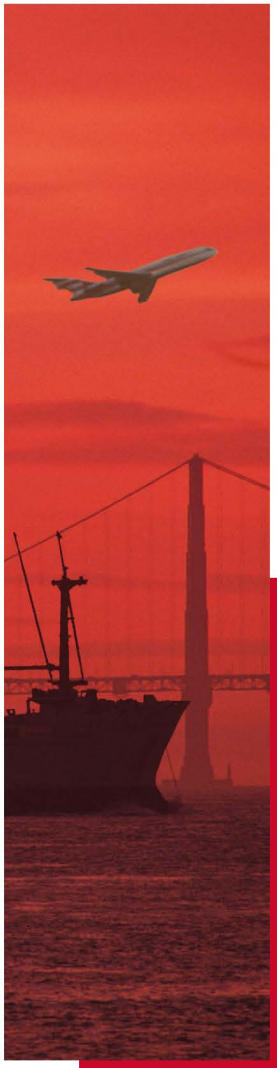
European Parliament

DIRECTORATE-GENERAL FOR INTERNAL POLICIES

POLICY DEPARTMENT B
STRUCTURAL AND COHESION POLICIES



Agriculture and Rural Development

Culture and Education

Fisheries

Regional Development

Transport and Tourism

# Research for TRAN Committee: Airport slots and aircraft size at EU airports

IN-DEPTH ANALYSIS

EN

2016

European Parliament

DIRECTORATE-GENERAL FOR INTERNAL POLICIES

**POLICY DEPARTMENT B: STRUCTURAL AND COHESION POLICIES**

TRANSPORT AND TOURISM

# Research for TRAN Committee - Airport slots and aircraft size at EU airports

## IN-DEPTH ANALYSIS

This document was requested by the European Parliament's Committee on Transport and Tourism.

**AUTHOR**

*École Nationale de l'Aviation Civile, France*: Nathalie Lenoir

**RESPONSIBLE ADMINISTRATOR**

Marc Thomas
Policy Department B: Structural and Cohesion Policies
European Parliament
B-1047 Brussels
E-mail: poldep-cohesion@europarl.europa.eu

**EDITORIAL ASSISTANCE**

Adrienn Borka

**LINGUISTIC VERSIONS**

Original: EN

**ABOUT THE PUBLISHER**

To contact the Policy Department or to subscribe to its monthly newsletter please write to: poldep-cohesion@europarl.europa.eu

Manuscript completed in June 2016.


| | | | |
|---|---|---|---|
| Print | ISBN 978-92-823-9507-3 | doi:10.2861/905874 | QA-04-16-544-EN-C |
| PDF | ISBN 978-92-823-9508-0 | doi:10.2861/09348 | QA-04-16-544-EN-N |

This document is available on the Internet at:
http://www.europarl.europa.eu/supporting-analyses

**DISCLAIMER**

European Parliament

DIRECTORATE-GENERAL FOR INTERNAL POLICIES

**POLICY DEPARTMENT B: STRUCTURAL AND COHESION POLICIES**

TRANSPORT AND TOURISM

# Research for TRAN Committee - Airport slots and aircraft size at EU airports

## IN-DEPTH ANALYSIS

**Abstract**
Congestion at major EU airports has led to a system of take-off and landings permits called 'slots'. Airlines are allocated slots according to their previous use, through the 'Grandfather Rights' rule. This note shows that while this system impacts negatively on aircraft size, through phenomena known as 'slot hoarding' and 'slot babysitting', this impact is mitigated by the increase in traffic which brings about operation of larger aircraft.

IP/B/TRAN/IC/2015_201 2016

PE 585.873 EN

# CONTENTS

# LIST OF ABBREVIATIONS

| | |
|---|---|
| **BTS** | Bureau of transportation Statistics (USA) |
| **FAA** | Federal Aviation Administration (USA) |
| **IATA** | International Air transport Association |
| **ICAO** | International Civil Aviation Organisation |
| **IFR** | Instrument flight rules |
| **GAO** | US General Accounting Office |
| **VFR** | Visual flight rules |

# LIST OF FIGURES

# EXECUTIVE SUMMARY

## Background

Major airports in the EU implement access restrictions regulated by means of a slot system. A slot can be understood as a take-off or landing right at an airport in a specified time period.

The number of slots per hour is determined on the basis of available infrastructure (runways, taxiways, terminals, etc.) and possible constraints, so that operating at a specified capacity will generate acceptable delays. Slots are allocated at each airport by a coordinator, on the basis of a principle of historic rights called the 'grandfather rights' rule (which includes a 'use it or lose it' rule), which essentially mean that airlines are allocated slots at an airport on the basis of their previous use of that airport.

At almost all US airports, and contrary to the EU, runway access is allocated on a 'first come, first served' basis. This enables full utilisation of capacity at all times, and easier access to airports for airlines, but nothing prevents delays – harmful to both airlines and consumers – from building up during peaks of demand.

While the EU system keeps delays at a reasonable (and predetermined) level, economists question the efficiency of the slot system, in terms of capacity utilisation and allocation of slots to airlines. Slots are unlikely to be allocated to those airlines that would put them to the best social use, not least given the fact that air transport evolves rapidly while slot allocation does not.

A specific concern is that this system may impact negatively on the size of aircraft at major EU airports, thus restricting supply and access to the air transport system.

## Aim

The aim of the present study is to investigate the effects of the slot system and the 'grandfather rights' rule on aircraft size and size evolution at major EU airports.

Economists criticise the current EU slot allocation system, mostly because it has negative effects on the efficiency of slot usage, and on competition between airlines, by freezing slot allocation and by giving an advantage to incumbent airlines benefiting from 'grandfather rights'. This allows them to engage in anticompetitive behaviour, that is, to hold on to slots that they are unable to use profitably rather than make them available to competitors.

It is believed that the current system of slot allocation leads to 'slot hoarding' and 'babysitting' of slots, which involves the operation of small aircraft and/or low load factors in order to keep slots rather that lose them. While individual instances can be pointed out or suspected, the extent of this behaviour in Europe is difficult to assess because there is no basis for comparison with non-slot-controlled major airports. In the USA, where comparisons could be made between a few slot-controlled airports and other airports, studies have shown a negative impact of the slot system on aircraft size.

Since airlines operate hub-and-spoke operations from the largest EU airports, they need various aircraft sizes to serve various markets. Consequently, the size of the aircraft operated cannot be used as an absolute indicator of the efficiency of slot use, which depends on the structure of competition and traffic.

However, in the context of traffic growth, it certainly appears socially desirable to allow more passengers to be able to benefit from existing airport capacities through the operation of larger aircraft.

It is for this reason that this note looks at the evolution of the payload (average number of passengers per flight) at main EU and US airports. It shows that payload has evolved at a steady rate in both regions, in line with the increase in traffic and congestion, whether airports are slot-controlled or not; any negative effects of the 'grandfather rights' rule on aircraft size are mitigated by traffic increases, resulting in the operation of larger aircraft.

# INTRODUCTION

National and international aviation has been growing at a rather impressive rate since the end of World War II, despite repeated crises. Traffic has doubled every fifteen years since 1970. If one accepts the forecasts made by Boeing and Airbus, it should double again in the next fifteen years.

The limit to such traffic growth is not the sky but rather the ground infrastructure, i.e. the airports. They are hard-pressed to keep up, and fail to do so in many places: demand for take-offs and landings exceeds capacity during peak hours. According to Eurocontrol, in 2012 the top 15 airports in Europe[1] were saturated during more than 12 hours per day, and are forecast to be heavily saturated during more than 16 hours per day in 2035.

In parallel, building new capacities at many European and US large airports is becoming increasingly difficult, and improvements are sometimes limited to seeking ways to use existing infrastructure in a better way.

The structural problem of airport capacity has existed for decades – first in the USA, then in the EU, and, more recently, in many places in Asia, where the strong increase in traffic is linked to rapid economic development in several countries. In China, for example, while new airports are being built, twelve of the existing large airports are currently congested.

Since the EU and the USA experienced this problem much earlier, they have devised solutions, or at least systems to cope with airport congestion in the best possible way. Although they have addressed the same problem very differently, they have both used the concept of slots to deal with congested airports, even if slots are of much more limited use in the USA.

