

Noise around airports

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Introduction

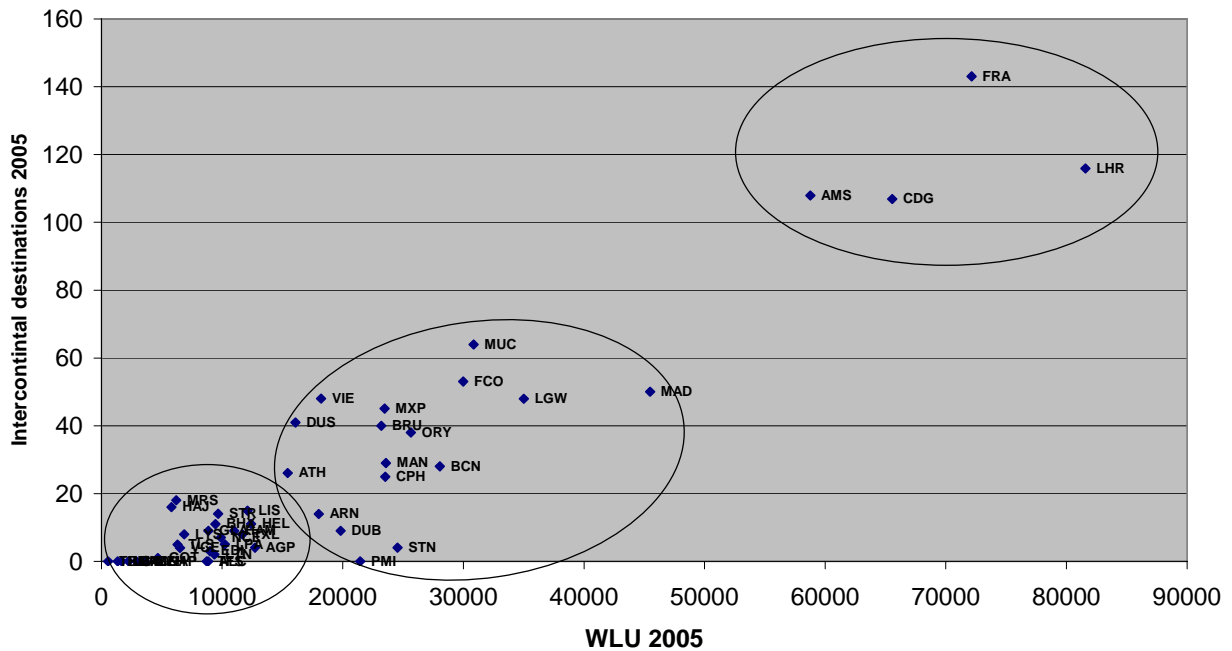
One of the most important negative impacts of civil aviation is noise. Aircraft landing and taking off are the chief causes of noise annoyance; the problem is therefore largely localized in the immediate environment of airports. This makes the noise problem a distributive problem (a question of distributive justice): whereas the whole region benefits from the presence of the airport, only those living around the airport suffer the negative impacts of noise.

In our contribution to the GARS Workshop on Aviation and the Environment we give answers to the following questions: What are the trends in air traffic at European airports? And what are the trends in aircraft noise emissions? How significant is the location of these airports in relation to surrounding residential areas? What strategies can be distinguished to reduce noise? To answer these questions, we first give the results of a general, quantitative analysis of 48 western European airports. After that, we will discuss some specific developments and new trends in the aviation industry, their impact on airports and the noise-efficiency of these airports. Moreover, we give extra attention to air-freight. We'll conclude with some speculative thoughts about the future of aviation and the environment

A typology of airports

To understand the developments in air traffic and noise at airports, it is necessary to have a framework to compare airports and explain differences between them. Therefore, we distinguish three types of airports, based on the quantity of their transportation product (in Work Load Units : 1 WLU is equal to 1000 passengers or 100 ton of cargo), and the quality of their transportation product: the total number of destinations and the number of intercontinental destinations. A cluster analysis resulted in a hierarchical division into 3 types of airports. The outcome is visualised in figure 1. Amsterdam Schiphol, London Heathrow, Frankfurt and Paris Charles de Gaulle are the four intercontinental hubs in Europe and at the top of the hierarchy. The second group consists mostly of larger airports in capital of other major cities and function as European hubs. The third group are airports that function mostly as points of departure or arrival.

Figure 1. Hierarchy of airports in Europe. Source: OAG.



Aviation noise

Noise is not easy to define or map: it has different sides. One can think of decibels but also of disturbance of the population. In this research, we have therefore subdivided 'noise' into three explorable parts: noise production or emission, noise load or immission and noise annoyance. First, the noise produced by aircraft depends on the type of aircraft: heavier and older models, for example, are noisier than smaller and newer types. The emission of noise therefore depends not only on the number of take-offs and landings – which have risen rapidly over the past few decades – but also on the type of aircraft. Finally, the timing of flights is an important factor in the annoyance caused because noise in the evening, and especially at night, is perceived to be much more intrusive than during the day.

