Pricing the Airport Infrastructure for the Airbus A 380: Efficient Pricing and Dynamic Inconsistency

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Abstract

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The introduction of the new large aircraft, the Airbus A380, will require investments by airports to enable them to handle it. These investments will be in the nature of sunk costs, such as in widening runways. As such they will pose problems for pricing, cost recovery and investment evaluation. Short run pricing efficiency involves not imposing any specific charge for the use of the aircraft, which will mean that users will not face the costs they impose. This can lead to a dynamic inconsistency problem, whereby following optimal policies at all points of time leads to non optimality in the long run. This will lead to excessive investment in accommodating the A380. In addition, the ownership/ regulatory environment within which most airports operate will further increase the incentives for excessive investment.

Keywords:

New Large Aircraft
Sunk costs
Efficient pricing
Airport Pricing
Cost benefit analysis
Rate-of-Return Regulation
Price Cap Regulation

1 Introduction[1]

The new large aircraft, the Airbus A380, is due to come into service by 2006. Before this happens, most airports will need to invest so as to be able to handle it. Many will need to widen runways, realign taxiways and redevelop terminals. Much of the investment needed will be in the form of sunk costs, and the marginal costs of operating the extended facilities will often be negligible. Thus the costs imposed by the A380 using the runway will be small, and comparable to those of other aircraft.

An obvious question is who should pay for the additional costs of the investment to make airports capable of accommodating the new aircraft. As airports invest to handle the A380, they are considering it. It is a deceptively simple question, which poses a number of complexities. If the objective is to achieve efficiency, in the short run and the long run, a number of issues need to be settled:

- If the marginal cost of using the A380 at an airport are zero, should any additional specific charge on its use be levied?

- If not, and airports need to recover the costs of their investments to handle the A380, how should price structures be adjusted?

- What role might two part tariffs play in efficient pricing and can they ensure that "users pay"?

- If prices for the use of the A380 are set at zero, how can investments by airports to accommodate them be assessed, and what signals will airlines face whether to purchase the aircraft? And

- When efficient pricing and investment solutions can be devised, will the ownership/regulatory environment most airports operate within provide the incentives to set prices and assess investment correctly?

Each of these issues is examined in this paper. However one particular risk, that of dynamic inconsistency of optimal plans, is given particular attention. This is a situation in which following optimal policies at each point of time leads to less than optimal outcomes over time. This problem has been analysed in the macro literature, though it is equally pertinent in the micro context. A possible example of this occurred when airlines first bought jet aircraft- these required investments by airports in longer runways. It also possibly occurred when airlines chose aircraft which required stronger and more expensive runways, than the alternative aircraft on offer.

The nature and possibility of dynamic inconsistency of optimal plans is considered first. After this, the Airbus A380 and its airport requirements are considered. In section 4, optimal pricing in the short run is considered. Following this, the problem of optimising investment is considered, and the possibility of efficient policies leading to long run non optimality, when airlines effectively play a game with airports, is examined. This concludes that there is a risk of excessive investment. In section 6, the

[1] I am grateful to Anthony Bell for helpful research assistance, and to Paul Hooper and Anming Zhang for helpful comments.. Any errors are my own.

incentives for efficient pricing and investment are considered in a world where airports are either publicly owned or privately owned but subject to regulation; these incentives are weak, thus increasing the risk of excessive investment. Finally, the key points of the paper are synthesised and some broad conclusions are drawn.

2 Efficient Pricing and Dynamic Inconsistency

When government agencies seek to implement policies which are optimal, it is possible that a course of action which is optimal at every point of time will be non-optimal over time. This is a possibility which has been explored by Kydland and Prescott (1977), and which has received some attention in macroeconomics. It has been explored in the context of tax policy, where the efficient taxation of capital depends on whether it has been sunk or not (Blanchard and Fischer, 1989, pp592-596). It has received rather less attention in microeconomics, though it is equally applicable, especially where substantial sunk costs are involved.

The problem arises when the agency commits to implementing an optimal policy at each point of time. Normally, efficient pricing in the short run leads to efficiency in the long run. However, there are exceptions to this. For example, the agency may incur a sunk cost, after which marginal costs are zero. Efficient pricing then would involve zero prices. The agency has to choose whether to incur the sunk cost. However this may induce users to commit to courses of action which, after the event, make it worthwhile for the agency to incur the sunk cost. In spite of this, it is possible that the gain from the course of action may be less than the sunk cost- in short, it is optimal not to incur the sunk cost, but to allow higher costs to be incurred by users later. Following a short run optimal policy all the time- in this case setting prices at zero- does not result in the optimum in the long run being achieved.