Section 1 of this note deals with the meaning of slots according to US and EU laws, explaining the way they are allocated on both sides of the Atlantic, and why the USA do not use slots at most airports. It also looks at the performance of the EU and US systems in terms of congestion.

Section 2 looks at the effects of the slot system on aircraft size. What do economists think about slots: is it an efficient system from an airport usage point of view? How does the EU system of slot attribution perform? More specifically, what are its effects on aircraft size or on payload?

Section 3 concludes the note by describing economists' thoughts on the possibilities of improving the system from the point of view of economic efficiency, downstream market competition and the stability of the industry.

[1] Eurocontrol is the pan-European organisation that supervises air traffic operations throughout Europe. With 41 contracting states, Eurocontrol area is wider than the EU. (Thus, in 2012, Turkey had the most unaccommodated demand within the Eurocontrol area.)

# 1. THE SLOT SYSTEM

**KEY FINDINGS**

- A **slot** can be understood as a **landing or take-off right** at an airport during a specified period of time. There are currently 180 slot-controlled airports in the world, 93 of which are in the EU and 2 in the USA. In slot-controlled airports, airlines need to obtain slots for landings and take-offs **in advance**.
- The **number of slots** is computed as a number of landings/take-offs per hour. It is linked to an **average capacity**. Once the number of slots has been fixed, **the level of congestion** (and of delays) is known and operators face less uncertain operating conditions.
- Slots are allocated at the airport level by **coordinators**. In the European Union, airlines are allocated slots on the basis of their previous use, according to a system based on what is known as the '**grandfather rights**' rule, which includes a '**use it or lose it**' rule.
- At most **US airports**, slots are not used. Airlines land on a '**first come, first served**' basis. As long as capacity is sufficient to accommodate all existing demand, it is an efficient system in terms of use and allocation of capacity. If demand exceeds capacity during significant periods, it can rapidly lead to **congestion-related delays**.
- A slot system prevents the building up of delays. A comparison of delays at main EU and US airports shows that, on average, **delays are longer at US airports**.

## 1.1. Slots: what are they?

A slot can be understood as a landing or take-off right at an airport during a specified period. The exact definition is somewhat more precise, and the EU definition is different from the one used in the USA. However, in both cases a slot is not a property right of the airline but a right of use.

In the USA, slots refer only to the use of runways. In the EU, they refer to all infrastructure necessary to operate a service, as stated in Regulation 95/93: 'slot shall mean the entitlement of an air carrier to use the full range of infrastructure necessary to operate an air service at a coordinated airport on a specific date and time for the purpose of landing and take-off'.[2]

We will later see how slots are allocated to airlines, but let us first point out some important facts:

- A slot is not attached to a route but allocated to an airline, which can operate it wherever it likes, sometimes with distinction made between domestic and international slots (USA). This means that the slots do not limit the freedom of airlines to change their networks and adapt them to new demands.
- An individual slot is not of much use to an airline. In order to set up an operation between regions of the world, airlines need to take off and land from many airports

[2] Council Regulation (EEC) No 95/93 of 18 January 1993 on common rules for the allocation of slots at Community airports, OJ L 14, 22.1.1993, p. 1.

– flying between congested airports, a take-off right is only useful as long as it is associated with a landing right somewhere else. This creates a complex situation in which airport capacity needs to be allocated in a somewhat coordinated way all around the world.

We therefore need to look at the big picture: twice a year, the International Air Transport Association (IATA) sets up scheduling conferences at which airlines and slot coordinators come together to improve initial allocations for the coming season, in order to ensure that airlines have consistent sets of landing and take-off slots.

Airports at which it is necessary to get a slot are sometimes called 'fully coordinated' airports, or 'level 3' airports in IATA guidelines. The number of 'level 3' airports in the world is growing every year. The latest list published by IATA (April 2016)[3] indicates 50 airports in the Asia-Pacific region, 107 in the Europe region (of which 93 in the EU) and 2 in the USA, for a world total of 180. In the 2005 IATA document, there were 96 'level 3' airports in the world, so the number has nearly doubled in 11 years.

## 1.2. How is the number of slots computed?

Before looking at the allocation of the slots, we have to know how they are computed. Why, for example, was the capacity at Paris-Orly in 2013 limited to 76 slots per hour[4], and not 75 or 80?

The actual capacity tends to vary, depending on the weather or the traffic mix. For instance, in bad weather conditions (fog, snow storms, etc.), capacity can be greatly reduced. Since the allocation has to be made in advance of the coming season, which means that it is not possible to know what the actual capacity will be, a theoretical average capacity needs to be computed.

This means that in periods of good weather and homogeneous traffic, the chosen number of slots may actually be lower than the number of flights that could have been accommodated with acceptable delays, meaning a net loss of airport capacity. This is a drawback of advance capacity planning that is inherent to the concept of slots.

In most cases, the number of slots is determined by consideration of the infrastructure (runways, taxiways, terminals, etc.) and other possible constraints[5] to ensure that operating at the capacity chosen will only generate acceptable delays. Not zero delays: in order to have zero delays, the allocated capacity would have to be reduced significantly, which would be a waste of resources. A certain level of delays is therefore accepted by the industry in order to ensure a higher number of available slots.

This question of optimal computation of slots is in itself a subject of research.[6] There is currently no guarantee that the number of slots allocated at a given airport has been fixed to the economically optimal level: in theory, at that level, the benefit of adding one slot should equal the added congestion cost generated by this additional slot.

[3] IATA Worldwide Slot Guidelines, Annex 11.12

[4] http://www.aeroportsdeparis.fr/en/professionals/airlines-services/airlines-our-platforms/airlines-paris-orly, last accessed 12 April 2016.

[5] In the case of Paris-Orly, for example, there is a set limit of 250 000 flights per year for environmental reasons.

[6] See for example Forsyth, P. and Niemeier H., 2008, 'Setting the slot limits at congested airports', *in Airport Slots, International Experiences and Options for Reform*, Ashgate Publishing.

Optimal or not, however, once the number of slots has been fixed, congestion is also fixed at a certain level. Authorities/airports/airlines no longer have to worry about it (except in exceptional situations of degraded operations), and they face less uncertain operating conditions.

## 1.3. How are slots allocated?

Slots are allocated by coordinators at each airport. According to IATA principles, to ensure their neutrality the coordinators should be independent and not beholden to private interests, but this is not always the case. In most places, the allocation functions under a principle of historic rights, called the 'grandfather rights' system. Airlines are allocated slots on the basis of their previous use of the airport.

This is the system recommended by IATA, for reasons of consistency and stability. The airlines represented by IATA want to recoup their investments at specific airports, and devise future strategies with a certain degree of certainty over such fundamental strategic assets as slots.

In the EU, Regulation 95/93 is based on the 'grandfather rights' philosophy: the slots are allocated to airlines which have used them in the preceding scheduling period for at least 80 % of the time. If a slot has not been used 80 % of the time, it is lost and returned to a pool of unused slots (the 'use it or lose it' rule). Some of the slots in the pool are then allocated to new entrants at the airport. Airlines can then exchange slots in order to improve the initial allocation.

In the USA, there are currently only two 'level 3' airports (New York JFK and Newark).[7] The approach to allocate the domestic slots at those airports is a combination of a 'grandfather rights' system and a market-based mechanism, the 'buy and sell' rule set in 1985 (secondary market for slot trading).