Second, the noise that is emitted is then immitted by the population who are exposed to it. The extent of this load of noise therefore not only depends on the number and time of the flights and the type of aircraft, but also on the spatial distribution of the population in relation to the location of the airport. The larger the number of people living near the airport or close to the runways, the larger the number exposed.

Third, noise annoyance is the subjective response to noise. There are considerable differences in the subjective response to noise and thus the degree to which individuals perceive the noise to be an annoyance (e.g. Miedema & Vos 1999; Stallen 2004).

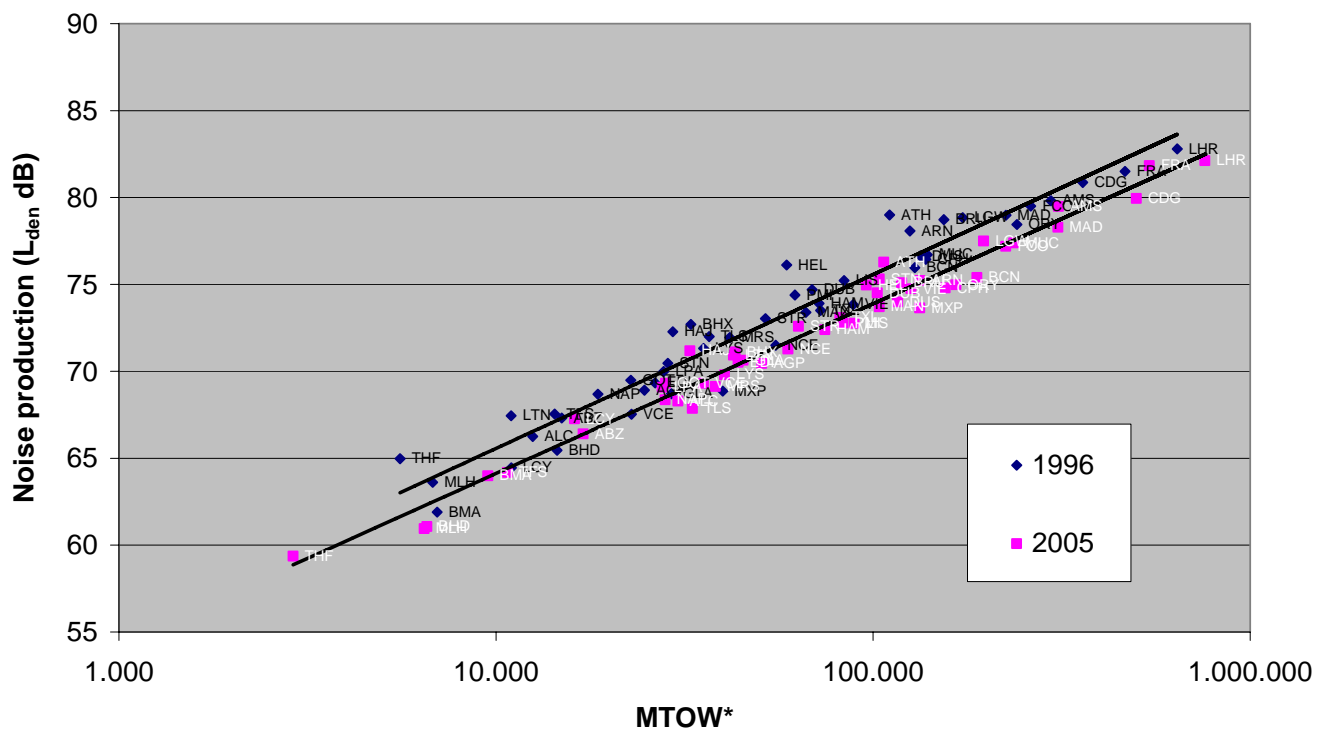
Trends in noise around airports: emission

Despite the increase in the number of flights, the total amount of produced aviation noise in 2005 was less than in 1996. Figure 2 shows the sums of the Maximum Take Off Weights (MTOW) of the scheduled flights (according to the Official Airline Guide OAG) at 48 airports in Western Europe. We use this MTOW as a compound indicator for the performance of airports (transportation output) as it reflects not only the number of flights and the size of the airplane

(quantity) but also the quality in terms of destinations; heavy airplanes usually carry more passengers and/or fuel when they serve an intercontinental connection.

The MTOW is compared with the noise production, calculated in L_{den} – day-evening-night - decibels in which noise in the evening and at night weigh respectively 3.3 en 10 times as heavy in the calculations as at daytime.

Figure 2. Noise production and transportation output at European airports 1996-2005.
Source: OAG.