There have already been examples of this in the aviation sector. At the time jets were first being introduced, the two main options for long haul aircraft were the Boeing 707, and the Douglas DC8. The two differed in their runway requirements. The DC8 had landing gear which had lower wheel loadings and thus which required less strong and therefore, less expensive, runways. In other respects it was less preferred. Runway strengthening is a sunk cost. Once the runway had been strengthened, the marginal cost of using it was approximately the same, at close to zero, for both types of aircraft. Optimal pricing thus required the same user charges for both aircraft. In this situation, it is possible that the least cost solution all-up would have been for airlines to purchase the less preferred aircraft, but for airports to have invested in the lower cost runways. Since airports were committed to optimal pricing, and this did not involve any pricing penalty for the Boeing 707, airlines tended to buy the Boeing. Granted that airlines had purchased the Boeing 707, the optimal policy for airports was to strengthen their runways, to be able to cope with the dominant choice of aircraft. If airlines which purchased the Boeing 707 had faced the costs of stronger runways, they might have opted for the DC8 instead- however short run optimisation demanded that airport charges for the two types of aircraft be the same. There was no way in which the airports could both optimally price, and give airlines the incentive to

choose the aircraft which minimised the overall costs. In a sense, the airlines played a game against the airports and won.

Another example also occurred when jets were being introduced. The new jets required longer runways than existing aircraft, though they could have been designed to use shorter runways, at some additional capital cost. Manufacturers made, and airlines bought, the new jets, and once the longer runways were in place, the cost of using them was the same for aircraft regardless of whether they capable of using shorter runways. Manufacturers had no incentive to build aircraft capable of using shorter runways, though this could have been a more efficient option in the long run (see Doganis, 1992, pp80-84).

This problem seems likely to reoccur with the introduction of the new large aircraft, the Airbus A380. This aircraft will require wider runways than many airports currently have, and additional terminal facilities, along with larger parking areas. Many of the costs associated with these will be sunk costs- for example, the widening of the runways would be sunk costs. The A380 will require capital expenditure by the airports, but it will lead to cost savings which will accrue to the airlines which operate it. The question arises of who should pay for the extra costs of accommodating the A380. If prices are set efficiently, since the marginal costs of the A380 in using an airport runway are the same as for other aircraft, (approximately zero), this implies that A380s should not be charged any more than other aircraft. If so, airlines will not take the extra costs of accommodating the A380 into their purchasing decisions, and will opt for the A380 even when smaller aircraft would be more cost effective, taking into account both airline and airport costs.

Alternatively, it is possible that airports will impose additional charges on the use of A380s to recoup the sunk costs of accommodating them. This will make airlines take the airport costs into account when they decide whether to purchase the A380, and this will result in minimisation of overall capital costs. However, this will introduce a short run inefficiency- since it will be more expensive to schedule an A380 into an airport, airlines will have a disincentive to use them even when they are the most efficient choice of aircraft.

The upshot is that there is no single best way to price for the A380- short run optimisation can create an excessive incentive for airlines to choose the aircraft, while using prices to condition long run choices results in inefficient utilisation of airports. Are there ways round this dilemma?

3 The Airbus A380, Airport Costs and Pricing

The Airbus A380 is a substantially larger passenger and freight aircraft than any currently flying. The usual stated capacity is 550 passengers, though it will be capable of carrying considerably more, depending on seat pitch. It will be able to offer lower costs per passenger than long haul aircraft currently in service, such as the Boeing 747, or aircraft currently being delivered, such as the Boeing 777, the Airbus A330 and Airbus A340. Many of the long haul airlines of the world have confirmed orders for it, including European airlines such as Lufthansa, and Asia Pacific airlines such as Singapore Airlines and Qantas- each of these has 12-15 aircraft on order. However the

most spectacular order has been from Emirates, a rapidly growing Middle Eastern airline, which has around 40 aircraft on order. The A380 is scheduled to come into service in 2006.

Most or all airports will require some investments, sometimes substantial, in order to be able to accommodate the A380 (see Holzschneider, 2004). It has a significantly wider wingspan than the largest aircraft currently in use. This will require larger separations in taxiways, and wider runways. The A380 will be more demanding of apron and parking space. Terminals will need to be adapted to handle it. Since it is a double deck aircraft, new double deck air bridges will be required if turnaround times are to be kept at levels currently achieved with smaller aircraft. Within the terminals, larger gate holding areas will be needed for the larger numbers of passengers.

These adaptations will impose costs on airports. The exact cost will vary from airport to airport, and will depend on the current stage of development and on the current layout. Some adaptations may not be very costly. For example, if the airport is upgrading its terminals, building new gates and facilities capable of handling the A380 need not add much, if anything, to costs. Facilities will need to be larger, but they may not be more expensive, on a per passenger basis, than existing facilities. Where terminals were adequate and upgrading is not contemplated, it will be necessary for the airport to incur more capital expenditure or to incur such expenditure earlier than originally planned- this will add to costs. To some extent, a larger aircraft will impose larger short run marginal costs. The A380 will require more parking space, and where space is at a premium in an airport, this will have an obvious opportunity cost.

However, a substantial proportion of the costs which need to be incurred to accommodate the A380 will take the form of sunk costs with low or negligible subsequent operating costs. Some airports will need to widen runways, and to realign taxiways so as to achieve adequate separations. These involve investments which, once completed, will not be required to be repeated. Once a runway is widened, the marginal cost of using it will be unchanged. This marginal cost or runway use is often taken to be around zero. (This assumption has been challenged -see Hogan and Starkie, 2004- and it has been suggested that costs of runway damage could be significant). However, costs will be related to wheel loadings, not the size of the aircraft. Thus the A380's marginal cost of runway use need not be very different from that of other large aircraft currently in use. Where taxiways have to be realigned, a sunk cost will be incurred, but the marginal cost of their use will not be altered- again, the marginal cost of an A380 using these taxiways is likely to be little different from that of other aircraft.

