some lots without knowing whether (and at what price) it will be able to acquire complementary lots. A solution to the problem of exposure and aggregation risks is provided by two auction designs that allow bidders some flexibility throughout the auction, namely the simultaneous multiple round auction, which has been extensively used for the sale of radio spectrum licences, and the combinational auction, which has been recently chosen by the Federal Communications Commission for future spectrum auctions.

SIMULTANEOUS MULTIPLE ROUND AUCTIONS[87]

The first use of a simultaneous multiple round auction (SMRA) was in the United States, for a US$617 million sale of ten paging licences in 1994. After this first and rather successful experience several other countries were inspired to use similar auction formats to allocate radio spectrum.[88]

An SMRA is characterised by the fact that bidding takes place at the same time for all lots, and that the auction closes only when bidding has ceased on all lots. In each round, bidders can submit bids (which have to meet certain criteria in order to be valid). Bidders may switch between lots and may bid on various combinations of lots, thus being able to respond flexibly to price changes and the resulting changes in the overall cost of any specific combination they might wish to acquire. At the end of each round, some information[89] is released by the auctioneer, which can help bidders to reassess their own valuation and refine their bidding strategy.

In order to prevent bidders from ‘hiding in the grass’ and waiting for information about other bidders’ strategies to be revealed, which can create the risk of bringing the auction to an unexpected and premature end, implying low revenues and potentially inefficient outcomes – bidders must usually adhere to activity rules.

COMBINATIONAL AUCTIONS

Another way to protect bidders from the risk of acquiring incomplete sets of lots or paying more than the aggregate value for complete sets is to allow them to bid for *combinations* or *packages* of lots rather than on each lot individually. In this case, a complication is that identifying the highest bidder is not a straightforward task. More specifically, the auction mechanism has to check for the combination of *mutually consistent* bids that result in the highest revenue.

However, this possibility is not free from other kinds of inefficiency. With combinational bidding, a group of slots may inefficiently fall in the hands of

[87] This section draws very much from Milgrom’s paper on application of simultaneous ascending auctions for radio spectrum allocation (Milgrom, *op cit.)*.

[88] Amongst these there are the multi-billion dollar 3G mobile licence auctions in Europe.

[89] Depending on the format chosen by the authority, the auctioneer may communicate either all the information available (valid standing bids, ranking, waivers, etc.) in which case the auction would be *fully transparent*, or only a part of it (e.g. only the first two highest bids).

whoever makes a bid for the package as a whole. This is usually called the "free rider" problem. Consider the following example. There are three competitors: *A*, *B* and *C* who are bidding for two lots *R* and *S*. *A*'s valuations for *R* and *S* are £4 and £1 respectively. The valuations of *B* are reversed: £1 for *S* and £4 for *R*. Both of them value the package *R*&*S* at the sum of the valuations of the standalone lots, £5. *C* is not interested in the item separately, but places a valuation of £7 on the package *R*&*S*. The auction would finish with the assignment of both items to *C* at a total price slightly higher than £5, as:

- C would bid only for *R*&*S*, being prepared to pay up to 7;
- *A* and *B* would stop bidding for *S* and *R* respectively at prices higher than £1, and not bidding for the package at all. Therefore, the prices for *R* and *S* separately will reach at most 1. *A* and *B* will each be prepared to bid at most 5 for *R*&*S*.

This outcome is inefficient, as the sum of the valuation of the allocated resources is not the possible maximum, which would be attained if *R* went to *A* and *S* went to *B* (£8 in total).

Although combinational bidding removes aggregation risks, it does introduce other forms of inefficiency, as this example shows. Therefore, the desirability of combinational bidding depends on the specifics of the application to which it would be applied and, in particular, the extent to which all bidders face synergies. The Federal Communications Commission (FCC), the US regulatory body in the telecoms sector has decided to adopt a simultaneous multi-round auction with combinational bidding as of 2001 for allocation of regional spectrum licences.