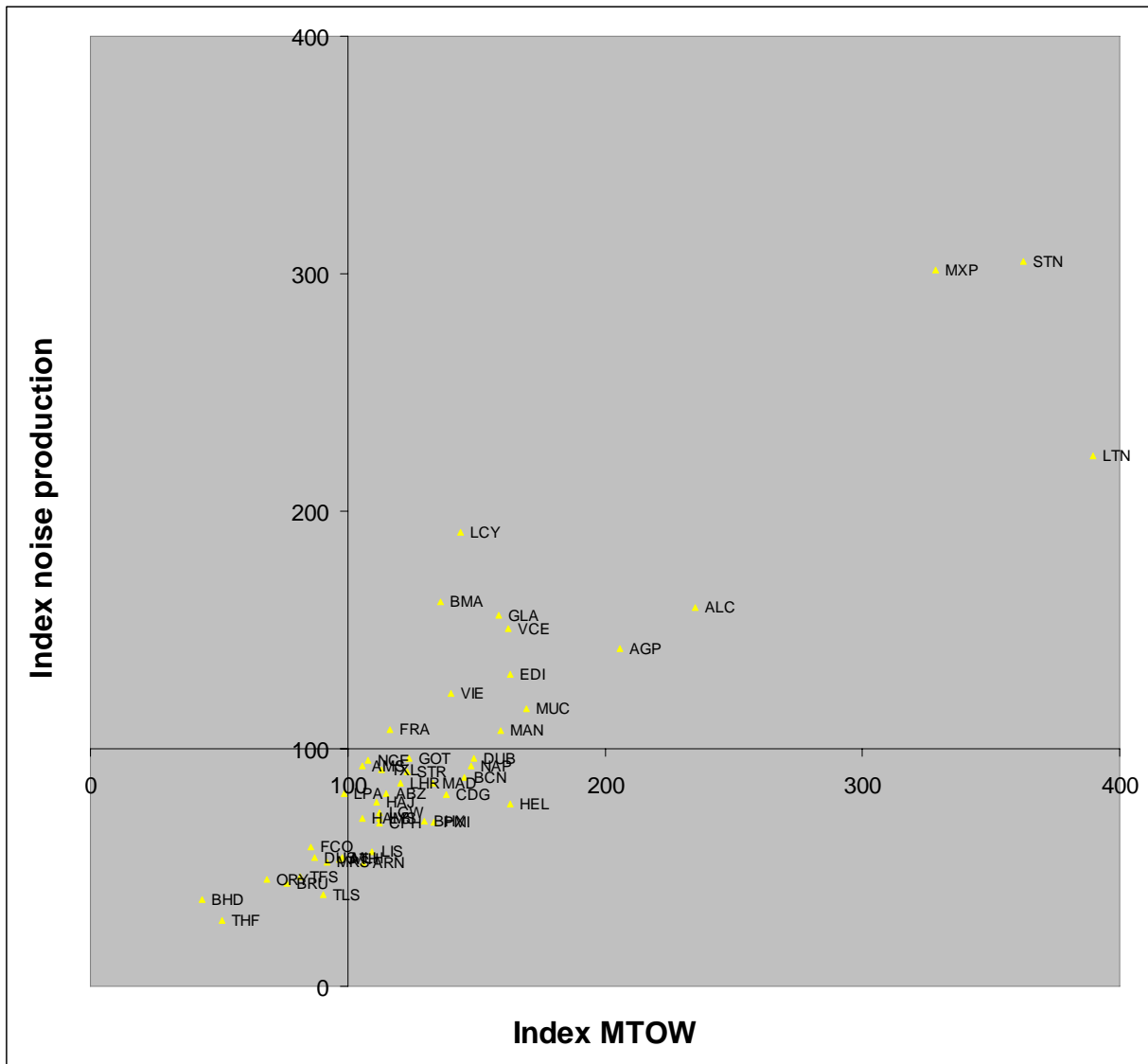


On average, as the difference between the trendlines for 1996 and 2005 shows, the MTOW has increased and the noise production decreased. We can conclude from this, that growth of the aviation product (and the advantages from it) can indeed be combined with a reduction of the disadvantages (noise). This improvement is mainly due to technological improvements: during the last ten years older aircraft have been replaced by more modern and therefore quieter models.

Similar improvements in the levels of noise have not been achieved at all European airports; some have performed better than average, others worse. There are two explanations for this: the different fleet mixes at the various airports – older and heavier models produce more noise – and differences in the timing of flights – evening and night flights weigh more heavily in the calculations of total noise production.