There are some estimates available of the costs of accommodating the A380. In the US the General Accounting Office (GAO) has made estimates of the costs of modifying US airports to handle the A380 (GAO, 2002). It estimated that the cost of modifying Los Angeles International Airport would be $US1,215m (by far the highest cost), $US109m for Kennedy Airport in New York, and $US26m for Atlanta. Airbus disputes these figures on the ground that some of these expenditures would be incurred anyway, and are not purely A380 related. Their estimate is $US177m for Los Angeles, the same for Kennedy and $US25m for Atlanta (GAO, 2002, Appendix V). It is reported that 450m pounds is being spent at London Heathrow Airport to

accommodate the A380 (Rozario, 2004). Some of this is on terminal modifications, and would enable savings in expenditure elsewhere. These estimates suggest that the costs associated with modifying airports to handle the A380 can be substantial, but that they vary considerably from airport to airport. Where airports are tightly land constrained (Los Angeles) the costs are much higher than where land is readily available (Atlanta).

Thus, depending on the airport, there could be substantial capital expenditure required to ensure that the airport is capable of handling the A380. This expenditure will be in the nature of a sunk cost- it will be a once-off amount, and there will not be any increase or decrease in operating costs of the airport associated with it. This expenditure will be necessary, in several cases, for a relatively small number of flights, at least for the next decade or so.

This raises the question of who should pay the costs of accommodating the A380. They could fall on:

The airport;

The airlines which use the A380; or

Airlines in general, including the airlines which do use the A380.

A simple and popular answer would be that there should be user pays- i.e. that the airlines which use the A380 should pay for the upgrading of the airport to accommodate the aircraft. As with many simple answers, matters are more complex than they suppose.

If the second or third of these is the case, it will be, in the first instance, the airlines which pay. If the airline market is competitive, airlines will pass these costs on to passengers. There will be some distributive consequences. Passengers who fly on predominantly international routes on A380s will be different from those who fly on airlines in general. If charges are levied initially on airlines which operate the A380s, the costs will fall relatively more heavily on international passengers than when charges are levied on airlines generally.

In this and the next two sections, it will be assumed that the objective is to promote efficiency in the aviation sector. This includes a short run dimension, namely that of ensuring efficient use of the airport facilities and aircraft which are present at a particular point of time. It also includes a long run dimension, namely that of ensuring that investments are only made when the benefits from them, such as in reduced aircraft operating costs, are at least as great as the costs of making them. This said, other objectives, such as achieving fairness, e.g. in terms of allocating costs between users, will be recognised, and the conflicts between these objectives will be discussed later.

The short run efficiency problem involves getting the right mix of aircraft using an airport. Overall costs, including costs to the airline and to the airport, should be minimised. If the marginal costs imposed by all types of aircraft are the same, then airline costs (including costs of time and convenience to passengers) should be

minimised. The long run efficiency problem involves ensuring that only those airports for which net benefits are positive make the investment in infrastructure to accommodate the A380. For some airports, investment is clearly worthwhile or not worthwhile, though there are many in between these cases for which investment might or might not be worthwhile, and efficiency demands that these face incentives to make the right choice.

Where the introduction of the A380 involves increased operating costs of the airport, or opportunity costs of using scarce facilities and space, short run marginal costs will be positive. These types of costs are not too difficult to handle, since in general, it is efficient for users to be faced with the marginal costs which they impose. Thus it may be efficient to charge more for parking to an aircraft which uses more space. This said, there may be reasons for diverging from this rule if prices are not set optimally in the first place. To this end, the handling of short run marginal costs is considered in the context of airport pricing structures in the next section.

The handling of sunk costs is more problematic. There are both short term allocation, and long term investment, problems to be solved. Once the investment has been made, it will be efficient to set prices such that these sunk costs are not recovered, since the marginal costs associated with them are zero, and any charge would lead to incentives to operators of the A380 to underutilise the airport. On the other hand, it will be important to ensure that the long term problem is solved, and that airlines do not have too great an incentive to switch to the A380, which they might have if they face none of the costs incurred in upgrading airports to accommodating them.

This also poses the question of what allocative role prices should have. Prices have an obvious role in the short run- they will determine the use to which airlines make of an airport, and which aircraft they choose to fly into it. Prices also *can* be used as a signal for investment- the prices which the provider of the facility expects to receive will influence whether it will find an investment worthwhile. Prices will also condition the investment decisions of the airlines- if airports are charging more for A380s to use their facilities, airlines will buy and schedule fewer A380s.

However, prices need not be the only signal for investment. An airport which plans to not recoup the sunk costs from airlines which operate A380s can still undertake a cost benefit analysis to determine whether it is worthwhile (in overall efficiency terms) investing to accommodate the aircraft, and can choose not to accommodate if it is not worthwhile. Airlines will make their decisions whether to purchase the A380 based on whether the airports they wish to fly into can accommodate them. If airports do not invest to accommodate the A380, then airlines will purchase fewer of the aircraft. In short, prices may be used for the short run allocative problem, but alternative approaches may be used to resolve the long run investment problem. This could be a way around the dilemma posed by the fact that the prices which ensure efficient solutions of the short run problem are different from those which solve the long run problem.