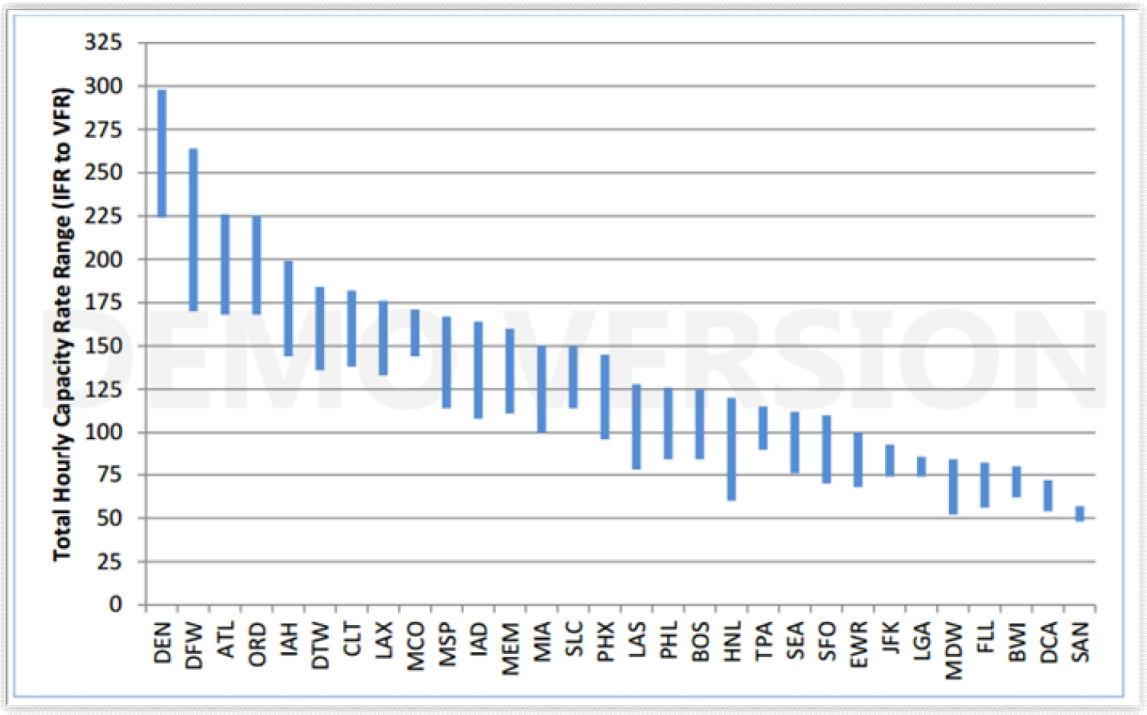
## 1.4. The US case: no slots?

At almost all US airports, runway access is allocated on a 'first come, first served' basis. The US authorities believe that they should refrain from using a system of slot-control as long as congestion does not reach a high level. The reasons for this can be divided into two lines of reasoning: use of capacity and allocation of capacity.

***Use of capacity***: as mentioned above, with a system of slots, the capacity (number of slots per hour) is fixed 'once and for all' for a whole season, regardless of traffic or meteorological conditions. In favourable conditions – if, for example, the weather is good and the traffic homogeneous – the actual number of flights that could be accommodated may be higher than the number allowed under the fixed, 'average' capacity. In other words, with a fixed number of slots, the use of capacity is suboptimal. This is especially true in the USA where aircraft during approach to landing in good weather can use 'visual flight rules' (VFR) instead of 'instrument flight rules' (IFR), reducing their time of approach and landing, as shown in Figure 1. For example, in San Francisco (SFO), capacity ranges from 70–72 under IFR rules to 100–110 under VFR rules.

[7] La Guardia and Washington are not considered 'level 3' airports in the IATA list, but they are nonetheless slot-controlled and subject to a perimeter regulation: Reagan Washington National may not accommodate non-stop flights to or from cities beyond 1250 statute miles (2010 km), with limited exceptions. La Guardia is in the same position with a limit at 1500 statute miles (2400 km).

**Figure 1: Capacity at main US airports**




**Source** FAA (Airport capacity Profile), July 2014.

Furthermore, at slot-controlled airports the 80 % utilization rule does not lead to full use of capacity. The US General Accounting Office (GAO) sums this up in its 2012 assessment of the system of slot-controlled airports (four airports at the time): *'The rules, however, in effect, allow some existing airport capacity to go unused, and this capacity is therefore unavailable to other airlines because airlines are not required to schedule a flight for each of their slots, but instead are only required to use their slots 80 percent of the time.'*[8]

***Allocation of capacity***: the main problem with slots is the efficiency of their allocation. By having no slots, but an open access to airports, the authorities get around this problem and leave it to competition between airlines to use the existing capacity in the best possible way, given passenger demand. This can only work, however, as long as congestion-related delays do not become a pervasive problem that reduces passenger welfare (and airline profits).

This 'first come, first served' system is thus an efficient system, and is widely accepted by airlines as long as runway (and terminal) capacity is sufficient to accommodate all existing demand. If demand exceeds capacity during significant periods, it can rapidly lead to congestion-related delays.

Not all delays are inefficient though, and there is an optimal level of delay: the social costs of scheduling one more flight should not exceed the social benefits ('social' meaning here that we take into account the costs and benefits for all users of the system, airlines and passengers). Unhindered, the airlines will not reach that optimal level because when scheduling a flight they only take into account their private costs and benefits and not those of other users (other airlines and passengers). Because of this, delays can sometimes reach levels where there are net losses for all users of the system.

[8] GAO, September 2012: 'Slot-Controlled Airports: FAA's Rules Could Be Improved to Enhance Competition and Use of Available Capacity'.

For this reason, the US authorities maintain a database of all delays at US airports, with their causes, so that they can monitor their evolution. Thus, in January 2016 the Bureau of Transportation Statistics (BTS) could report that, in that same month, 81.29 % of all flights at US commercial airports were on time, 15.90 % were delayed[9] and 2.81% were either cancelled or diverted. The average delay of delayed flights was 58 minutes, and the average delay excluding weather and security-related delays was 55 minutes.

For the year 2015, somewhat similar figures can be computed[10]: 18.28 % of flights were delayed; the length of the average delay of delayed flights was 59 minutes, and the average delay excluding weather and security-related delays was 56 minutes.

A comparison of delays at main EU and US airports (September 2015 and March 2016 data from FlightStats[11]) shows that, on average, delays tend to be longer in the US. At the most congested airports in the US, delays tend to build up during the day and reach high levels in the evening. There is no mechanism, as in the EU, to prevent delays from reaching disruptive levels.

**Figure 2: Comparison of flights delayed per region**

| Region | *Flights delayed (%)* | Average delay (minutes) |
|---|---|---|
| | **September 2015** | |
| **US** | ***14.61*** | **54.14** |
| **EU** | ***27.91*** | **39.29** |
| | **March 2016** | |
| **US** | ***18.32*** | **58.82** |
| **EU** | ***21.60*** | **43.45** |

**Source**: FlightStat.

[9] According to BTS definitions, a flight is considered delayed if it arrives at the gate 15 minutes or more after the scheduled arrival time, as reflected in the Computerised Reservation System.
[10] All data from US Bureau of Transportation Statistics.
[11] www.flightstats.com, last accessed 12 April 2016.

# 2. THE EU SYSTEM AND ITS IMPACT ON AIRCRAFT SIZE

**KEY FINDINGS**

- Economists criticise the current EU slot allocation system, mostly because it has **negative effects on the efficiency of slot use and on competition** between airlines, by freezing slot allocation and giving an advantage to incumbent airlines benefiting from 'grandfather rights'.
- It is believed that the current system of slot allocation leads to '**slot hoarding**' and '**babysitting**' of slots, which involves the **operation of small aircraft and/or low load factors** in order to keep slots instead of losing them. While individual cases can be pointed out or suspected, the extent of this behaviour in Europe is difficult to assess because there is no basis for comparison with non-slot-controlled major airports.
- In the context of **traffic growth**, it certainly appears desirable to allow more passengers to be able to benefit from existing airport capacities through the operation of **larger aircraft**. However, since airlines operate **hub-and-spoke** operations from the largest EU airports, they need various aircraft sizes to serve various markets. Consequently, the size of aircraft cannot be used as an absolute indicator of the efficiency of slot use, as it depends on the structure of competition and traffic.
- In the USA, the GAO has found that flights operated at slot-controlled airports tend to be scheduled with **smaller aircraft** than flights operated at other airports.
- A comparison of **payload evolution** at main EU and US airports shows that they have evolved at a steady rate in both regions, in line with the increase of traffic and congestion. **Traffic evolution** at major European airports pushes therefore towards **larger aircraft**.

## 2.1. What do economists have to say about current EU slot allocation?

Economists all agree on one thing: although it has the advantage of working and keeping congestion at an acceptable level, the current EU system of slot allocation using 'grandfather rights' is not efficient.