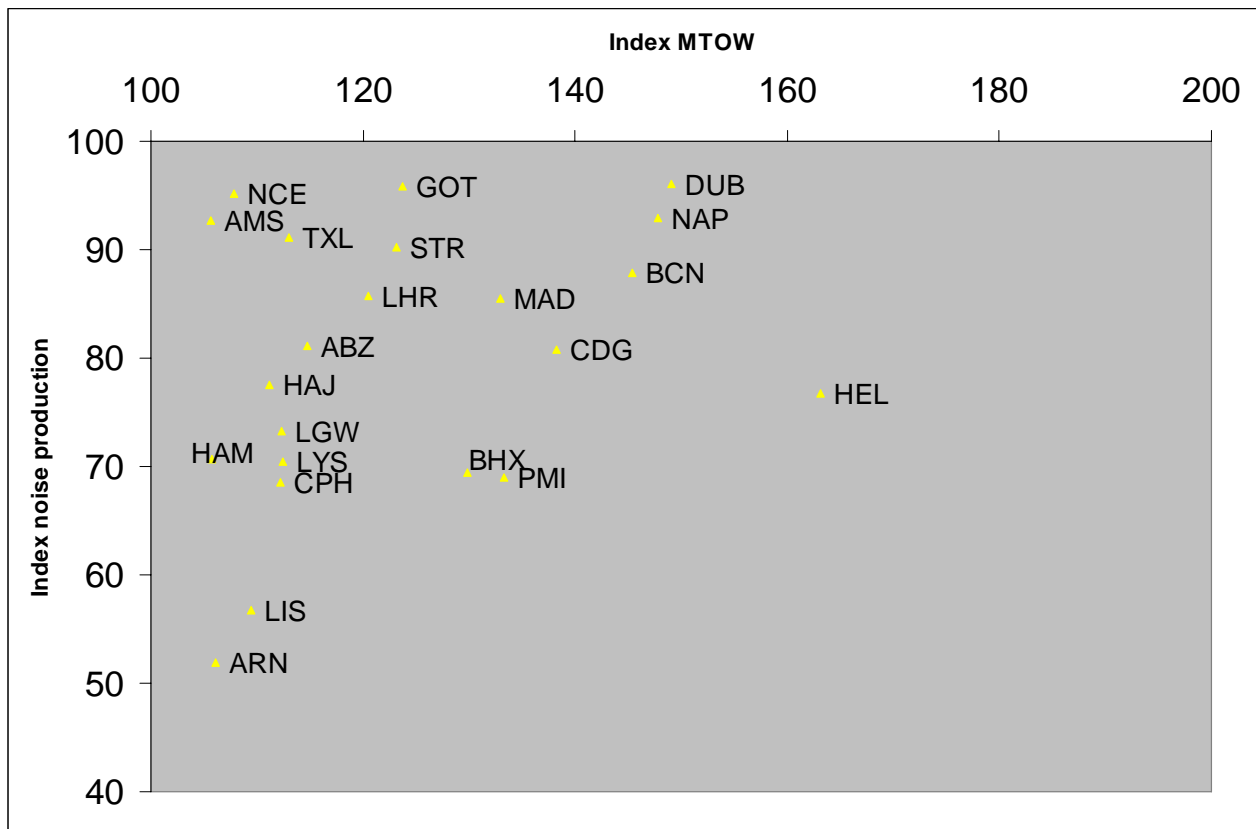
In figure 3 we have distinguished 4 theoretical quartiles: 1. increase of noise level, decrease of MTOW 2. increase of noise level, increase of MTOW 3. decrease of noise level, decrease of MTOW and . 4. decrease of noise level, increase of MTOW.

Figure 3. Development of noise and MTOW at European airports 1996-2005 (1996=100). Source: OAG.



The first category doesn't occur in practice. Almost one third of the airports are in the second category more MTOW, more noise production. These are airports that have grown significantly over the last ten years, e.g. due to an extra runway or the rise of low cost carriers (London Gatwick, London Stansted). Although the noise production has increased, for almost all the airports in this category applies that the noise-efficiency has increased – the index for MTOW is higher than for noise production. The third category consists of airports that have faced a major decline over the last years due to partly closing (e.g. at night) (Stockholm Bromma) or bankruptcy of the home carrier (Brussels). The last category has the best of both worlds; a reduction of the noise production combined with a growth of the MTOW. This category holds the most airports. When we zoom into this category (figure 4), we see that in the case of Amsterdam, the total amount of noise emitted by aircraft at Schiphol has declined during the past ten years, but less than at most of the other airports that have improved their noise efficiency, also less than two other hubs, London Heathrow and Paris Charles de Gaulle.