Another dimension of the problem which must be taken into account is that the starting point for pricing differs from airport to airport. For some airports, current pricing structures are quite efficient- for others, current price structures are distinctly inefficient. Some airports have more than adequate capacity, and prices are imposed

to recover costs. Other airports are busy. Some of these are congested, especially in North America, and prices are well below those which would ensure efficient use of the airport. Some busy airports, especially in Europe, are subject to excess demand, and are slot rationed. Sometimes these slots are tradable, and sometimes they are not. The case for imposing specific charges on users of A380s could depend on what the starting point is.

4 Efficient Pricing and the Short Run

In this section, it will be assumed that for an airport to be able to handle the A380, it will be necessary for it to make some capital investments, such as in widening the runways. These investments will be sunk costs in nature, and there will be no changes in operating costs associated with them. The marginal costs of an A380 in using these facilities will be the same as for other aircraft. In the main, the marginal costs of using the A380 will be taken as zero, though the case of positive marginal costs will also be considered briefly. Airports may have more than enough capacity, or they may be busy and congested or subject to excess demand. These possibilities are considered in turn.

(a) Non Busy Airports

Many airports around the world have more than adequate capacity, because investments such as runways are subject to substantial indivisibilities. Passenger related investments such as terminals can be more closely tailored to demand. Typically, there will be a large sunk cost in building the runways and taxiways, and the marginal costs of using these will be zero, or low relatively to the total cost. Marginal costs of using the terminals are likely to be positive and close to the average costs.

With this cost structure, there will be a cost recovery problem if prices are set efficiently. Efficient prices will fail to cover the costs of building and operating the airport. If cost recovery is imposed, as it is for most airports in this situation, then second best pricing will be required. Ramsey pricing, which sets prices proportional to the inverse of the elasticity of demand for a particular user, will achieve cost recovery at minimum cost in terms of efficiency. Ramsey prices are often regarded as impractical and demanding of too much information. However, airports have long implemented an approximation to Ramsey prices. Charges for most non busy airports are based on aircraft weight, or passenger numbers. Terminal costs depend on passenger numbers. Furthermore, aircraft size and passenger numbers are roughly correlated with the inverse of the elasticity of demand. Thus this pricing structure is tolerably close to a Ramsey price structure, and if so, cost recovery can be achieved at little cost in terms of efficiency (Morrison, 1982).

Suppose the case of a non busy airport incurring a sunk cost to accommodate flights by A380s. How should these sunk costs be recovered in a way which is most consistent with efficiency? Should specific charges be levied on users of A380s, or should the extra sunk costs be included in to cost base to be recovered from all users?

Since the marginal costs associated with the A380 are the same as for other users, they should not be priced differently. The price structure should be adjusted to recover the higher costs. This means that all users will pay more. The all-up price for using an A380 will be higher than for smaller aircraft, though the per kilogram or per passenger charge will be about the same. In terms of airport charges, airlines will face approximately the same costs if they use A380s or smaller aircraft, and this will reflect cost conditions, since the costs of handling different aircraft are the same. The choice of aircraft will be based on the operating and other costs of using different aircraft, and will be efficient.

If there are positive marginal costs specifically associated with the A380, then it will be efficient to allow for these in the pricing schedule. Just as aircraft which stay longer in parking areas impose greater costs on the airport, the use of a very large aircraft may impose additional costs, which it is efficient to recognise in the price structure.

This result whereby sunk costs are recovered from all users may not be seen as very "fair", and it can be seen as a divergence from the principle of "user pays". A small number of airlines schedule A380s into an airport, which is then required to incur costs to accommodate them. The airlines which operate the A380s will enjoy reduced operating costs. Other airlines will shoulder most of the burden of the costs of providing for the A380s. However, once the facilities are upgraded, it is then efficient to make the best use of them, and this requires that airlines face no disincentive to schedule the A380 rather than other aircraft. While this may be an efficient solution, it could be regarded as not fair. Fairness is a concept which economists do not often use, but public decisions are often conditioned by perceptions of fairness (for a discussion, see Zajac, 1995).

(b) Busy Airports

The significance of the distinction between busy and non busy airports is that while the pricing structures of the later are mostly tolerably efficient, the pricing structures of busy airports are often quite inefficient. Three types of busy airports can be distinguished:

Ones with slot limits and efficient price structures;

Ones with slot limits and inefficient price structures; and

Ones which use congestion to ration excess demand.

These are considered in turn.

