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DISCUSSION PAPER**

**Proposal For A Market-Based
Solution to Airport Delays**

by

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Abstract

With the clamor rising over airport delays and with both the Congress and the Administration considering remedies, this paper advocates the use of market mechanisms, specifically slot auctions, to promote efficient usage of airport capacity, reduce airport delays, and, more generally, promote competition.

I. Introduction and Overview

As highlighted in recent news articles, airport delays are increasing, significantly so, and both the Administration and the Congress are actively seeking ways to reduce the scope of the problem and to better protect the rights of passengers in case of delays.¹ Airport delays occur because airport capacity (e.g. runways and gates) is a scarce resource and, at key airports, airlines are scheduling more flights than that capacity can support. As a result, more and more flights are delayed, even under normal weather conditions, and considerable costs are imposed on the traveling public. Passengers are paying, in effect, a much higher total price than the dollar price of their tickets. Solutions for ameliorating an increasingly untenable situation are needed, especially as more airports are forecast to be capacity constrained in the near future. In this short paper, we explain how to rely on market mechanisms to better allocate existing airport capacity, to lessen delays, and to help finance capacity expansions whose projected benefits justify their costs.

Airlines' private incentives to schedule flights to serve more destinations and offer passengers more choice in departure times do not take into account the delays that their own flights impose upon other airlines because airlines do not face the proper price incentives to use scarce airport capacity. Consequently, airlines schedule too many flights, generating delays that ripple across the highly integrated airline network and adversely affect all passengers. One approach to solving this problem might be to get the airlines together and have them collectively hammer out a solution. This would, however, require the airlines to make individually costly compromises on a multitude of scheduling decisions, and each airline would in the end agree to abide by a settlement only if it left it better off than not agreeing. Such collective decision-making would not necessarily benefit consumers. Indeed, collective decision-making by actual and potential rivals raises serious risks to competition.

Other proposed solutions to the airport delay problem seem to have a common theme: eliminate the problem by expanding the airports and improving the air traffic control systems to, in effect, eliminate the capacity scarcity. For example, currently popular proposals include the spending of billions of dollars to add runways and expand other physical capacity (such as gates) at airports to accommodate more concurrent flight operations, and to improve air traffic control systems to allow for more intensive usage of existing capacity (by, e.g., shortening the distance between aircraft in airspace). These methods of dealing with the problem are, as their price tags indicate, costly, providing a prime illustration of the economic axiom "There is no

¹ See The Wall Street Journal ("Small Jets, More Trips Worsen Airport Delays" 8-13-07), The New York Times ("Ugly Airline Math: Planes Late, Fliers Even Later" 7-5-2007, "Push For Action On Flight Delays" 9-28-2007), for recent articles on rising airport delays.

such thing as a free lunch.”² Moreover, plans to expand capacity will not even under the most optimistic projections ameliorate the problem of delays in anything but the very long term.

We propose a complementary approach, one that uses basic economic and market principles to help allocate existing scarce assets more efficiently. Only by allocating existing assets efficiently can society squeeze the greatest possible value out of its scarce resources. Moreover, failure to do so may well result in capacity expansion plans whose costs do not justify their benefits. In brief, we advocate a market-based approach to the allocation of scarce takeoff and landing rights at airports where the demand for those rights at a zero price exceeds the ability of the airport to handle that many takeoffs and landings during some time period.³

Under our proposal, the FAA and airport authority would determine the number of takeoffs and landings that an airport can safely accommodate in each time period given its current design (e.g. runway layout) and the airside requirements (on, e.g., optimal spacing between aircraft).⁴ Property rights to use these scarce takeoff and landing resources should then be auctioned off to those willing to pay the most for them. Acquirers should have clear ownership rights to retain the slots for some predetermined length of time, or to sell or lease them in secondary markets. This process would foster competition for airport access rights and help ensure that they are allocated to their highest valued uses, efficiently rationing demand, reducing delays, and benefiting society. And to the extent that competitive concerns are raised by, for example, individual airlines attempting to purchase too many of these rights at particular airports, antitrust authorities can step in where appropriate to block such purchases.

Key to this process is the reliance on competitive market mechanisms to efficiently allocate airport resources. Although the airline industry has unique features, these features do not justify reliance on non-market mechanisms to ration airport access. Airlines urging the continued use of non-market mechanisms have an incentive to do so in order to benefit

² For example, in August of this year, the FAA award a \$1.86 billion contract for the initial stage of deploying and operating a GPS tracking system to replace the current use of radar.