THE THREAT OF COLLUSION

In addition to the specific characteristics of the allocation problem – private or common value, synergy benefits across lots and systematic differences between bidders – the auction designer will also have to take account of the likely threat of collusion. If the number of participants in an auction is small, the risk of collusive behaviour becomes a concern when designing the auction mechanism, as collusion tends to depress revenues and lead to inefficiencies.

In general, the more transparent the auction and the more information is being made available to participants, the easier it is for bidders to collude, as intentions can be signalled and 'cheating' on collusive agreements can be detected. For example, the participants in a spectrum auction set out in the U.S. in 1997 managed to signal their preferences on the various licences using the last three digits of their multi-million dollar bids. The cash raised was less than $14 million, well below the $1,800 million expected from the FCC.[90] Subsequent spectrum auctions (UK, Germany, Italy, etc.) ruled out this possibility by considering valid only those bids that were multiples of some predetermined unit (e.g. whole 100,000s). However, whilst this clearly made signalling more expensive, it did not make it impossible. In the recent German 3G auction, Vodafone/Mannesmann was allegedly signalling its wish to end the auction through the last three digits of its bids – which given that bids had to be made in whole DM 100,000s implied a cost of tens of millions.

STRATEGIC COMPLEXITY

Auction formats differ in the demands that they make on bidders. Whilst theoretical models assume that bidders are fully rational and make optimal use of all information available to them when making decisions, in real-world auctions this may often not be the case. Not only do decision-makers make mistakes, but often the overheads of corporate approval processes can limit bidders' abilities to fine-tune strategies. In practice, we would rather expect that bidders act in a *boundedly rational* manner, being able to gather and process only a limited amount of information.

In a first-price sealed bid-auction bidders have to second-guess what their competitors will do. Forming expectations about the likely behaviour of other bidders is an important in deciding what sealed bid to make. In contrast, in an English open auction bids are called out by participants, the optimal strategy simply consists of staying in if the price is below that bidder's valuation. Therefore, it is not necessary to second-guess what other bidders might do.

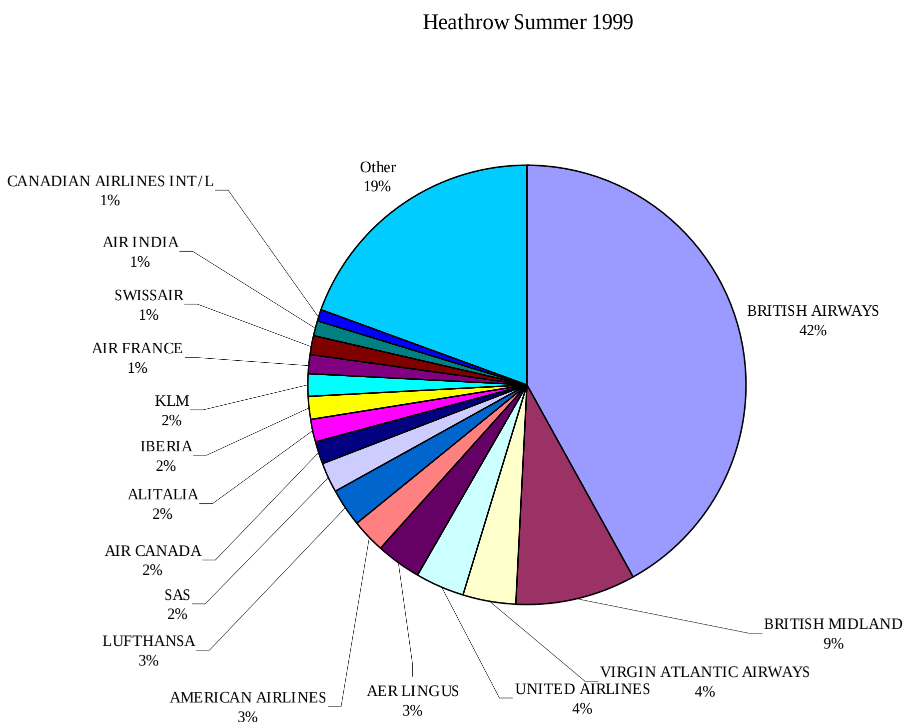
Given that bidders may have limited decision making powers, this issue of strategic complexity is relevant. In general, auction formats that required complex decision-making may, other factors equal, lead to less efficient outcomes.