Slot Limited Airports with Efficient Prices

Pricing efficiency for slot constrained airports requires that both slots are efficiently allocated and prices for use of the airport reflect marginal costs and opportunity costs of capacity. Efficient allocation of slots will be present if there is a slot auction, or effective, unconstrained trading of slots. An efficient price structure for use of the airport involves a flat charge for use of the runway and associated facilities, combined

with a per passenger charge which reflects the marginal costs of terminal use. One efficient solution would be for the user charge for the airport to be sufficiently high to eliminate the slot premium. This rarely occurs- mostly, airport charges are held down by owners or regulators, and there is a premium for slots. The price to an airline for an aircraft to use the airport includes a flat amount equal to the slot premium and runway charge, plus a per passenger charge reflecting passenger related costs.

There are few airports which meet these conditions. The closest approximation is London Heathrow Airport. The pricing structure has a large fixed element in it, though there is also a per passenger charge. Slots are tradable, and there is an active market for slots (though it is difficult to determine exactly how efficient this slot market is).

Given a starting point of a tolerably efficient pricing structure, it would be efficient not to impose a separate charge on the use of the A380 to recover the sunk costs of accommodating it. If the sunk costs are to be recovered from airlines, the most efficient way of doing so would be to raise the flat per flight charge for using the airport, while leaving the passenger charge unchanged. The price for using the airport would move closer to the market clearing level, and the slot premium would fall accordingly. There would be no efficiency cost in recovering the additional sunk costs in this way. Unless demand elasticities are very high, the substitution of smaller aircraft by the A380 will lead to a fall in the demand for slots, and the slot premium will fall further.

With this pricing structure, airlines will face the right incentives when choosing whether to schedule the A380 or smaller aircraft. Each type will face the costs it imposes on the airport system. The price per flight will be the same, reflecting the same costs per aircraft. The A380 will pay more in total per passenger charges, reflecting its higher passenger load and greater passenger related costs. If slot prices are very high, as they are for London Heathrow, there will be a strong incentive for airlines to consider replacing smaller aircraft by the A380, thus economising on the scarce capacity.

If there are positive marginal costs of use, then it will be efficient for prices to reflect these. Thus if the A380 uses more parking space, and space is valuable, it will be efficient to charge it more than smaller aircraft.

As with the airports which are not busy, it will be the airlines in general which use the airport who will pay for the costs of accommodating the A380. Those who do not benefit from the use of the A380 will pay the costs associated with it. This will be essential if efficiency in the short run is to be achieved.

Slot Limited Airports with Inefficient Pricing

Inefficient pricing is the norm with slot limited airports. Except for the London airports, and a few US airports, slot trading is prohibited in many parts of the world, especially in Europe. In addition, most airports still operate with weight or passenger related charging systems, which, while efficient for non busy airports, are quite inappropriate for busy airports. Even though capacity to handle flights is at a premium, it is cheaper for smaller aircraft with smaller passenger loads to use the

airport than for large aircraft. The structure of pricing discourages the substitution of small by large aircraft, even though this would lead to better utilisation of the airport.

In this situation, the case for not imposing a specific charge on the A380 to recoup the sunk costs of accommodating is stronger than before. Such a charge would further discourage the use of the A380, and would compound the disincentives noted above. Assuming that airport charges are levied to recover costs, airlines which use smaller aircraft will pay the costs of accommodating the A380. In this case, while the fairness issue also arises, most of the flights which pay increased charges are underpriced, and efficiency is enhanced, rather than reduced, by imposing the costs on them.

Even where there are some marginal costs specific to the A380, it may be efficient to absorb them in the general price structure, rather than to relate charges to them, as was the case when price structures were efficient. Because large aircraft are over priced, an additional charge will lower, not raise efficiency.

Congested Airports

Most busy airports in the US which are subject to excess demand ration this demand by congestion. Service is predominantly on a first come first served basis and queues form. In addition, airports recover costs with weight based or passenger based charges. Granted that each movement imposes the same external delay cost, this means that while prices are, in general, below marginal cost, large aircraft are relatively discouraged and small aircraft are encouraged. A specific charge for the A380, to recover the sunk costs of its infrastructure, would lower allocative efficiency, since the marginal cost of the A380 would be the same as that for other aircraft, but the higher charge would discourage its use. A zero specific charge for the A380 would enhance efficiency in the short run by encouraging some substitution of small by large aircraft, thus reducing congestion.

(c) Non Linear Pricing

So far, it has been assumed that simple unit pricing would be imposed. When there is a cost recovery problem, non linear prices, such as two part tariffs, are often more efficient. This possibility needs to be considered in the context of recovering the sunk costs of accommodating the A380.

One possible solution would be to offer a contract which involved airlines which commit to using the A380 making a contribution to the sunk costs, in advance, and for those which do so zero specific charges for using the A380 would be levied. Other airlines, which do not contribute to the capital costs, would be charged a specific price when they use A380s at the airport. This solution would ensure efficient utilisation by airlines which contribute up front, since they face the marginal costs of use- namely zero. Other airlines would face a charge for use, and would not use the A380 to its full potential. Thus there would be some cost in terms of efficiency in the short run, though it would be small.

While, in principle, a two part pricing schedule has desirable properties, it may be difficult to determine the up front contributions. These might be on the basis of expected use of the aircraft, though this would result in some airlines making larger

up front contributions than others. Alternatively, a fixed up front contribution might be charged. As usual with two part tariffs, this fixed charge would discourage some users, and would thus have some efficiency costs.