³ We are not alone in the call for a market-based mechanism to allocate airport capacity. Among others, The National Center of Excellence for Aviation Operations Research (NEXTOR) has investigated market mechanisms to allocate scarce airport capacity, and legislation pending before Congress similarly calls for a market-based solution.

⁴ We assume for this paper that these requirements are known, though in fact, they should also be a subject for analysis. Moreover, we note that the “right” number of slots may be less than the maximum the airport could accommodate under ideal conditions if the number of slots is chosen in advance. Determining the “right” number, which we do not analyze, is itself amenable to economic analysis. See, for example Carlton (1977), Visscher (1973), Panzar and Sibley (1978), Brown and Johnson (1969), and Wilson (1989). The number of slots could also be allowed to vary by weather, for example. Here, we envision the number of slots being set in advance, and below we discuss a priority slot allocation program to help deal with changing conditions from day to day.

themselves at the expense of their rivals—and of the traveling public. It is well understood that firms that benefit from the legislative creation of non-market mechanisms can often be counted on to support the perpetuation of the non-market mechanisms. An important component of our proposal is, therefore, the elimination of existing “carve-outs” by airport authorities and the FAA for, in particular, corporate jets and other general aviation users. To the extent that these entities value scarce airport capacity highly, they can demonstrate this by outbidding others for the right to use it. If they are unwilling to do so, these scarce assets should go instead to larger commercial aircraft carrying greater numbers of travelers. Requiring by administrative fiat that small commercial aircraft occupy scarce and valuable assets is highly inefficient.

We also recommend that the property rights to slots include a cancellation priority in the event that inevitable weather-related or other delays temporarily reduce the number of flight operations that airports can support. This could perhaps be accomplished by assigning a different priority to slots within each time period, so that they would be cancelled in order of their priority in case of weather or other problems. Airlines could thus choose to pay a premium to acquire slots that are less likely to be cancelled, and they could advertise this high priority service to customers who value a lower probability of delay. By permitting travelers for whom delays would be most costly to, in effect, “buy priority,” such market-based approaches could perhaps squeeze yet more value out of our scarce airline industry resources.

Lastly, and significantly, rather than granting valuable rights to airport access at no charge, as has been done in the past, slot auctions would generate revenues for the FAA and airport authorities that could be used to fund the expansion of airport facilities when demand conditions make it efficient to do so, along with improvements in air traffic control systems. The auctioning off of scarce resources to obtain financing for expansion from those who themselves consume the scarce resources, whose demands create the delay problems, and who ultimately stand to benefit from efficient levels of capacity, is hardly a novel concept. And auctions have been successfully used already by other regulatory agencies to efficiently allocate valuable public assets.⁵ The implementation of such a market-based concept to the problem of airport delays is long overdue.

⁵ The Federal Communication Commission has, for example, auctioned licenses for the use of electromagnetic spectrum (see, e.g., Cramton 1997); the U.S. Forest Service has used auctions to sell harvesting rights to timber tracts (see, e.g., Haile 2001); the Department of the Interior has used auctions to lease rights to U.S. offshore oil and gas drilling (see, e.g., Porter 1995); and many European countries have used auctions to allocate “third generation” (3G) mobile telecommunication spectrum licenses (see, e.g., Binmore and Klemperer 2002).

II. Delays Have Risen As More Flights Are Scheduled At Capacity Constrained Airports.

The rising number of delays has not only been widely reported in the popular press, it is easily confirmed by viewing delay statistics collected by the Department of Transportation's Bureau of Transport Statistics (BTS). In July 2007, for example, the BTS reports that 30% of the flights in the U.S. domestic market arrived late, up from 20% in July 2003. And these system-wide averages obscure the fact that performance at the most capacity constrained of our airports is significantly worse: At JFK, for example, 43% of the arrivals were late in July 2007 while at LaGuardia 40% were late.

This rise in delays, not surprisingly, correlates with a significant increase in the number of flights across the U.S. Currently, no efficient constraint is imposed on the number of flights that can be scheduled at a given time at an airport where scheduled flights would exceed the maximum number the FAA would allow for safety reasons. In fact, at heavily demanded airports, as explained in more detail below, either no mechanism is being used to ration demand or the rationing mechanism has allocated too many landings and takeoffs.