There are two ways in which a system can be efficient: productive efficiency and allocative efficiency. Productive efficiency means that the maximum number of available slots should be used. Allocative efficiency means that the slots should be used in ways that provide the highest possible social value. Ideally, a slot system should have the properties of productive and allocative efficiency.

***Productive efficiency***: The EU slot system is not using slots at the maximum, since operators are free to use only 80 % of the slots allocated to them. While this gives the airlines some flexibility to adapt to demand, it does not maximise slot usage.

***Allocative efficiency***: Most criticisms of the slot system focus on the way that slots are allocated and on the impact this has on competition between airlines. Since they are allocated according to the 'grandfather rights' system, favouring schedule continuity, this

leads to the immobility of slots in successive schedule seasons, because airlines have a strong incentive to hold on to them. While individual airlines may redistribute their slots between their routes in an efficient fashion, there is very little mobility of the slots between airlines, as they constitute a very valuable asset for the incumbents that operate them. Therefore, even if the allocation was efficient at one point in time, there is very little chance that it will remain efficient over time, considering the fast evolution of the industry.

Also, it is important to note that incumbents are benefiting from rents, since they receive a valuable asset that contributes to the overall value of the firm without paying for it (coordinators allocate slots to airlines for free). This circumstance, and the difficulty of entering the market, may be seen as a distortion of competition between rival firms operating in the same market but without having the same access to slots at main airports.

## 2.2. 'Slot hoarding' and 'babysitting' of slots

Many authors and authorities have expressed suspicion that the 'grandfather rights' system has a negative impact on the size of aircraft at coordinated airports. This would be a typical allocative inefficiency. There are two phenomena involved: 'slot hoarding' and 'babysitting' of slots.

**Slot hoarding**: Since airlines lose slots that they do not use, and will lose slots forever if they release them voluntarily, they tend to keep them for future use. Since traffic is constantly increasing, they may feel that they might need their 'today-not-so-useful' slots in a couple of years. Airlines can also keep the slots in order to prevent entry by potential competitors.

The extent of this hoarding is hard to assess, since it is impossible for an outsider to know whether a slot has any current value for an airline (as opposed to a future perceived value).

A 2011 Commission study[12] showed that the proportion of slots withdrawn at the EU's most busy airports was low, but not equal to zero, reaching in summer 2008 2.3 % at Frankfurt, 2.6 % at Munich, 2.4 % at Paris-CDG, 2.0 % at Paris-Orly and 0.4 % at London-Heathrow.

Since airlines must use the slots in order to keep them, slot hoarding can lead to operations with higher frequencies and smaller aircraft, and/or lower load factors.

**Babysitting**: Airlines may also transfer slots to non-competing airlines, such as partner airlines (slots can be transferred within an alliance) before using them to uses that are more profitable.

A 2008 article[13] cites the case of KLM, which operated routes from Rotterdam and Amsterdam to London-Heathrow with Fokker 50s (holding around 58 passengers) and transferred the slots to their partner Northwest to start transatlantic routes with larger aircraft when it became possible.

Babysitting may also lead to the operation of smaller aircraft, or to larger aircraft at lower load factors.

[12] European Commission, 2011: 'Commission staff working paper, Annexes 1–11 to the Impact Assessment accompanying the Proposal for a Regulation of the European Parliament and of the Council on common rules for the allocation of slots at European Union airports (Recast)'.

[13] De Wit J., and Burghouwt G., 2008: 'Slot allocation and use at hub airports, perspectives for secondary trading', *European Journal of Transport and Infrastructure*, Vol. 8, Issue 2.

## 2.3. Is size an indication of 'good usage'?

Are we sure that aircraft size is a relevant indicator of efficiency of slot use? Larger aircraft, carrying more passengers, seem intuitively more adapted to situations of scarce capacity. The size of aircraft operated could therefore be seen as an indicator of a 'good' use of slots in a situation of airport congestion.

This intuitive notion is based on the idea that the value of a slot to society is linked to the number of passengers transported. It may not always be the case, but in the context of traffic growth, it certainly appears desirable to allow more passengers to be able to benefit from existing airport capacities through the operation of larger aircraft.

In larger-scale terms, therefore, aircraft size matters, or rather the average number of passengers per flight, which is called the payload. In this view, the average payload should be related to the level of congestion, and increase as traffic grows.

If we look closer at the smaller scale of airline operations, however, greater complexity appears: in Europe, airlines operate hub-and spoke-networks, in which one or two central airports are used as connecting platforms. Passengers change plane at the hubs to continue to their destinations. Each airline manages a whole network of short, medium and long-haul flights at its hub. All flights are useful to operate the network, because the network is valuable to passengers in proportion to the number of destinations that they can reach.

In this logic of hubs, a slot operated with a small aircraft could have a high value to society if it connects to many other flights. In hub-and-spoke operations, shorter legs to medium-sized markets are often operated with smaller aircraft, while long-haul flights are operated with larger aircraft. This is why one cannot have only large aircraft in a hub-and-spoke network.

Does this contradict our reasoning concerning aircraft size and/or payload? In part, but not entirely: aircraft size at an airport reflects the patterns of traffic, the degree of hubbing (percentage of connecting passengers, for instance), and probably other local factors. There is no absolute 'right' aircraft size' for the level of congestion at a given airport. This is also the reason why individual cases of 'slot hoarding' or 'babysitting' cannot easily be detected, or the extent of such behaviour assessed.

That said, it is still likely that the use of a slot system has detrimental effects by lowering the size of aircraft used or the average payload. In other words, at any given major, slot-controlled airport, size (or passenger payload) may not be what it would be without the slot system. How do we measure that?

## 2.4. Slots and aircraft size: the US case

In 2012 the GAO conducted a study on slots, in which it compared traffic usage at slot-controlled and non-slot-controlled US airports (the latter being in the majority). On the basis of the results reached, the GAO criticised the slot system of for two reasons:

—The 'use it or lose it' rule means that slots only have to be used 80 % of the time, which is bad, since some of that precious, scarce capacity can be lost: '*In addition to some existing capacity going unused, flights at the slot-controlled airports, even when operated, tend to be scheduled in such a way that available capacity is used more inefficiently than at like-sized airports that are not slot-controlled, thereby limiting passenger growth and access by new-entrant airlines that could offer new service or lower fares.*'

—Aircraft size is smaller at slot-controlled airports: *'For example, GAO found that flights operated at slot-controlled airports tend to be scheduled with smaller aircraft. Using statistical analyses, GAO found that scheduled passenger flights at slot-controlled airports are 75 percent more likely to be scheduled by airlines using an aircraft with fewer than 100 seats than flights at other like-sized airports that are not slot-controlled. Slot-controlled airports also tend to have certain routes that are flown at higher daily rates and aircraft that are less full.'*

In other words, the study points to a linkage in the USA between the slot system and a decrease in the size of aircraft, a decrease in the load factor and an increase in flight frequency. However, as the US air transport system is quite different from the European one, these results cannot simply be extended to the EU.

Unfortunately, performing the same type of analysis is impossible in the EU, since all major airports are slot-controlled. There is no basis for comparison with non-slot-controlled airports, unlike the USA where authorities could sample of both systems. For this reason, it is extremely difficult to know what the aircraft size at the large EU airports would be without a slot system and the 'grandfather rights' rule.

## 2.5. Can traffic increase lead to larger aircraft size?

If the extent of the reduction in aircraft size and payload at EU airports as a result of slot allocation is impossible to assess, we can still look at the evolution of size and payload over time. Is the increase in traffic pushing towards larger aircraft size?

Here it is of interest to compare the situation in Europe with that on the other side of the Atlantic.

Directly comparing traffic data for EU airports with that for US airports would be hazardous, given the inherent differences in the structure of traffic: in the USA there is much more domestic traffic, operated with smaller aircraft on average, on short- to medium-haul routes. However, it is possible to study the evolution of aircraft size in the USA and in Europe over time. In order to capture the effects of both 'babysitting' and 'hoarding' (i.e. their potential effect on aircraft size and load factors), we will look at the payload.