The two part tariff approach thus has some efficiency costs- though these need to be compared to the efficiency costs of setting zero specific charges for the A380. While such a pricing policy optimises the use of the aircraft, it does have an efficiency cost in terms of raising prices to all users a little further above marginal cost. This cost is likely to be small if demand elasticities for use of the airport are low, as is likely to be the case. A possible efficiency advantage of the two part tariff is that it creates the right signals for airlines to take into account the infrastructure costs of choosing the A380. Such a price structure makes it feasible to use prices to signal efficient investment choices by the airlines.

The main practical advantage of the two part tariff is that it results in users which use the A380 paying for its infrastructure- it thus achieves a good mix of efficiency and fairness.

5 Efficient Investment and the Long Run

(a) Investment Criteria

The long run decision for an airport is whether to invest to accommodate the A380. Suppose that welfare maximisation is the objective. Whether an airport invests will depend on the likely use of the airport by airlines scheduling A380s. If there is only likely to be limited use by airlines of the aircraft, accommodation will not be worthwhile. For some airports, such as London Heathrow and Singapore Changi, accommodation will be well worthwhile, since the A380 is likely to be used extensively. For many airports, it may or may not be worthwhile to accommodate- for these, there is the risk of inefficient decisions if excessive investments are made, or provision is not made when warranted.

Given the welfare objective, the appropriate course of action is to undertake a cost benefit analysis of accommodation, balancing the costs against the benefits that airlines and others may gain from the lower operating costs, greater availability of capacity (if relevant) and lower congestion (also, if relevant). For a slot limited airport, the use of the larger aircraft will make more slots available, which will be a benefit. If the additional infrastructure is provided, unless a two part tariff is feasible, the optimal specific charge for the A380 will be zero. In this context, there will be no role for prices in signalling how the airlines should invest in aircraft. However, availability of infrastructure will be the signal- some airports will not find it optimal to provide for the A380, and airlines will take this into account in determining how many of the aircraft to purchase.

This combination of zero pricing and cost benefit analysis of investment will result in an optimal result. The prices chosen will optimise the use of the airport whether or not the investment has been made, and the use of cost benefit analysis will result in an efficient investment choice. To the extent that cost recovery is required, there will be a slight efficiency loss when prices to all users are raised a little.

(b) Pricing and Dynamic Inconsistency

Even if this approach is taken, however, there is a risk of excessive investment. In section 2, the possibility of an agency following policies which, at every point of time were optimal leading to a result which in the long term is not optimal, was considered. This possibility was raised in the model of Kydland and Prescott (1977). It was argued that there had been some possible cases of this problem arising in the aviation sector, when airlines moved to jets, and chose between jets with different runway requirements.

This problem could arise again with the introduction of the A380. At every point of time, the agency, in this case the airport, may make decisions which are optimal- it prices existing infrastructure optimally, and it evaluates investment in infrastructure taking account of all benefits and costs. The users of the infrastructure, the airlines, know that it will be acting in this manner. In spite of this, it is possible for the long run outcome to be non-optimal, and for there to be excessive investment in infrastructure to handle the A380, and for airlines to purchase more A380s than would be efficient.

This is essentially because the airlines play a game with the airport. The game could be considered as one between a single airline and airport, or it could be considered as one between airlines in general and airports in general.

Both airlines and airports must make decisions to incur sunk costs. The airlines must choose whether to purchase A380s or smaller aircraft. Once the aircraft had been purchased, it will be costly to switch types, since the sunk costs of constructing the chosen aircraft have been incurred, but the sunk costs of the alternative have not been incurred. If they purchase smaller aircraft, no further investment in airport infrastructure will be needed. If the A380 is purchased, additional infrastructure will be required, and this will involve the airport in incurring a sunk cost.

If the airlines choose the A380, they know that the airports will not impose any specific charge for this type of aircraft, because this would result in less than optimal usage. They do not know whether the airports will upgrade to handle the A380 however. The airports will undertake a cost benefit analysis. If the airport does a cost benefit analysis knowing that the airlines have committed to the A380, it is very likely that the cost benefit analysis will indicate a positive net benefit from upgrading, since if this does not go ahead, it will be necessary for the airlines to incur further costs in purchasing smaller aircraft – this could be an expensive option. The airports then find it worthwhile to upgrade, and the airlines' gamble in choosing the A380 will have paid off.

In some cases, it will be efficient for the airports to upgrade to accommodate. However, there will also be cases where it would not be efficient. While it will be efficient to upgrade if the A380s have already been purchased, it would not be efficient if there was still the option of choosing either the A380 or smaller aircraft. By locking themselves in to the A380 purchase, the airlines have induced the airports to make investments which they not make if the sunk cost in aircraft purchase had not

already been made- the benefits to airlines of choosing the A380 fall short of the costs to the airport.

The problem arises because there are two groups both incurring sunk costs. One group incurs a sunk cost which then forces the hand of the other, making it worthwhile for it to incur its sunk cost. If airlines and airports made the decision to purchase the A380 and invest in airports to accommodate it jointly, this problem would not occur. However, in reality, decisions are taken separately.