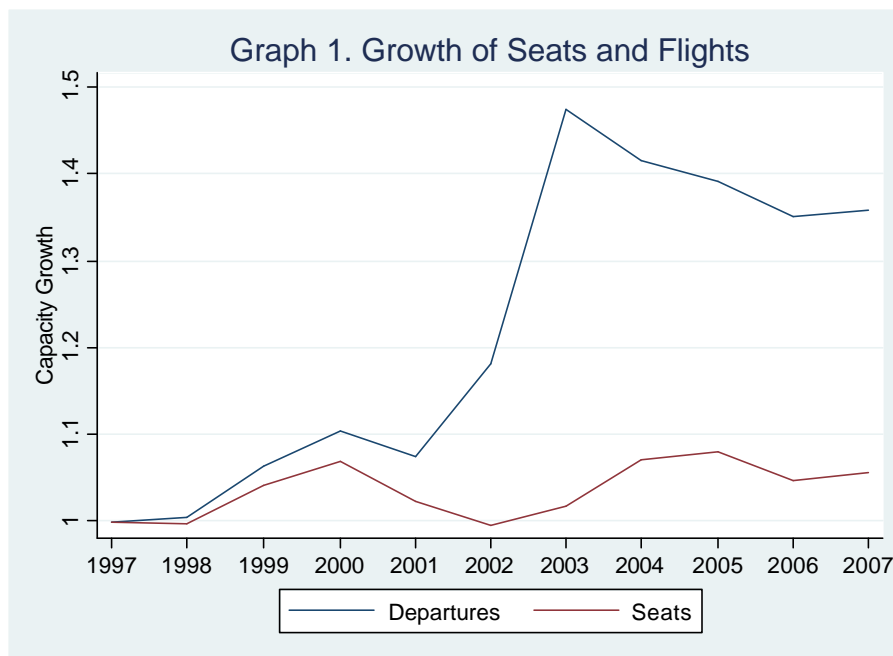
Some of the recent increase in the number of flights is due to rising demand for air travel, but the vast majority is coming from substitution away from large aircraft in favor of more frequent operations of small planes, regional jets in particular.⁶ Graph 1 illustrates this point, showing that the number of departures has skyrocketed by 35% in recent years while the total number of seats has risen by less than 6%. This implies that the number of seats per aircraft has declined dramatically. At some airports, and especially at those airports reporting the most delays, this effect is quite pronounced. At LaGuardia, for example, the average number of seats per aircraft was 143 in the first quarter of 1998, but had fallen to 94 as of the first quarter of 2007. At O'Hare, the average number of seats has fallen from 124 to 98 over the same period.

The shift to regional jets can benefit passengers, as it gives them more opportunities to find flights close to their preferred flying time, and more options should a flight be cancelled. The airlines have also used bankruptcy proceedings to renegotiate pilot contracts, which had traditionally limited the use of smaller aircraft.⁷ All of these additional small aircraft require

⁶ Airlines have used regional jets primarily in two ways. First, they have been deployed in densely traveled routes to boost frequencies where, for example, 2 50-seat regional jets might replace a Boeing 737, lowering total seat capacity but doubling the number of frequencies. Second, regional jets have been deployed in routes outside of the airline's hub-and-spoke network to offer nonstop, point-to-point service.

⁷ To be sure, there are benefits to using regional jets rather than larger aircraft. However, as discussed below, with individual airlines not being forced under the current system to bear the full costs of their plane size

the same access to the same scarce airport facilities and air traffic network as do larger aircraft.⁸ Hence, as more flights are scheduled into a capacity constrained air traffic system, delays rise. Problems are exacerbated whenever bad weather occurs, as delays at almost any airport in the U.S. cause ripple effects throughout the integrated airline network.



III. The Extent and Seriousness of Delays Are Likely Underestimated.

As troubling as the statistics on delay are, they likely understate the extent of the problem. Because the BTS defines a late arrival as one landing 15 minutes past its scheduled arrival time, airlines can reduce reported delays simply by increasing the scheduled time of the flight. And, indeed, evidence confirms that airlines have done exactly this.⁹ In Table 1, we list the average scheduled travel time of a common aircraft type in June 1998 and June 2007 for service originating at airports with some of the worst on-time performances in 2007.¹⁰ All but one of the routes we investigated saw travel times increase while on-time

decisions—in particular, with one airline not having to pay for the delay costs its decisions impose on other airlines—decisions on plane size are likely being skewed inefficiently.

⁸ Some policy makers have suggested regulations that would limit the use of regional jets, but a great advantage of a market-based solution to the delay problem is that airlines will receive a signal from the price of access about the efficient use of capacity. This will affect their choice of equipment type: regional jet, turboprop, or mainline aircraft, negating the need for potentially arbitrary regulations.