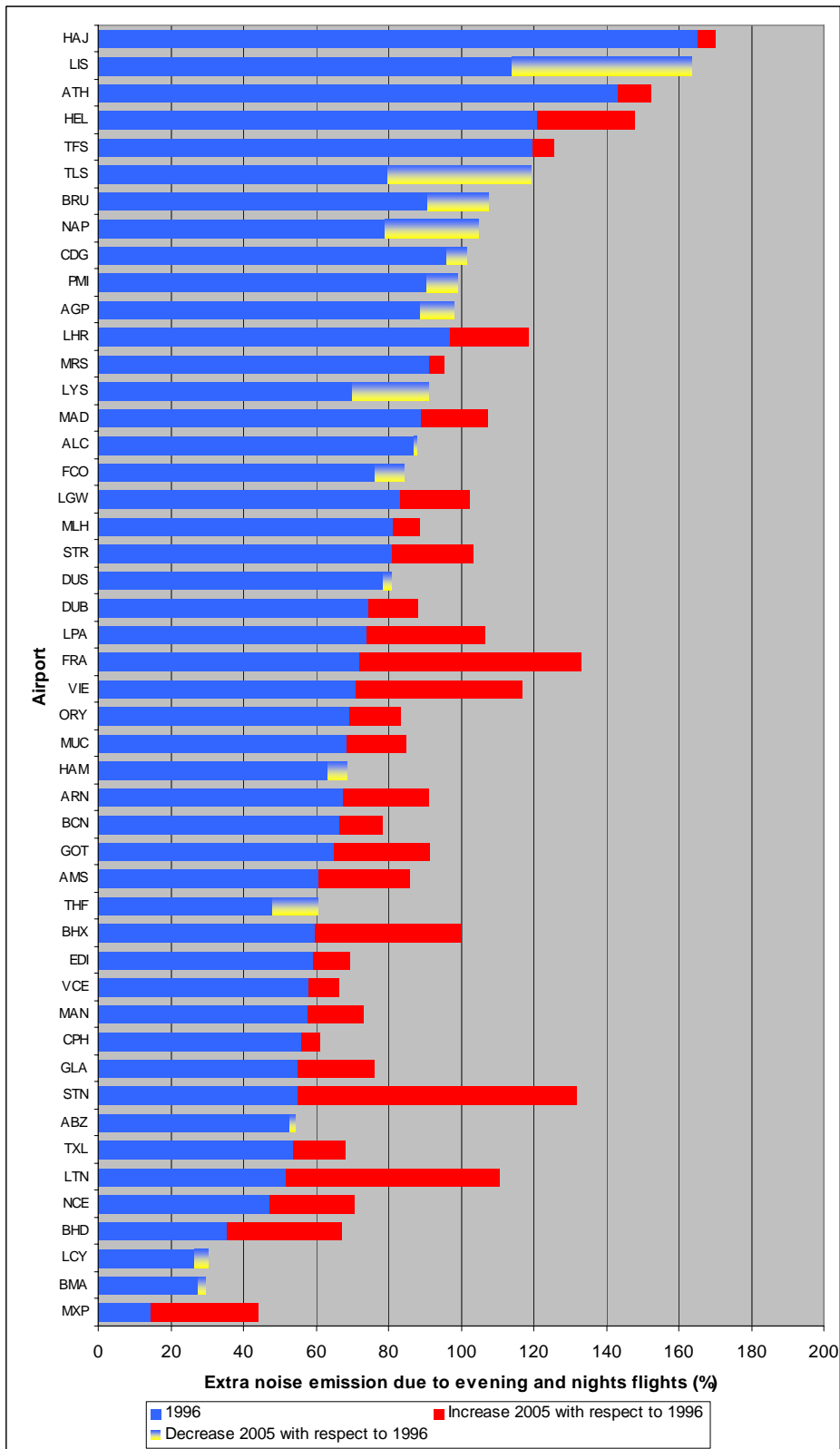
Figure 4. Development of noise and MTOW at European airports 1996-2005 (1996=100), category 4. Source: OAG.



There are two reasons for this. First, the fleet mix at Schiphol hasn't improved in terms of noise reduction as much as at other airports. Second, the numbers of evening and night flights at Schiphol have risen more than average. Paris Charles de Gaulle, the airport that produced the most night noise in 1996, has been able to reduce its night-time noise to some extent, while night noise levels at other airports, among which Schiphol, have risen. This is illustrated by figure 5, representing the extra noise emitted due to evening and night flights, taking into account their extra weight in the calculations.

In general, the contribution of flights during the evening and nights to the total noise production has risen. Airports have to fly more at nights to use their capacity and facilitate growth. Only few airports have less noise from evening and nights flights, mainly because of measures to reduce noise at nighttime by closing the airport at certain hours at night.