It might be objected that, from an individual airlines viewpoint, the purchase of an aircraft is not a sunk cost, since it can still on-sell the aircraft if it finds that it is not using it. However, if airlines as a group over order an aircraft, and then find they cannot use it as extensively as thought, then a sunk cost has been incurred. The lease price for this aircraft will fall, and the lease price of other aircraft will rise. In this situation, the airport, when determining whether to invest to accommodate the larger aircraft will recognise the lower lease costs of the larger aircraft, and the higher costs of using smaller aircraft in its cost benefit calculations.

Overall, there is the possibility of excessive investment accommodating the A380. If this game is played by airlines, there will still be many airports which do not accommodate- given their traffic; there is clearly no point in doing so. There will be other airports for which accommodation is clearly the efficient choice. However, in between these cases, there will be many airports for which accommodation is not worthwhile taking the long run perspective, but which will accommodate if airlines have already committed themselves extensively to the new aircraft.

6 Airport Ownership, Regulation and Incentives

In the discussion so far, it has been assumed that airports have the objective of maximising efficiency- pricing to maximise efficiency in the use of facilities, and investing where the net benefits are positive. This is the standard assumption of much public enterprise theory, and it has the merit of establishing a benchmark- if the enterprise were to seek to maximise efficiency, this is how it should do it. This said, however, most airports do behave in this way.

Historically, many airports have been publicly owned, though there has been a significant move towards privatisation over the past two decades. In North America, airports are often owned by local communities or governments. While some airports are still operated by government departments, most publicly owned airports have been corporatised.

Even though airports may be publicly owned, they need not be welfare maximisers. The objectives of airport managements may be complex, but they could include size maximisation, quality maximisation and maximisation of business for the local community. Typically, these airports will be subject to an overall cost recovery constraint. Such airports will not necessarily seek to implement price structures which make the most efficient use of their facilities (the widespread presence of totally inappropriate price structures for busy airports is clear evidence of this), or seek to invest only when benefits exceed costs.

Many airports are now privatised. These airports may be seeking to maximise profits, but all major private airports are subject to either explicit regulation or indirect regulation through price monitoring. Some are subject to either explicit or de facto rate-of-return regulation (Niemeier, 2004), while others are subject to price caps, which may or may not approximate rate of return regulation in fact (see Toms, 2004; Hendriks and Andrew, 2004).

The critical issue, for present purposes, is how they respond to investment proposals, such as ones to invest to accommodate the A380. It is likely that public and private rate-of-return regulated airports will respond in a similar way. They will both seek to expand their capital base, to increase total profits in the case of the private airport, or to increase size, in the case of the publicly owned airport. In neither case do they have any incentive to subject investment in accommodating the A380 to rigorous scrutiny, and to invest only if benefits exceed costs. If they make an investment, they will be permitted to pass on the costs to users. The size maximising airport will wish to invest because this is a way of increasing size. The quality maximising airport will see investment as being justified because it improves the range of services available to users. The profit maximising airport increases its regulated capital base and total profit. All have an incentive to invest in accommodating the A380 regardless of whether such investments are warranted or not.

The incentives facing the price capped airport are different, and depend on how the price cap is implemented. If a simple, unchanging, price cap is imposed over airport charges, the airport will have no incentive to invest to accommodate the A380, no matter how worthwhile doing so would be. Investment will increase the costs of the airport, but it will not lead to any price increases, and it will thus reduce profits. This disincentive to invest is frequently recognised (Hendriks and Andrew, 2004) and regulators devise methods to allow the regulated firm to recoup the costs of investment (Forsyth, 2002). If this is done, it will result in the regulator exercising discretion over the investment. The firm will come to the regulator with a proposal to allow pass-through of investment costs (ie to allow a price increase on top of the cap)- the regulator then assesses the investment and chooses whether to allow pass-through. In effect, the regulator evaluates the investment, and could choose to use welfare maximising/cost benefit criteria or alternative criteria. In this situation, here will be an explicit evaluation of whether the investments needed to accommodate the A380 are worthwhile or not. Just as in the case of welfare maximising airports, discussed in the previous section, there is the chance that the regulator will be pressured into allowing accommodation by airlines committing to purchase the larger aircraft.

Pure price caps are rare, though they have been implemented on occasions (eg in Australia from 1997 to 2002). A more common form or regulation is a mix of price caps and rate-of-return regulation. With this arrangement, price caps are set so as to be able to recover forecast costs, including capital costs. Prior to setting the price cap for a period, the regulator makes a forecast of capital expenditure, and evaluates whether all of the airports forecast expenditure is efficient. Under these arrangements, the costs of accommodating the A380 will be forecast, and the regulator may set the price cap at a level which allows recovery of them. If the regulator simply accepts the airport's own capital expenditure program, then this will be similar to rate-of-return regulation, and there is a chance that inefficient investments will be made. If the

regulator assesses the proposed capital investment on cost benefit criteria, then the outcome will be similar to that under the pure price cap, where the regulator determines whether to allow pass-through or not.