⁹ See, for example, Shumsky (1993), which shows that the introduction of the on-time reporting requirement in 1987 led to longer scheduled flights.

¹⁰ These routes were chosen because they had the worst on-time performance for 2007 through July with a median on-time arrival performance of 51%. Routes with fewer than 8 flights per day and those without common aircraft types in 1998 and 2007 were excluded.

performance fell. On one of the worst performing routes, O’Hare to Newark, average scheduled travel time on a 737 aircraft rose by 21 minutes while delayed arrivals rose by 12 percentage points. While it is hard to estimate the exact extent to which padding the schedules affects reported delays, the direction of the effect is clear: If scheduled travel times had not changed over time, airlines would have reported more delays.

Origin - Destination	Average Scheduled Travel Time (minutes)		Change in Travel Time	Change in % of Flights Delayed
	June 1998	June 2007		
Detroit – Newark	103	108	5	9%
Charlotte - Newark	112	110	-2	22%
O’Hare – Newark	125	146	21	12%
Detroit - LaGuardia	114	117	3	2%
Denver - LaGuardia	212	222	10	17%
Dallas – Newark	205	227	22	19%
Boston - Philadelphia	80	86	6	17%
Cincinnati - Newark	125	131	6	16%
Raleigh, NC - Newark	95	106	11	20%
Dallas - LaGuardia	200	211	11	20%
Minneapolis - Newark	154	169	15	1%

Source: OAG and BTS Delay Statistics. Travel on the second Wednesday of June in 1998 and 2007. Travel times are compared for a common type of aircraft. Change in % of Flights Delayed compares January through July 1998 with 2007.

While delays are rising, and likely by more than the official statistics indicate, the actual cost of a delay consists of, most importantly, the opportunity cost of the time that delayed travelers spend on planes, in airports, and in more serious cases in hotels. To get a glimpse of how large these costs likely are, we use a conservative estimate of the total number of hours “lost” by passengers due to delays and multiply this number by an estimate of the value of an hour of a traveler’s time. For the first quarter of 2007, we estimated the cost of delays at \$239 million (see the Appendix for details). This is equivalent to the cost of one million one-way flights between Reagan National airport and Seattle, Washington.¹¹ This estimate is conservative, and a likely underestimate, in that it only counts delay at the destination airport of a passenger’s itinerary,¹² and it omits the delay costs incurred by connecting passengers who miss their connections at intermediate airports and spend hours (or days) in airports waiting to continue their trip.

¹¹ In the first quarter of 2007, the average fare between Reagan National and Seattle, Washington was \$238.86 on a one-way basis according to the Department of Transportation Origin and Destination Survey, DB1B.

¹² For roundtrip tickets, delays at the endpoints of each of the outbound and inbound itineraries are factored in.

Perhaps even more troubling than the current cost of delays is that over the next 20 years the number of airports where demand exceeds capacity is expected to grow. FAA forecasts of demand for airport capacity show that even with all planned airport improvements, a growing number of airports will find demand for departures and arrivals in excess of capacity.¹³ While these forecasts show only 4 airports as being short of capacity in 2007 (LaGuardia, O’Hare, JFK, and Newark), by 2015 between 6 and 18 airports will have insufficient capacity to meet demand—depending on the completion of planned improvements. The situation worsens by 2025, when between 14 and 27 of the busiest airports in the country are forecast to be short on capacity.

IV. Policies Implemented Over Time to Control Airport Delays Have Not Worked.

Historically, the FAA has restricted landing and takeoff rights at four key airports. These airports are LaGuardia, JFK, O’Hare, and Washington’s Reagan National airport,¹⁴ and they accounted in 2006 for about 64 million arriving passengers and 20% of flight departures and arrivals across the U.S. The High Density Rule, adopted by the FAA in 1969, imposed slot constraints at each of these four airports. A slot gave an airline the right to either takeoff or land at the airport in a specified time period, and airlines could only access the airport with a slot. The slot allocations were awarded at no charge by the FAA and largely went to incumbent airlines based on their levels of service at the time.