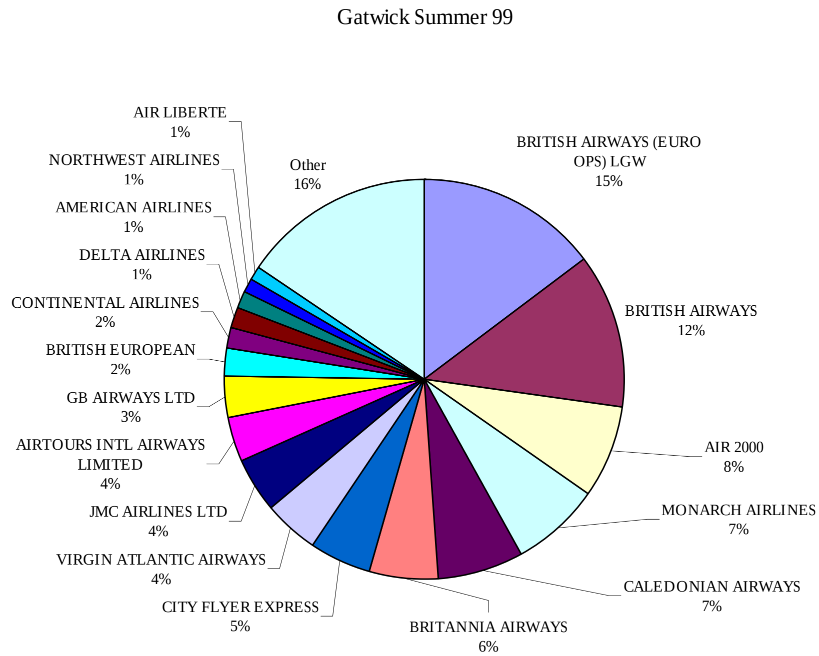
[90] See Crampton & Schwartz: "Collusive Bidding in the FCC Spectrum Auctions", *Working Paper University of Maryland*, 1999.