In 2014 the average payload at 11 of the largest US airports[14] was 108 passengers per aircraft. At 10 of the largest EU airports[15], the average was 134 passengers per aircraft. This confirms that the structure of traffic is quite different.

Over the past 20 years, from 1994 to 2014, the number of passengers and the payload have increased in both regions. While traffic has been growing more slowly in the USA, which is a more mature market, the payload has increased more, especially in non-slot-constrained markets (i.e. excluding Chicago and New York airports, which are slot-constrained). That the payload increase is larger in the USA is to be expected, given the initial level differential, whereby the payload was already much higher at EU airports, as shown in Figures 4 and 7 below.

[14] Atlanta, Chicago, Denver, Houston, Los Angeles, Miami, New York Kennedy, Orlando, Phoenix, San Francisco, Seattle.

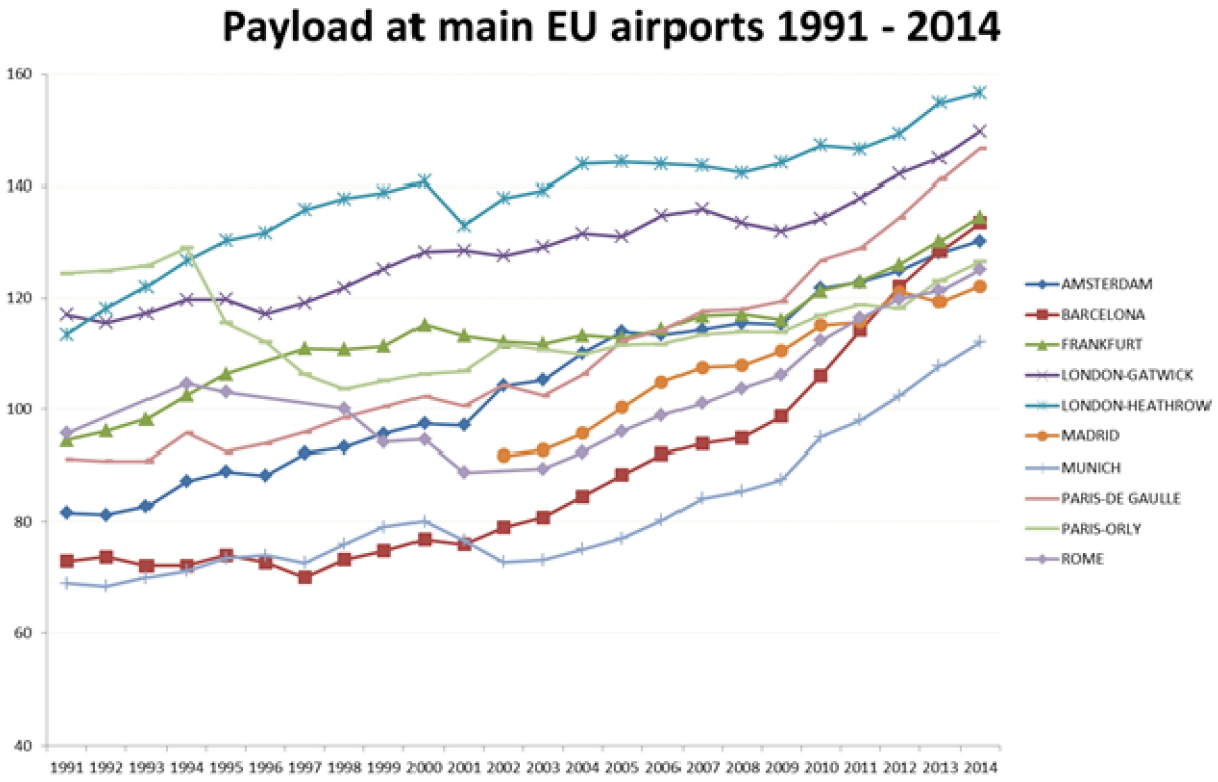
[15] Amsterdam, Barcelona, Frankfurt, London Heathrow, London Gatwick, Madrid, Munich, Paris CDG, Paris Orly, Rome.

**Figure 3: Passengers and payload increase in airport samples**

| Annual average increase 1994-2004 (%) | *Passengers* | Payload |
|---|---|---|
| **EU** | ***3.26*** | **1.46** |
| **US** | ***2.09*** | **1.80** |
| **US without New York & Chicago** | ***2.33*** | **2.00** |

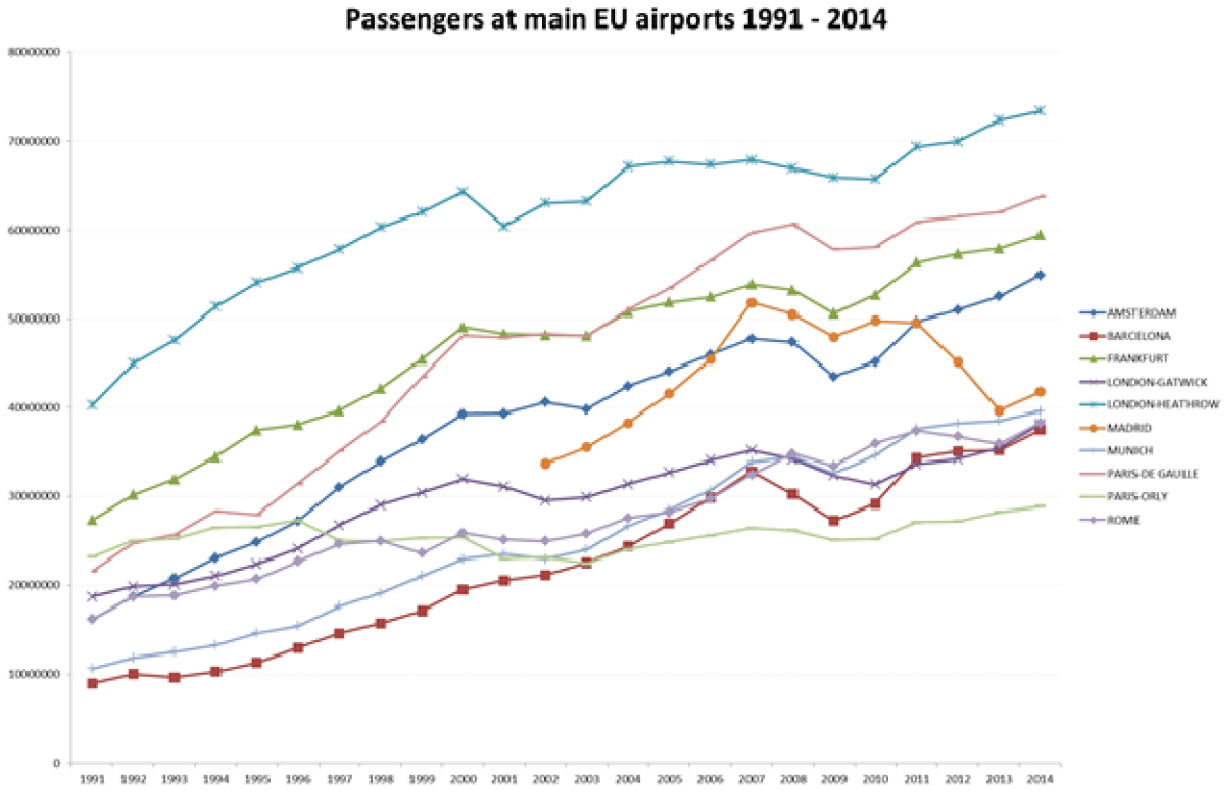
**Source**: ENAC air transport data.