Whether or not the initial allocation of slots in 1969 was efficient, more than 15 years went by before a mechanism was put in place by which airlines could reallocate slots through sale or temporary lease. Then, in 1985, the FAA allowed for the development of a secondary market for sales and leases to promote entry and competition. In theory, a secondary market should have allowed slots to flow to airlines that valued them most highly, thereby resulting in a more efficient allocation of airport capacity. Yet after an initial burst of trading, the FAA found that it was rare for more than a few slots to be available in the secondary market at any given time. While the small number of transactions is not itself proof that the secondary market failed, it is doubtful the result was an optimal use of airport capacity.

In part because of the perceived failures of the secondary market, the FAA in the early 1990s received statutory authority to grant exemptions from the slot rules to new entrant airlines, and when additional slots were periodically made available, the FAA would hand

¹³ “Capacity Needs in the National Airspace System 2007-2025. An Analysis of Airports and Metropolitan Area Demand and Operational Capacity in the Future,” Federal Aviation Administration, May 2007.

¹⁴ There are local noise regulations at some airports (e.g. Burbank and Santa Ana in CA) that reduce some landing and takeoff activities.

them out at its discretion, usually through an application process that predictably fostered intensive and costly lobbying efforts by parties working to convince the FAA to choose them.

A lack of clear property rights could have contributed to the apparent problems with the secondary market. Under FAA regulations, slots are operating authorizations, not property rights, and the FAA retains the right to repossess them at any time. This uncertainty can impose substantial transaction costs because parties to a slot transaction may have to specify a variety of contingencies to the transaction, and it may also reduce the economic value of a slot (a problem not helped by the thin trading volume). The structure of the slot system may also have led incumbents and potential entrants to systematically value slots differently, preventing what would otherwise be efficient transactions. In particular, because the FAA gives away new slots for free from time to time to airlines with few or no slots, these airlines' valuation of slots would include the possibility of getting some from the FAA in the future for free. In fact, in 2000 the FAA gave away for free 24 new slots at Reagan National to airlines with no or few slots at the airport.¹⁵ Similarly, before JetBlue began operations it was granted 75 slots for free at JFK to facilitate its startup.¹⁶ The same policy that prioritizes new entrants or those with few slots when new slots are made available makes it very unlikely that the FAA will allocate new ones to incumbent airlines.¹⁷ If incumbents, thus, are able to acquire additional slots only in the secondary market, their valuations of slots may be higher than those of new entrants.

In 2000, in an attempt to promote entry and competition, Congress passed the Wendell H. Ford Aviation Investment and Reform Act of the 21st Century ("AIR-21"). AIR-21 relaxed, and ultimately eliminated (at least temporarily), slot constraints at three of the airports: LaGuardia, JFK and O'Hare. As shown in Table 2, in all three cases airlines quickly responded to the new rules by expanding the number of flights they offered regardless of total airport capacity, and, not surprisingly, delay problems significantly worsened. In 2000, after exemptions to the slot rules were allowed at LaGuardia, the number of scheduled arrivals rose by 34% and on-time performance fell 28 percentage points. At O'Hare, from February 2002, shortly before slots were lifted, to February 2004, scheduled arrivals rose 37%, while on-time performance dropped 16 percentage points. At JFK, after the slot system expired in 2007, scheduled arrivals rose 58% and on-time performance fell 13 percentage points.

¹⁵ The slots were allocated as follows: American Trans Air-4, Midway Airlines-2, Midwest Express-2, Spirit Airlines-4, America West-6, TWA-2, Frontier-2, and National-2.

¹⁶ See <http://www.dot.gov/affairs/1999/dot13999.htm> for details.

¹⁷ In addition, if the chance of receiving new slots is perceived as being dependent on whether the incumbent has "given up" slots in the past by selling or leasing them, this too would impede the efficient operation of the secondary market.

Table 2. Number of Scheduled Arrivals and On-Time Performance¹⁸

	Arrivals			On-Time %		
	Slots	No Slots	Change	Slots	No Slots	Change
LaGuardia	10,477	14,063	34%	75%	47%	-28%
O'Hare	25,944	35,597	37%	83%	67%	-16%
JFK	8,037	12,680	58%	78%	65%	-13%

Source: BTS Airline On-Time Performance Data and T-100

At LaGuardia and O'Hare, the FAA intervened to ration demand by forcing airlines to reduce their number of flights, and it is considering similar action at JFK. At LaGuardia, the FAA chose to freeze entry and roll back service across airlines, and at O'Hare it organized "conferences" to secure voluntary cutbacks from all airlines operating at the airport. As a result, despite the official expiration of slot controls by Congress, the FAA is again administratively controlling airport access to LaGuardia and O'Hare.