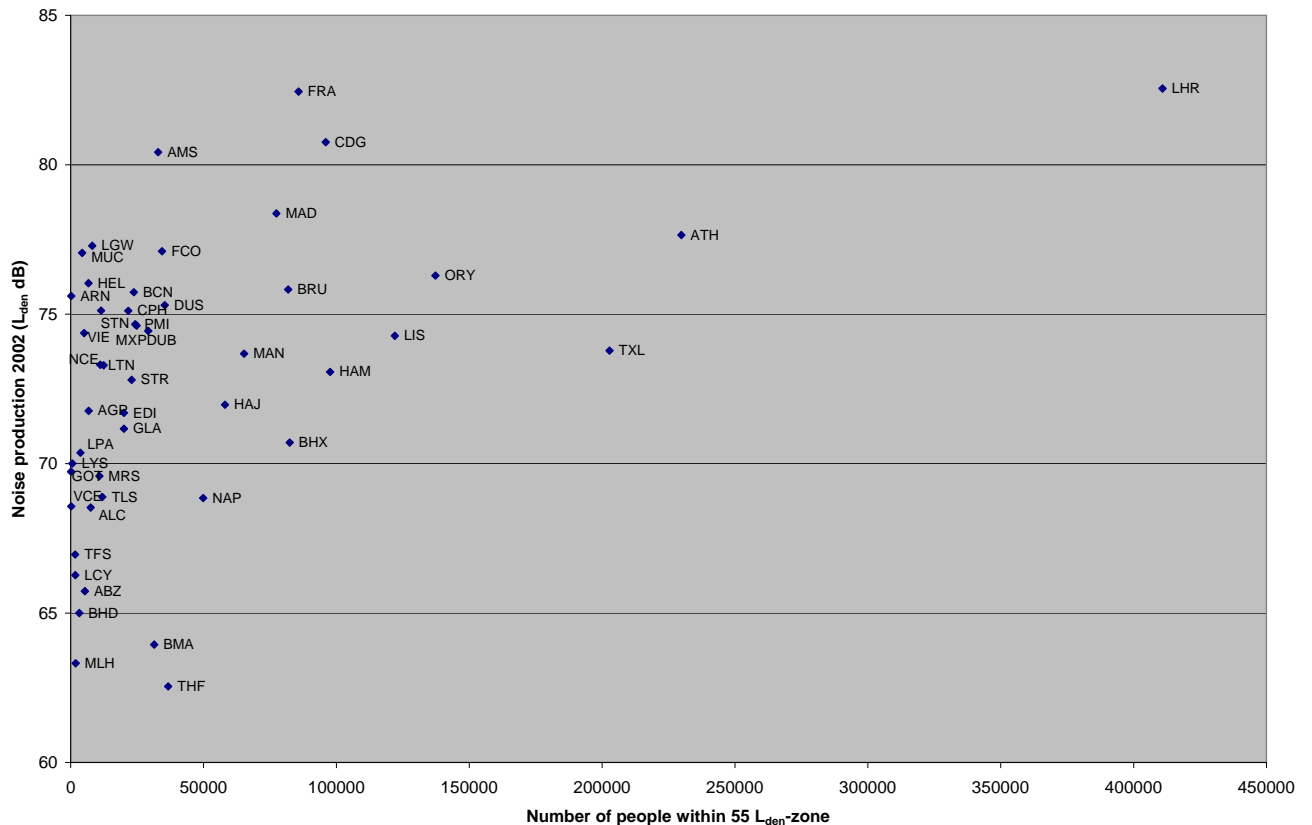
Figure 5. Development of the extra noise produced by evening and night flights 1996-2005. Source: OAG.



Differences in noise at airports: immission

As said before the differences in the immission of noise are not only resulting from the produced aircraft noise at airports but are also due to the location of the airport with respect to residential areas. Whether an airport is well situated with respect to the population can be determined when we look at both the noise emission and the number of people exposed (i.e. living within the 55 Lden dB zone around the airport) in figure 6. In theory, when the population is evenly spread around all the airports, the same amount of emission would lead to the same number affected. A well located airport, however, has compared to its noise production relatively few people exposed.

Figure 6. The favourability of the location of the airports. Source: Anotec (2003).



When we look at the four major hubs, London Heathrow has by far the largest number of people within the 55 Lden zone. Heathrow is not only the biggest airport, and therefore produces the most noise, but the number of people living within the 55 Lden zone is disproportionately high, at 400,000.

Schiphol performs relatively well for a large airport in a densely populated region. It is the best of the four hubs, with a relatively limited number of people living within the 55 Lden contour: 33,000. Moreover, Amsterdam performs better than airports like Brussels, Lisbon and Hamburg, which have fewer flights and produce less noise.

The performance of Schiphol can be explained by a consequent spatial planning policy in the areas surrounding the airport. Other regions also seem to have restrictions on building in areas around airports, but in reality these policies have not been carried out as strict as around Schiphol.

Noise annoyance

The noise emitted by aeroplanes and the resulting noise burden can be objectively measured, but this is not true for the subjective response to noise. One way of measuring this noise annoyance is to record the number of complaints and the existence of interest groups around airports lobbying for a reduction in noise levels. Although e.g. Amsterdam Schiphol performs relatively well in terms of aircraft noise emissions and the overall noise burden, the number of complaints by people living around this airport is extremely high (Lieshout, Veldhuis & Balke, 2006). Numerous factors contribute to this situation, and all of them are related to poor communication and high levels of mistrust (Procescommissie Evaluatie Schipholbeleid, 2006).

Reducing noise

Various measures can be taken to restrict aircraft noise. Almost all airports have introduced operational measures: the aeroplanes have to comply with certain operational procedures, sometimes backed up by sanctions for failure to meet these requirements. These procedural requirements may include rules on engine tests, management of flight paths and take-off and landing procedures. More and more airports are also setting limits on aircraft numbers and the amount of noise they can emit. However, most such quotas are set so high that they impose few constraints on the functioning of the airport. This can be explained by the fact that this measure might lead to less noise, but also limit the airports' possibilities and its economic sustainability. Therefore, measures that both secure noise and economic sustainability are more promising. Selectivity through charging is one of these measures. Noise-related fees are increasingly applied and in stronger degree (Hornis & Gordijn, 2007). We have observed an effect of it in the phasing out of the oldest and noisiest aircraft (Gordijn & Hornis, 2007). However, this research shows no one to one relation towards modernization of the fleet. The charges are, for the most common airplanes, relatively low and give no real incentive towards early modernization. However, pricing policies do indeed seem to have an impact on noise: the really noisy aircraft now hardly ever fly to airports that impose high noise fees. Another way to decrease the noise is to fine too noisy planes. The growing use of flight tracking systems and noise measurements make it possible to monitor aircraft and fine the relevant airlines if their aircraft emit too much noise.