Regulation and ownership also have implications for incentives to price efficiently. Public size maximising or quality maximising airports, and private rate-of-return regulated airports do not have clear incentives to price efficiently. While pricing of non busy airports is tolerably efficient, pricing of most busy airports is seriously inefficient. Pricing incentives under price caps are better and interestingly, the busy airports which have the best price structures are those in London, which are subject to a price cap regime, albeit not a pure price cap.

It has been suggested above that the best pricing structure for the A380 would involve either no specific charge for use of this aircraft, or a two part tariff scheme as outlined. What incentives are there for airports to price in this way? It is likely that public and regulated airports will choose not to implement a specific charge, partly because it is simpler not to do so, and partly because they will seek not to discourage traffic. To an extent, they (and in particular, local communities) may see being able to accommodate the A380, and encouraging its use, as a matter of prestige. They may also wish to encourage the use of the airport by A380s in the hope that this may foster the development of the airport as a hub. To this end they will choose to avoid specific charges.

It is also possible that they may respond to the fairness argument. Their existing airlines will not like being charged more to provide facilities for a small number of airlines. If so, they will be under pressure to ensure that users of the A380 cover the costs of the infrastructure they require. They can do this at least cost in terms of efficiency by implementing a two part tariff schedule, though whether they have a strong enough incentive to handle the issue in this way is not obvious.

7 Synthesis and Conclusions

There are several main propositions in the discussion above. These include:

- The introduction of the Airbus A380 imposes pricing and investment problems for airports and airlines, especially since there are significant sunk costs associated with upgrading airports to accommodate the A380, along with possible sunk costs when airlines commit to purchasing the aircraft.

- There are two aspects of choice which are important from an efficiency point of view. These are firstly, achieving efficient use of airports and aircraft in the short run, and secondly, ensuring that efficient investments are made, and especially, ensuring that investments which are not warranted in terms of net benefits are not made.

- From a short run perspective, to optimise the use of the A380, it is desirable that airports do not levy specific charges for the use of the A380 in addition to normal airport charges. This is so for most airports regardless of the price structures already in place. For most busy airports price structures are already

inefficient in that they discourage the use of larger aircraft. In this environment the case for zero specific charges is stronger.

- If zero specific charges are levied, so airports can recover the additional costs of accommodating the A380, charges will have to be increased across the board. This will imply that other airline users of the airport will pay most of the costs so that users of the A380 enjoy the cost savings. This may be seen as unfair.

- A two part tariff approach, which involves zero charges for users which make an initial capital contribution, and specific charges for others, could achieve the goal of fairness at little or no cost in terms of efficiency. In this situation, the primary reason for the imposition of a two part tariff would be to achieve fairness rather than the more usual efficiency goal.

- To the extent that the A380 imposes additional operating costs, and the marginal costs to the airport of it being used exceed zero, there is a case for specific charges based on these, but only if initial price structures are efficient. If they are not, there may be a case for absorbing them within the general pricing structure.

- When there are no specific charges for using the A380 at airports, prices cease to serve as signals for investment by airports and airlines. Granted this, the role of investment criteria in determining whether investments should go ahead becomes more critical.

- It is possible to reach a situation of overall efficiency in the short and long run, if investments to accommodate the A380 are subjected to cost benefit analysis, and only those investments which produce net benefits are undertaken.

- However, with prices not reflecting long run costs, this possibility may not become a reality. A dynamic inconsistency situation can arise, where an agency such as an airport, by following policies which are optimal at all points of time, can result in a situation which is non optimal in the long run. This could happen if airlines play a game, and incur a sunk cost by committing to the A380, and induce airports to invest to accommodate the aircraft, even when it would not be optimal in the long run to do so. This would be a situation where airports invest in accommodating the A380 when the cost savings do not warrant doing so.

- While airports may make efficient choices about investments, the ownership and regulatory environments in which most operate create incentives for inefficient choices. Publicly owned, and rate of return regulated airports have an incentive to invest excessively, and to pass on the costs to users. In this type of environment, many airports will invest to accommodate the A380 even when doing so is not worthwhile.

- Price capped airports have no incentive to over invest in this way. Their incentive to invest to accommodate the A380 will depend critically on the cost

pass-through arrangements which the regulator imposes. The regulator effectively decides whether an airport should accommodate the A380.

It may well be that the short run aspects of the problem are easier to solve, in a practical way, than the long run aspects. It is easy for airports to make investments to accommodate the A380 and recover the costs of doing so by raising charges across the board. This is a violation of "user pays", and it may not be regarded as fair, though it will lead to efficient choices of aircraft. In cases where there is pressure for user pays, the two part tariff option is an efficient one.

Implementing an efficient solution of the long run aspect of the problem is more difficult to achieve. There are at least two forces which will lead to pressure for airports to invest excessively, and upgrade facilities to accommodate the A380 in situations where this is not worthwhile. Excessive investment in accommodating new aircraft types has arguably happened more than once in the past. The dynamic inconsistency of optimal policies can lead to this result, and coupled with this, most airports operate in a regulatory environment which weakens incentives to scrutinise investment proposals. For them it is easy to make questionable investments and pass the costs on to users. It is likely that many airports which need not upgrade their facilities to accommodate the A380 will nonetheless make the investments, and pass the costs on to airlines, and ultimately, their passengers.

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