V. Allocating Airport Capacity More Efficiently.

In most markets, resources used to produce a product have prices that act as a rationing mechanism. Use of a resource to produce a product is less profitable to firms as its price rises, all else equal, and when resources are scarce and firms compete for the right to use them, their prices begin to be bid up. Price rises until those valuing the resource the least drop out, and eventually the market clears when the quantity demanded is equal to the quantity supplied. In this way, scarce resources are allocated by the price mechanism to their highest valued uses. In the airline industry though, the rationing mechanisms, if they exist at all, are executed through scheduling conferences or arbitrary service suspensions. None of these measures is likely to promote efficient airport usage or promote competition.¹⁹

Market-based methods of allocating scarce airport resources could rely on either a quantity-setting mechanism or a price-setting mechanism.²⁰ Under a quantity-setting

¹⁸ Because delays are seasonal, we restrict our comparisons to the same month in different years, before and after slots expired. For LaGuardia, we compare December 1999 with December 2000; for O'Hare, February 2002 with February 2004; and for JFK, May 2006 with May 2007.

¹⁹ Across the U.S., airports impose a weight-based fee on landings (there is no fee on takeoffs) to pay for the maintenance and operation of the airfield. To the extent that heavier aircraft impose more costs on the runway and taxiways, a weight-based fee is a sensible means of covering those costs. It, however, is not a substitute for a mechanism designed to reduce delays.

²⁰ While in principle both approaches yield the same outcome, in instances where there is uncertainty in demand or supply, the two mechanisms differ (see Weitzman 1974).

mechanism, such as slot auctions, regulators would fix the total amount of output by creating slots while the prices for landings and takeoffs would be determined through a competitive bidding process. Under a price-setting mechanism, such as variable access fees at airports, regulators would set prices for landings and takeoffs that induced the “appropriate” level of output at the airport.²¹ In the airline industry, engineering and technological factors such as airport design (e.g. runway configuration) and air traffic control requirements (e.g. on optimal aircraft spacing) largely determine the output an airport can safely support, given weather conditions. Since the FAA must first determine the number of slots that can be used consistent with safety considerations, we propose the use of slot auctions rather than access pricing to allocate them, although either method can in principle be used to ration demand more efficiently than is being done today.²²

VI. Our Proposal: A Market-Based Slot System with Well-Defined Property Rights.

Our preferred method to allocate scarce airport capacity is to auction slots for landings and takeoffs by time of day and to convey upon their purchasers well-defined property rights. Unlike access pricing, which may require the airport authority to continuously adjust prices, slot auctions require only that the airport authority set at the outset the total number of takeoffs and landings that the airport can accommodate in each time period under normal weather conditions.²³ This approach plays to the strengths of airport authorities and the FAA, who have far greater expertise in determining an airport’s capacity than they do at setting prices.

These slots should then be auctioned off through a market-based bidding process where each airline decides how much it would be willing to pay for each slot.²⁴ The prices obtained for slots would reflect the degree of scarcity of capacity. The price could be close to zero at times of the day where capacity is great relative to demand, and it will be highest during periods where demand is at its greatest. Property rights would be awarded to the highest bidders, as long as acquisitions do not anti-competitively enhance market power. Prohibiting airlines from scheduling flights at times when they do not have the right to use

²¹ One could also consider imposing a fee on the airline (perhaps paid to passengers) when its flight and perhaps surrounding flights of others are late. Fees could be chosen to induce airlines to schedule fewer flights.

²² The optimal market-based mechanism may depend on the costs of implementing the system and the severity of capacity scarcity at the airport. For example, quantity-setting might be more attractive at the most severely constrained airports, while price-setting might be more efficient at airports constrained only at some peak times or at certain times of the year.

²³ Whether the appropriate number of slots should be set at the maximum number of operations under the best possible weather conditions is a question worthy of study. We do not analyze that question in this paper.