Measures can be aimed at reducing the emission, the immission and the annoyance or hindrance. The measures above aim mainly at decreasing the production of noise. Supporting policies can also be used to reduce the noise immission. First, the number of people affected by noise can be restricted by not flying above populated areas, while noise insulation of homes can limit indoor noise levels. Other complementary policies include good information services, financial compensation (to reduce the annoyance) and specialising in particular services by relocating certain market segments, such as freight carriers, charter flights or low cost carriers to other airports (to reduce emission).

Spatial strategies

We have showed in this paper already that the spatial location is very important for the noise immission. Airports that are well located, have a comparative advantage, because the airports aren't noise-restricted. Spatial planning is an important measure to reduce the noise burden on the environment. Besides spatial planning around the 'established' airports, other spatial strategies might therefore also be an option, both for governments and airports or airlines, to facilitate a growth of air traffic in combination with a reduction of the noise emission. One can think of an multiple airport system, in which functional differentiation involves devolving various airport functions to other airports. Relocation of air traffic to a site where no human being lives has of course one major disadvantage; there's no market for. For that reason, only those market segments that don't rely heavily on close proximity are feasible on remote locations. On the other hand, a good connectivity to other airports or metropolitan areas can compensate for the remote location.

Today, we can see different (but entwined) developments in the aviation industry that offers new possibilities for a functional differentiation of airports and where smaller airports that have a comparative advantage with regards to the noise burden can function complementary to the major airports. We distinguish three new types of airports that derive from this.

1. Regional airports. Low Cost Carriers require cheap airports with short turnaround times. Regional airports provide for this. Travellers appreciate the trend towards regional airports, which are gaining in popularity not only because they are easy to reach but also because of their fast procedures, cheap parking and convenient lay-out. Regional authorities appreciate the direct connection with the international aviation network as well as the extra jobs and the incoming tourists. The noise is limited because most regional airports close at night and low-cost companies use modern, quiet aircraft. Moreover, the development of regional airports can function as 'relieve' for the larger hubs, that are situated in populated areas and noise-restricted. In the Netherlands, Lelystad airport could take over some of the low cost and holiday flights that now operate from Schiphol. The environmental impact statement for this airport reveals that its location is favourable with respect to the built up areas.
2. City airports. The second is the rise of city airports. An example is London-City Airport. It was opened in 1987 in the heart of the London Docklands. It serves business travel with a 10 minute check-in. Its slogan is "we sell time". London City Airport offers businessmen from various European cities a much faster connection to the financial heart of London than the further away located airports Heathrow, Gatwick, Stansted and Luton. It now has connections with 31 European cities on a single 1319 x 30 meter runway. The airport is the close neighbor of a number of residential communities; there are homes within approximately 100 meters of the runway. The airport works with local people to maximize its positive impacts for the local communities, while at the same time minimizing the environmental impacts (restricted opening hours, steep approach, and low noise levels).
3. Cargo airports. Vatry, Liège, Hahn, Ostend, Luxemburg, Maastricht, Köln/Bonn: airports that are not in the top of the European hierarchy of airports and some are quite remotely located in their region, but may be functioning as a specialized airport for air freight and low-cost. We will look into this category a little deeper below.

The role of freight

Airfreight is growing fast (table 1). The average growth in the period the past 30 years was 6.9% per year. Airfreight is mainly inter-continental; within Europe "airfreight" is often trucked.

Traditionally airfreight is shipped in the belly of intercontinental planes. But full-freighters take a growing share (Boeing, 2007). A fast growing segment of freight transport is the so-called Integrators (FEDEX, UPS, DHL, TNT). They operate their own fleet. Fedex operates the largest fleet in the world with 670 airplanes, larger than American airlines or Lufthansa group. DHL with 420 airplanes is also in the top-10, before Air France / KLM.

In the world of express-delivery the concept of "next day delivery" is very important and therefore night-operations are necessary. The combination of heavy intercontinental planes and night operations gives airfreight a special role in noise-hindrance. At Schiphol airport freighters make only 4% of the flights but contribute for 25% of the noise emissions calculated in Lden.

In Brussels the expansion of DHL was blocked because of environmental concerns. DHL will shift its operations to Leipzig/Halle. Lufthansa is under pressure in Frankfurt where mediation delivered a deal in which the airport can have a fourth runway in exchange for a partial night-closure. In Paris the number of night slots for FEDEX are frozen. Growth of airfreight at

Heathrow is limited and shifted to Stansted and East Midlands. In Amsterdam and Maastricht TNT was not allowed to open a hub and Liège-Bierset was chosen instead.