**Figure 4: Payload at main EU airports**




**Source:** ENAC Air Transport Data.

**Figure 5: Passengers at main EU airports**




**Source:** ENAC Air Transport Data.

**Figure 6: Passengers at main US airports**

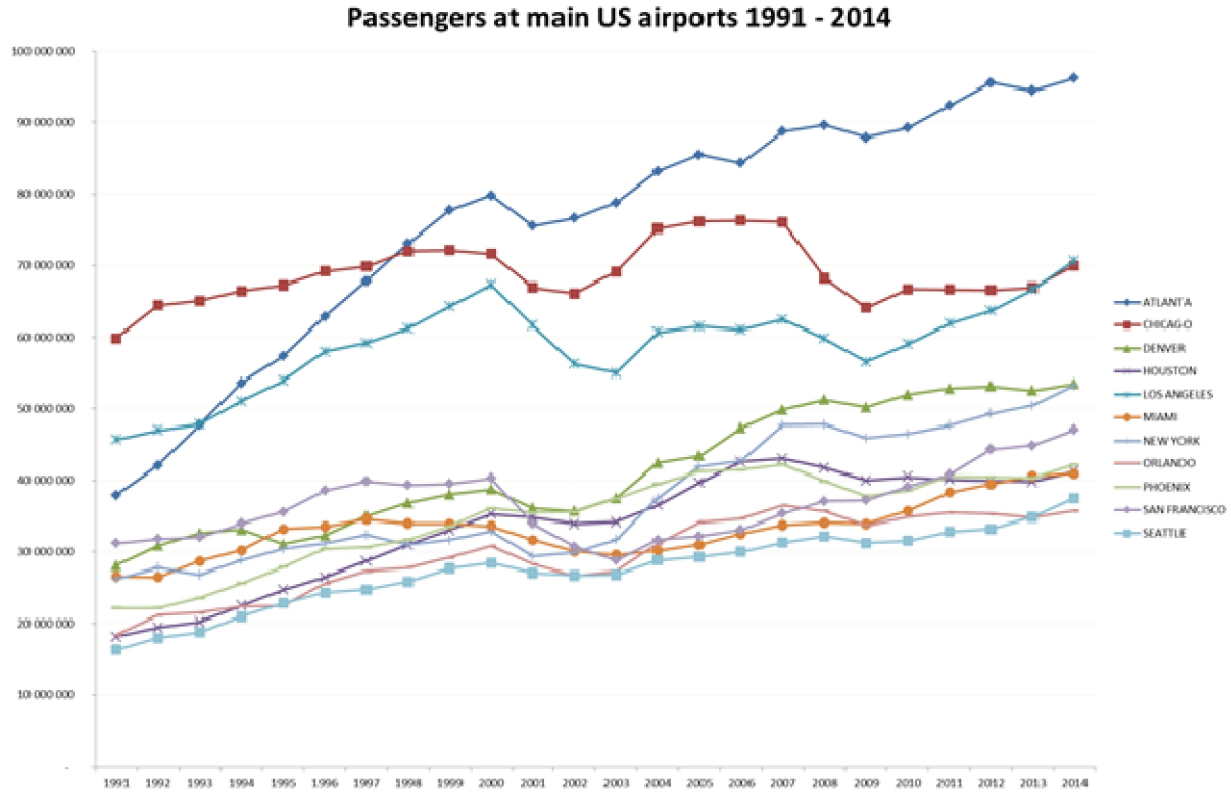
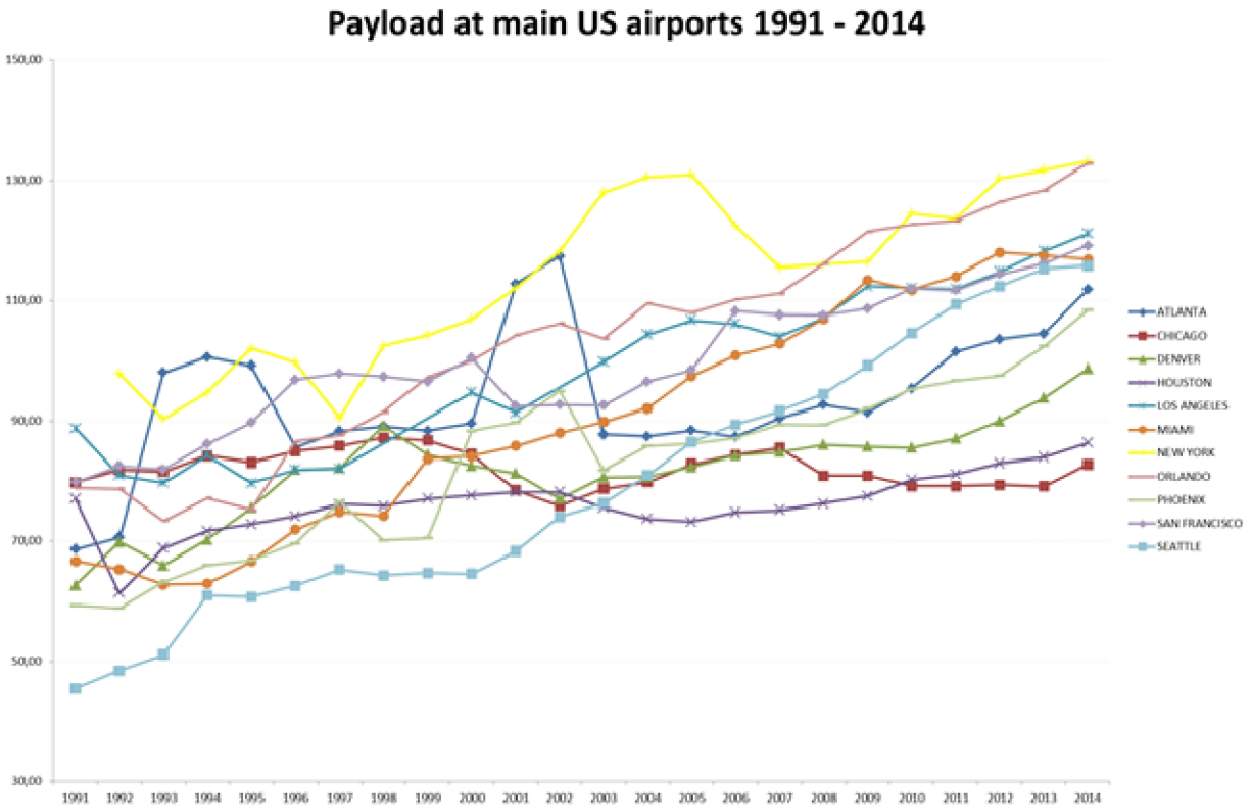


**Figure 7: Payload at main US airports**



# 3. IMPROVEMENT OF THE CURRENT SYSTEM

**KEY FINDINGS**

- A 'good' slot allocation should enable **efficient use of scarce airport capacity**. Other goals can be viewed as desirable, however: for the airline industry, some sort of **stability**, and for the competition authorities, a **sufficient degree of competition** between airlines at airport level. However, killing two (or even three) birds with one stone has never been straightforward.
- **Secondary slot trading** can be seen as an option for improving the slot allocation at EU airports without changing the primary allocation. There are concerns, however, that the market **may not function well** and generate enough sales, or that it could **lead to a reduction in competition** by reinforcing the position of carriers that are already dominant.
- **Auctioning** a relatively small fraction of the slots each year is another option for improving the slot allocation at EU airports without changing the primary allocation. The difficulties are the **design** of the auctions, the **costs** associated with them for all operators, and, above all, the probable **reluctance** of the airline industry to pay tomorrow for what they get for free today. Moreover, the **risks of market monopolisation** must be carefully balanced when there are dominant carriers at the airports.

We examine here the possibilities of improving the existing 'grandfather rights' system. Another option, not explored here, would be to replace it with another mechanism.

Not considered here are small improvements to the current allocation that are more or less straightforward, such as improving the transparency of the current process, ensuring the independence of the coordinators and communications between them at EU level, or reinforcing the application of the 'use it or lose it' rule. We believe that such improvements should be an ongoing process, whereby advantage is taken of the experiences gained year by year.

## 3.1. What are the objectives of a 'good' slot allocation?

There may be several objectives to a slot allocation. The first and obvious objective is the efficient use of scarce airport capacity. But other valuable objectives can be pursued either by the authorities or by the industry.

From the point of view of the airline industry, stability is viewed as important: it is clear that any system must take into account of this issue, since airline strategies and long-term planning rely on some stability of airport access. From the point of view of the competition authorities, on the other hand, the level of competition between airlines operating at the constrained airports is equally important.

As economists know, with only one instrument (whether a price, a tax, an allocation, etc.), it is difficult to pursue several goals. This is why there is a tension between the potentially conflicting goals of the allocation, and no real agreement between economists, or between authorities (in the US and in the EU, for example), as to what is the best solution to the slot allocation problem, or on the question of access to congested airports.