²⁴ There is a considerable economics literature on optimal auction design (see, e.g., Klemperer 2004).

one of the auctioned slots would efficiently address the problem of airport delay. Moreover, this market-based auction would allocate these scarce slots to their highest valued uses.²⁵

Slot holders should also be permitted to sell or lease slots in a secondary market. As service patterns and market conditions change, particular airlines may want to move some of their operations at slot constrained airports to different times, and the right to sell or lease would facilitate these types of efficient adjustments. Having well-defined property rights should encourage the development of a robust secondary market for slots, helping to ensure that slots are allocated to their highest valued uses.²⁶

An important component of our proposal is that general aviation users, such as corporate jets, be required to bid for access rights in competition with all others who wish to use them. Under the current system, a number of slots are reserved for general aviation aircraft. This number varies across airports, but it is at times relatively high compared to the total capacity available. At Reagan National, for example, 20 percent of slots are reserved for general aviation even though very few unscheduled flights can meet the security restrictions imposed when such flights were again permitted after October 2005.²⁷ At LaGuardia, just over 7 percent of slots are reserved for general aviation. While such special interest carve-outs greatly benefit some, they impose potentially substantial costs by interfering with the market's ability to allocate these scarce and valuable assets to those who value them most.²⁸ To the extent that these entities value scarce airport capacity highly, they can demonstrate this by outbidding others for the right to use it. If they are unwilling to do so, these scarce assets should go instead to larger commercial aircraft carrying greater numbers of travelers.

The creation of priority rights through slots auctions may be used to further improve the efficiency of our current system. Weather issues at almost any airport in the system

²⁵ If controlling the supply of slots over time (e.g. to adjust for capacity changes) or having large numbers of slots immediately available for new entrants is important, some percentage of slots could be set to expire periodically at known dates. Upon expiration, ownership of the slots would revert to the FAA (or airport authority) and the slots would be re-auctioned. Auctions could be held annually, allowing a certain proportion of the slots, say 10% or 20%, to go up for auction each year. Analysis would be needed to determine the appropriate duration for the property right.

²⁶ At some airports, to facilitate entry and expansion, property rights to slots may have to come with access rights to constrained physical facilities, such as gates and counter space. To guarantee that slot holders do get access to conveniently located gates and facilities, airports may need to reacquire control of these assets. Airport authorities at LaGuardia, for instance, have begun to actively manage and monitor gate assignments and gate utilizations.

²⁷ Government Accountability Office, "Reagan National Airport Update on Capacity to Handle Additional Flights and Impact on Other Area Airports," GAO-07-352, February 2007, pp. 7-12.

²⁸ If individual general aviation users value slots highly but are unlikely to purchase them because of the unscheduled nature of their service, new businesses might arise and, for example, purchase slots and lease them out on a temporary basis to high-value general aviation. Such owner-brokers might occasionally lease them also to scheduled airliners that have a temporary need for increased frequencies.

frequently force airlines to delay or cancel flights, as the FAA temporarily limits operations to respond to weather conditions. When those conditions arise, not all slot holders will be able to exercise the right conveyed by the slot, and the reduced capacity will have to be rationed. A question then arises as to how most efficiently to allocate that capacity among slot holders. One approach would be for the property rights of each slot to include a cancellation priority in the event of weather-related cancellations.²⁹ This could be accomplished by ordering the slots in each time period, each with a different priority. As weather conditions required cancellations, slots would be cancelled in order of their priority. Airlines could thus choose to pay a premium to acquire slots that are less likely to be cancelled, and they would be able to advertise this high priority service to customers who value a lower probability of delay.³⁰ Such tickets likely would command a premium. Moreover, during the delay period, the secondary market for slots would allow the airlines to efficiently transact slots for that day. In particular, an airline with a valuable departure could “buy up” to a higher priority position, while an airline with a priority slot but a less valuable flight on that day, could sell its priority position (though it could obviously not do so if it had sold its flight as a “high priority” one).³¹

Significantly as well, under our proposal the slot auctions would generate revenues for the FAA and airport authorities. One possible use for the revenues generated by slot auctions would be to help fund expansion projects designed to increase capacity, such as the NextGen satellite navigation system the FAA is constructing to improve capacity utilization of air space. Indeed, it is difficult to justify subsidizing airlines by granting them for free rights to use valuable public assets whose sale at auction could generate considerable revenue.

Auctioning the use of scarce public resources is hardly a novel concept, and it has been used with success by other regulatory agencies, such as, for example, the Federal Communication Commission and U.S. Forest Service. Indeed, the FAA could use the price bidders are willing to pay for scarce slots as a measure of the value of adding additional capacity at an airport or in a metropolitan area. Rising slot prices are a sign of increasing scarcity, and the FAA could use these prices as an input into cost-benefit analysis for when,

²⁹ Another way is to add an access charge to use a slot so that the slot conveys the option to land or takeoff and the access price is the cost to exercise that option. The access price might be zero when airport conditions are optimal but rises when weather or other conditions reduce the capacity of the airport below the total number of slots.