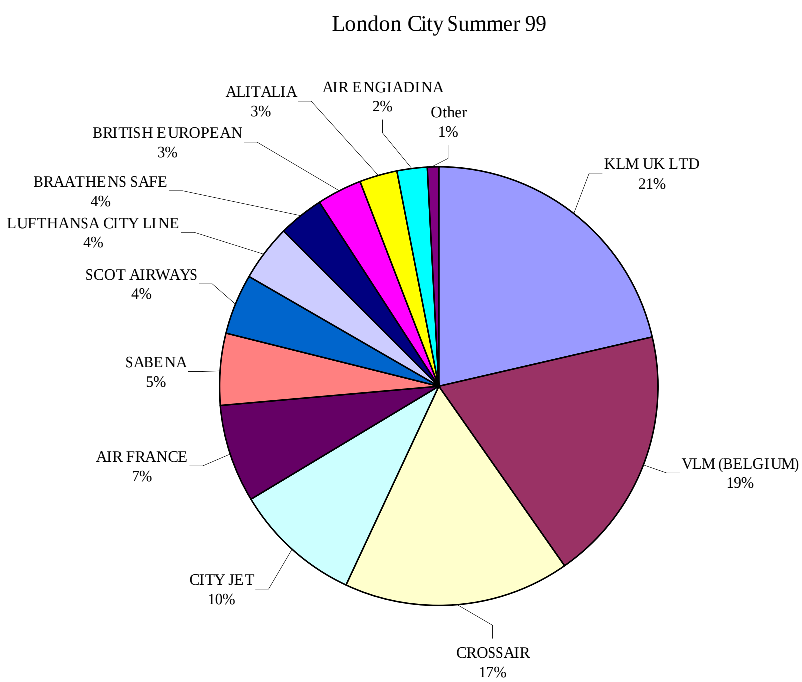
ANNEX 2: CURRENT MARKET POSITIONS

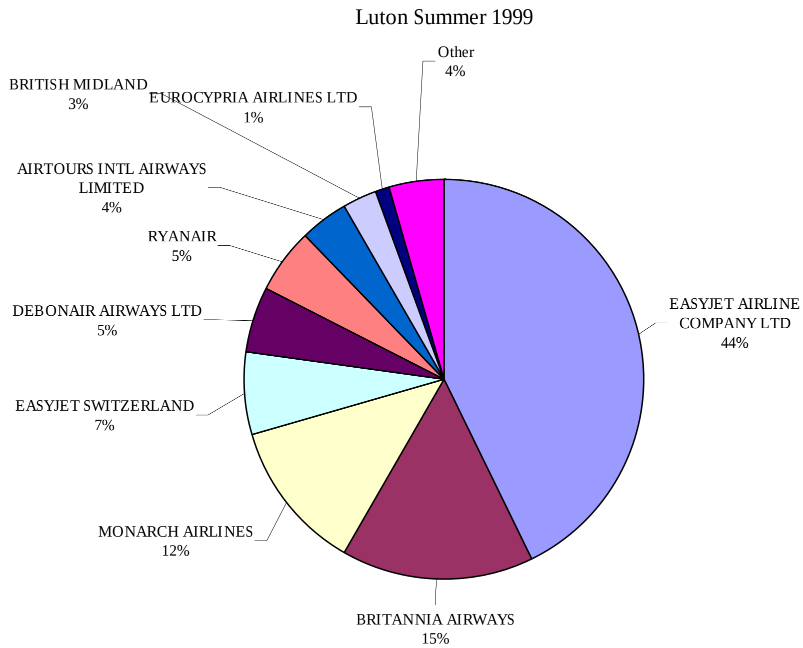
The following diagrams show the shares of passengers served by different airlines at the five London airports (Heathrow, Gatwick, London City, Luton and Stanstead), and for all London airports together. This shows that, at each airport, a small number of airlines account for a large proportion of passenger volumes.

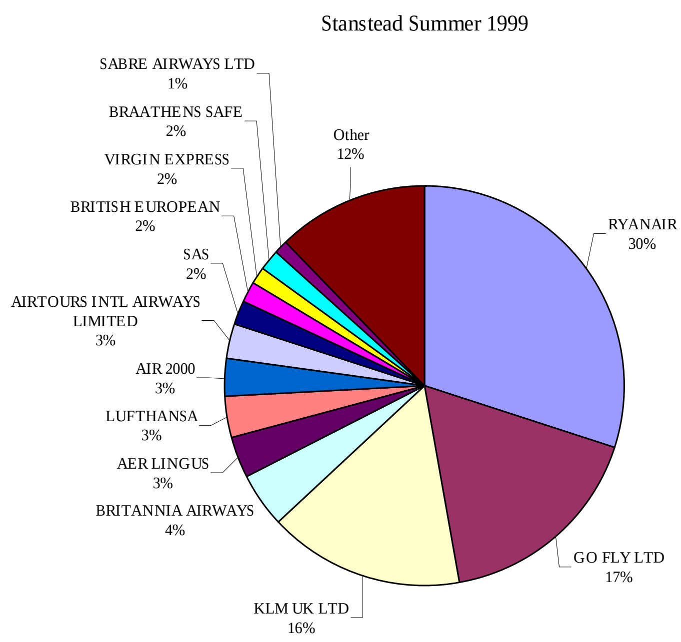
Figure 4: Shares of Passengers at London Airports