## 3.2. Secondary slot trading

One way to improve the current system without too much upheaval is to introduce secondary trading after the primary 'grandfather rights' allocations have been made. Secondary slot trading has been in force at US slot-controlled airports since 1986. It has also been used at UK airports.

In theory, secondary slot trading should lead to a more efficient use of airport capacity by enabling airlines to sell slots to other airlines. Sales would improve the efficiency of slot use, as slots would be purchased by those airlines that value it more and that would use it in way more valuable to society. In a competitive situation, this is generally true: the profit of the airline is a reliable indicator of the social benefit attached to the use of the slot. However, where competition is limited, as is the case in the airline industry, this may not always be the case.

In the USA, the outcome of slot trading was documented by the GAO in its 1999 report. The GAO expressed concerns that it has led to a reduction of competition between airlines. Carriers with a strong position at an airport tend to reinforce that position by acquiring more slots. While securing more slots may permit the dominant carriers to offer more destinations, and increased frequencies on existing routes in the context of the hub system, it also offers more opportunities for anticompetitive behaviour.

Another concern is that airlines may not want to part from valuable resources that may become even more valuable in the future. That being the case, could such markets function? In 2006, a report for the European Commission[16] found that only 1.2 % of slots were traded each year at Heathrow in the period 2001–2006. Heathrow is a special airport, however, with a high level of congestion throughout the day, and the behaviour of a market at other EU airports may not necessarily be similar.

## 3.3. Auctions

Many authors of scientific articles have considered auctions as a means of revealing the real values of slots for airlines and of improving slots use. We can cite Rassenti, Smith and Bulfin (1982), Gruyer and Lenoir (2003), NERA (2004), Button (2008) and Bruckner (2009). In the USA, the Federal Aviation Administration (FAA) has gone as far as to propose an annual auction for a number of slots in the New York area in 2008, but the proposal was subsequently dropped.

Economic theory tells us that in a well-designed auction, the willingness to pay for a good by a buyer shows the welfare he derives from the use of this good, which in turns reflects the social welfare created, as long as the market remains competitive. An auction also has the considerable appeal of revealing the value the buyer attributes to slot use (as opposed to slot trading, where the seller fixes the price).

Following the idea of improving current EU slot allocation, one idea would be to auction a fraction of the slots each year, in order to adjust the allocation of slots to the changing conditions of the market and give new airlines more chances to enter congested airports, without creating too much disruption to the operations of the incumbent airlines at those

[16] Mott MacDonald, European Commission, 2006, 'Study on the Impact of the Introduction of Secondary Trading at Community Airports'.

airports. In its 2008 proposal for a New York slot auction, the FAA suggested several options, with 10 % or 20 % of slots reallocated every year.

There are several difficulties with this, such as the design and cost of the auction, and the probable reluctance of the industry: while airlines may view slot trading favourably, since it brings revenues, they may not be so enthusiastic about auctions if they have to buy 10 % of their slot pool each year. The question of potential anticompetitive effects, thorough the monopolisation of slots by the dominant carriers must also be raised: preventing entry to its markets has a value for a dominant airline. There is a real risk here of market monopolisation and of deviation from the social optimum.

# 4. CONCLUSIONS

As air traffic continues to increase, the question of access to EU airports and the efficient use of airport capacity takes on great importance.

In the EU, airport slots are defined as take-off and landing rights. Their number corresponds to a computed average capacity of each infrastructure (runways, terminals). The allocation of these airport slots is then made by coordinators at each airport in accordance with the 'grandfather rights' rule, which includes a 'use it or lose it' rule, whereby airlines are allocated slots on the basis of their previous use of the airport.

In the USA, a different choice has been made: airlines access most airports on a 'first come, first served' basis (except at the two 'level 3' slot-controlled airports). This enables a full utilization of capacity at all times, and easier access to airports for airlines, but nothing prevents delays – harmful to both airlines and consumers – from building up in times of peak demand. By comparing both systems, we found indeed that delays concern a slightly smaller proportion of the flights, but are longer, in the US air transport system in the periods considered in our study, reaching nearly one hour per delayed flight.

While the EU system keeps delays at a more reasonable (and predetermined) level, there is widespread agreement among economists that it has negative effects on the efficiency of slot use, and on competition between airlines, by preventing mobility of slots and favouring incumbent airlines benefiting from 'grandfather rights'. Slots are unlikely to be allocated to the airlines which would put them to the best social use, especially since air transport evolves rapidly, while slot allocation does not. Moreover, airlines may engage in anticompetitive behaviour involving slots, keeping them when they are not able to use them profitably instead of making them available to competitors.

A specific concern is that this system may impact negatively on the size of aircraft at major EU airports, thus restricting supply and access to the air transport system. It is believed that the current system of slot allocation leads to 'slot hoarding' and 'babysitting' of slots, involving the use of small aircraft and/or low load factors, in order to keep slots instead of losing them. While individual cases can be pointed out or suspected, the extent of this behaviour in Europe is difficult to assess because there is no basis for comparison with non-slot-controlled major airports. In the USA, where comparisons could be made between a few slot-controlled airports and other airports, studies show that the slot system (similar to the EU one) has a negative impact on aircraft size.

Since airlines operate hub-and-spoke operations from the largest EU airports, they need various aircraft sizes to serve various markets. Consequently, the size of aircraft cannot be used as an absolute indicator of the efficiency of slot use, as it depends on the structure of competition and traffic.

However, in the context of traffic growth, it certainly appears socially desirable to allow more passengers to be able to benefit from existing airport capacities through the operation of larger aircraft.

It is for this reason that we looked at the evolution of the payload (average number of passengers per flight) at main EU and US airports. Our analysis shows that payload has evolved at a steady rate in both regions, in line with the increase of traffic and congestion, whether the airports are slot-controlled or not. We found that, over the past twenty years,

payload has increased by 1.46 % per year in the EU and by 1.80 % per year in the USA. It is quite difficult to compare these figures, since the structure of traffic is very different, with smaller aircraft and shorter flights in the US system, on average. This shows, however, that operators on both sides of the Atlantic adapt to the increase in traffic and limited airport capacity by switching to larger aircraft.

This means that any negative effects of the 'grandfather right' rule on aircraft size are mitigated by traffic increases, resulting in the operation of larger aircraft.

Potential improvements of the current allocation system include a secondary market, or a periodic, partial slot auction. In the first scheme, we have no guarantee that the market would function and generate sales. The second scheme in untried and is likely to meet with reluctance from the airline industry. Moreover, in both cases, the risks of market monopolisation must be weighed carefully into the balance when considering airports with dominant carriers.