³⁰ Similar mechanisms are in use in other industries. In the natural gas pipeline industry, for instance, shippers can either buy firm capacity, granting them priority shipping rights on a pipeline, or interruptible capacity, which grants them temporary shipping rights and may be interrupted on short notice. A shipper with firm rights may decide to temporarily not exercise these rights and, to defray some of the fees otherwise associated with securing these rights, the shipper may offer them in a secondary market for the pipeline to sell as interruptible capacity (here at the discretion of the shipper with the firm rights).

³¹ In one sense, this plan is not a significant departure from the current system under which airlines can give back the right to take off an aircraft during weather-related delays in exchange for a later time in the day. We are essentially proposing a formal market to allow these types of transactions between airlines.

where and whether costly capacity-enhancing investments are worth the benefits they would provide. Taken as whole, our proposal would not only help achieve efficient usage of airport resources and reduce delays, but also provide signals and generate revenues for efficient capacity expansion.

VII. Conclusion

With the clamor rising over airport delays and the Administration and the Congress actively seeking ways of addressing the problem, it is time to implement an effective, market-based solution that promotes efficient usage of airport capacity and reduces delays. In this paper, we have proposed implementing a market-based auction system with well-defined property rights to slots to allocate scarce airport capacity. Our proposal would ensure that airlines effectively take into account airports' scarce resources when scheduling their flights, thereby reducing delays, and it would help ensure that these public resources are allocated to their highest valued uses. This approach strives to balance administrative costs with economic efficiency, as it facilitates efficient flight schedule adjustments and entry at capacity-constrained airports. Lastly, and importantly, the revenues generated by this approach could be utilized to fund capacity expansions when the benefits of these expansions outweigh the costs, as might be indicated, for instance, by the prices airlines bid for airport slots.

While slot auctions, clearly defined property rights, secondary markets, capacity additions, and an end to special interest carve-outs can go a long way towards enhancing the efficiency of our air traffic system, they alone would not prevent airlines with an already large share of rights at particular airports from enhancing or maintaining their market power by, for example, purchasing too many of these scarce rights. Here, antitrust authorities would need to remain watchful; not to prevent large carriers from growing efficiently, but to ensure through the use of an analytical framework such as that used routinely to evaluate proposed mergers, that anti-competitive acquisitions in these markets would be prevented.

Lastly, the proposal developed in this paper should further be applied to the allocation of operating authorizations for international service to countries with which the U.S. does not have an Open Skies Treaty. These authorizations, which come up on occasion, are currently awarded at the discretion of the FAA, again for free. As a result, during the regulatory proceedings to award the authorizations, airlines spend significant sums of money lobbying the FAA intensely to secure these highly valued rights, as evidenced by the recent proceeding for authorizations to China. Here as well, a simple market-based auction should be used to not only determine which airline has the highest valued use for the authorization, but also to ensure that the FAA, and not lobbyists, collects the revenues from the allocation process.

The use of market-based solutions to problems of airport capacity allocation and airport delays is long overdue. Implementation of proposals along the lines of those laid out in this paper would contribute greatly to achieving this objective.

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Appendix: Computing the Cost in Dollars of Flight Delays.

Using the BTS delay statistics, we calculate the average number of hours of delay on every airport-pair segment tracked by the BTS data. Then, using the Origin and Destination Survey (DB1B),³² we break down each itinerary into its "terminating segments." For one-way passengers, this is the last coupon segment of the itinerary. Round-trip passengers have two terminating segments: the coupon segment before arriving at their destination airport and the coupon segment that returns them to their originating airports. For each airport-pair in the BTS data, we calculate the total number of passengers from DB1B who had terminating segments in the airport-pair. For the passengers on these segments, the effect of a delay is simple to interpret: a one hour delay means the passenger arrived, on average, one hour late to his destination airport or one hour late returning to his origination airport. Multiplying the

³² Because the survey is a 10% sample of passengers, we multiply the number of sampled passengers by ten.

average delay by the total number of passengers yields the total number of hours passengers were delayed on that airport-pair. As a proxy for the value of time of passengers, we divided the average per capita income at the two endpoints of the segment by a forty-hour workweek to compute average hourly wage. The hourly wage was then multiplied by the passenger-hours lost to estimate cost of delays on each segment, and the total delay cost was the sum of all segments.³³

³³ These estimates are conservative in several respects: first, they do not take account of the costs of cancelled or diverted flights. Second, they include only the 4462 routes tracked in the BTS delay data. Third, they exclude the cost of missed connections.