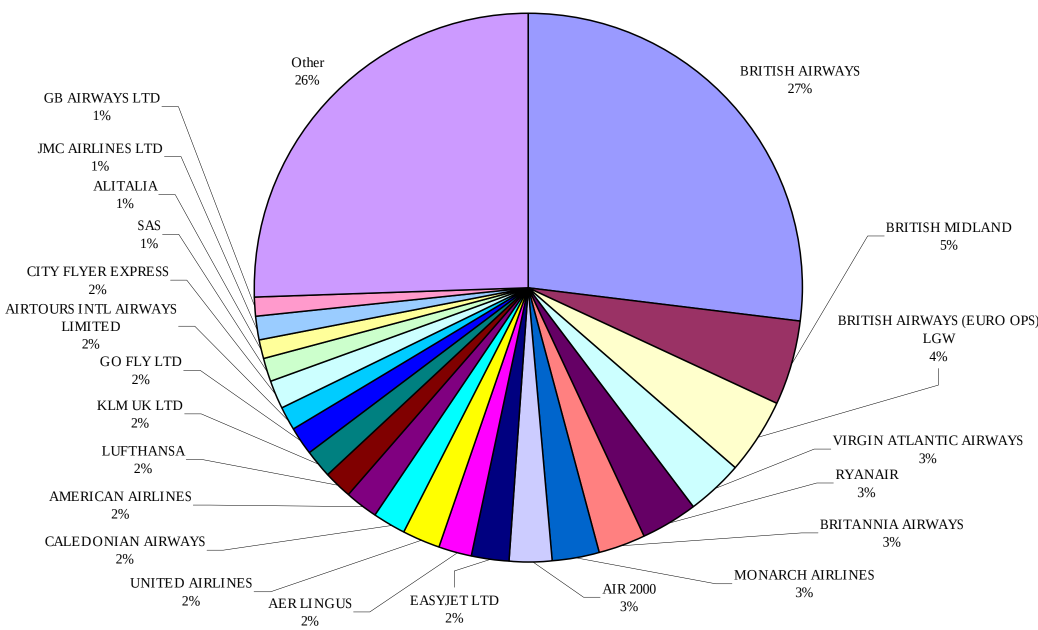

Gatwick Summer 99
BRITISH AIRWAYS (EURO OPS) LGW 15%
BRITISH AIRWAYS 12%
AIR 2000 8%
MONARCH AIRLINES 7%
CALEDONIAN AIRWAYS 7%
BRITANNIA AIRWAYS 6%
CITY FLYER EXPRESS 5%
VIRGIN ATLANTIC AIRWAYS 4%
JMC AIRLINES LTD 4%
AIRTOURS INTL AIRWAYS LIMITED 4%
GB AIRWAYS LTD 3%
BRITISH EUROPEAN 2%
CONTINENTAL AIRLINES 2%
DELTA AIRLINES 1%
AMERICAN AIRLINES 1%
NORTHWEST AIRLINES 1%
AIR LIBERTE 1%
Other 16%


London City Summer 99
KLM UK LTD 21%
VLM (BELGIUM) 19%
CROSSAIR 17%
CITY JET 10%
AIR FRANCE 7%
SABENA 5%
SCOT AIRWAYS 4%
LUFTHANSA CITY LINE 4%
BRAATHENS SAFE 4%
BRITISH EUROPEAN 3%
ALITALIA 3%
AIR ENGIADINA 2%
Other 1%


Luton Summer 1999
Other
4%
BRITISH MIDLAND
3%
EUROCYPRIA AIRLINES LTD
1%
AIRTOURS INTL AIRWAYS LIMITED
4%
RYANAIR
5%
DEBONAIR AIRWAYS LTD
5%
EASYJET SWITZERLAND
7%
MONARCH AIRLINES
12%
BRITANNIA AIRWAYS
15%
EASYJET AIRLINE COMPANY LTD
44%


Stanstead Summer 1999
SABRE AIRWAYS LTD
1%
BRAATHENS SAFE
2%
VIRGIN EXPRESS
2%
BRITISH EUROPEAN
2%
SAS
2%
AIRTOURS INTL AIRWAYS LIMITED
3%
AIR 2000
3%
LUFTHANSA
3%
AER LINGUS
3%
BRITANNIA AIRWAYS
4%
KLM UK LTD
16%
GO FLY LTD
17%
RYANAIR
30%
Other
12%

All London Airports Summer 1999



Source: CAA Airport Statistics as reported by the UK airports.