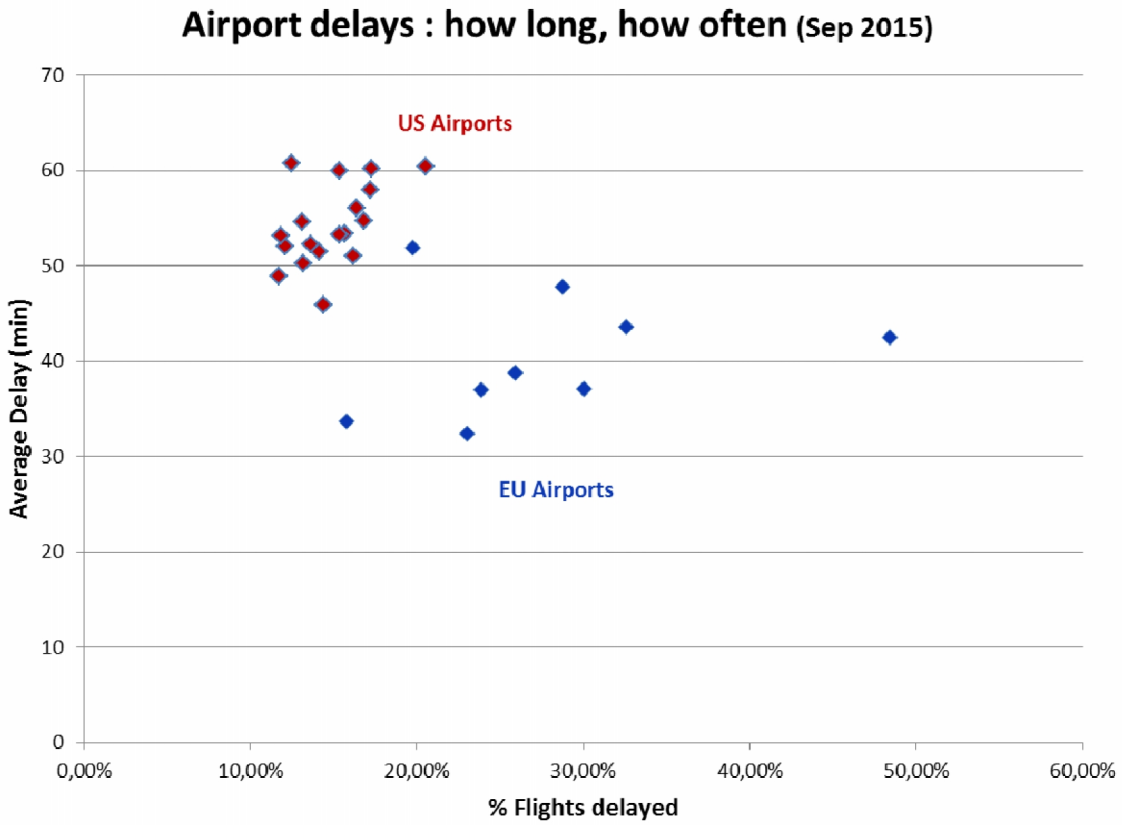
# REFERENCES

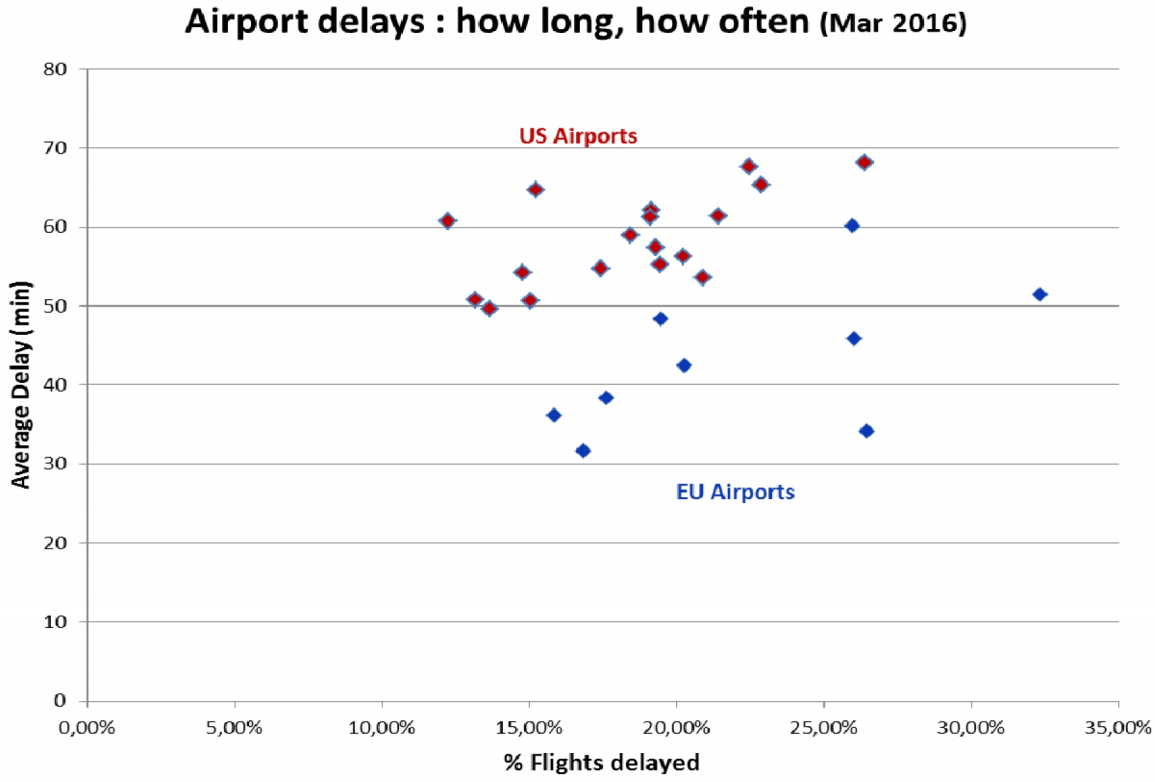

- Basso L., Zhang A., 2010: *Pricing vs. slot policies when airport profits matter*, Transportation Research Part B 44 (2010) 381–391.
- Brueckner J., 2009: Price vs. *Quantity-Based Approaches to Airport Congestion Management*, Journal of Public Economics, Elsevier.
- De Wit J., and Burghouwt G., 2008: *Slot allocation and use at hub airports, perspectives for secondary trading*. European Journal of Transport and Infrastructure, Vol. 8, Issue 2.
- De Wit, J. and Burghouwt, G., 2007: *The impact of secondary slot trading at Amsterdam Airport Schiphol*. SEO Economic Research. Report Number 957.
- Eurocontrol, 2013: *Challenges of growth 2013, task 6, the effect of air traffic network congestion in 2035.*
- European Commission, 2011: *COMMISSION STAFF WORKING PAPER, Annexes 1–11 to the Impact Assessment Accompanying the document Proposal for Regulation of the European Parliament and of the Council on common rules for the allocation of slots at European Union airports (Recast)*
- GAO, 1986: *Airlines takeoff and landing slots*. GAO/RCED-86-92.
- GAO, 1999: *Airline Deregulation, changes in airfares, service quality, and barriers to entry*. GAO/RCED-99-92.
- GAO, 2012: *Slot-controlled airports, FAA's Rules Could be Improved to Enhance Competition and Use of Available Capacity*. GAO-12-902.
- Gruyer N., Lenoir N., 2003 : *Auctioning airport slots*, ATRS conference proceedings.
- MacDonald M., 2007: *Study on the impact of the introduction of secondary trading at Community airports*. Volume 1. Commissioned by the European Commission.
- Morrison S., Winston C., 2007: *Another Look at Airport Congestion Pricing*, The American Economic Review Vol. 97, No. 5 (Dec. 2007), pp. 1970–1977.
- NERA, 2004: *Study To Assess The Effects Of Different Slot Allocation Schemes*. A Report for the European Commission, DG TREN
- Pels E., Verhoef, E., 2004: *The economics of airport congestion pricing*, Journal of Urban Economics, Elsevier.
- Rassenti S., Smith V., and Bulfin R., 1982: *A Combinatorial Auction Mechanism for Airport Time Slot Allocation*. The Bell Journal of Economics, Vol. 13, No. 2 (Autumn, 1982), pp. 402–417


# WEB REFERENCES


- Federal Aviation Administration: http://www.faa.gov/
- European Commission slot page: http://ec.europa.eu/transport/modes/air/airports/slots_en.htm
- FlightStats: http://www.flightstats.com/
- ENAC Air Transport Data: http://leea.recherche.enac.fr/databaseA.htm

# ANNEX: AIRPORT DELAYS IN EUROPE AND IN THE US



CAT: QA-04-16-544-EN-C (paper)
CAT: QA-04-16-544-EN-N (pdf)

DIRECTORATE-GENERAL FOR INTERNAL POLICIES

# POLICY DEPARTMENT B
## STRUCTURAL AND COHESION POLICIES

## Role

The Policy Departments are research units that provide specialised advice to committees, inter-parliamentary delegations and other parliamentary bodies.

## Policy Areas

- Agriculture and Rural Development
- Culture and Education
- Fisheries
- Regional Development
- Transport and Tourism

## Documents

Visit the European Parliament website:
**http://www.europarl.europa.eu/supporting-analyses**

PHOTO CREDIT: iStock International Inc., Photodisk, Phovoir

ISBN 978-92-823-9507-3 (paper)
ISBN 978-92-823-9508-0 (pdf)

doi:10.2861/905874 (paper)
doi:10.2861/09348 (pdf)

Publications Office