Table 1: Developments in air traffic. Source:ICAO.

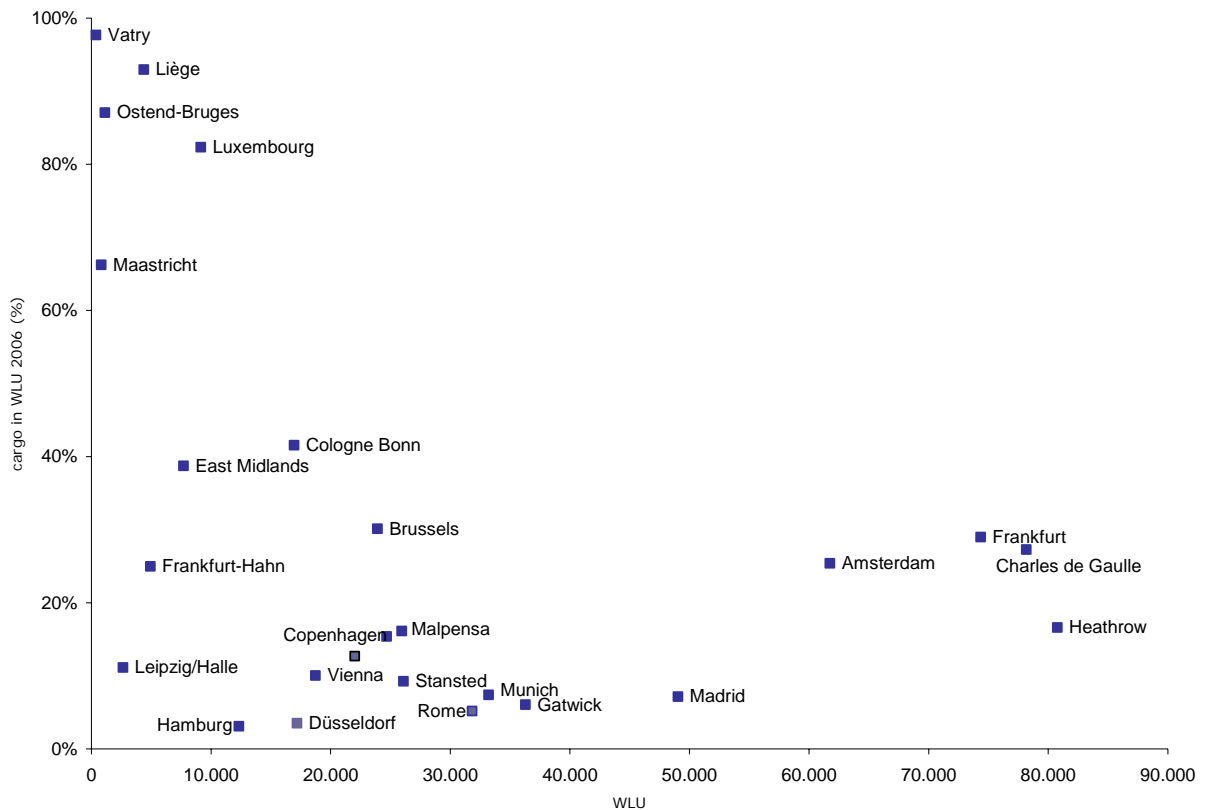
	Passengers	Passengers	Freight
Year	Million	Billion pKm	Billion tonKm
1950	31	28	0.8
1955	68	61	1.3
1960	106	109	2.0
1965	177	198	4.8
1970	383	461	11.9
1975	534	687	19.4
1980	748	1089	29
1985	898	1366	40
1990	1165	1894	59
1995	1304	2248	83
2000	1656	3017	118
2005	2022	3720	143
Mean Growth 1975-2005	4.5%	5.8%	6.9%

Government policy is directed to a modal shift towards (high-speed) rail transport. In Paris the initiative of CAREX (Cargo Rail Express) was taken by Fedex, Aéroports de Paris, Air France/KLM and others (Roissy CAREX, 2006).

Airports in less densely populated areas are chosen as possible alternative. Fraport bought shares in Hahn. The Chinese integrator LinkGlobal Logistics bought the Parchim airport between Hamburg and Berlin. The French government is pushing Vatry and Chateauroux as alternatives for Orly and Roissy/CDG.

The figure presented below from the Atlas of cargo airports in Europe shows the positioning of the most important cargo airports of Europe (Klaver, Gordijn & Harbers, 2007).

Figure 7: Cargo airports



The horizontal axis shows the importance of the airports in terms of WLU (Work Load Units i.e. 1000 passengers or 100 tons of freight). The vertical axis indicates the share of cargo in the WLU. The main hub airports (CDG, FRA, LHR, AMS) are important for cargo because of their belly-freight. At the upper left we see the specialized freight airports like Vatry, Maastricht, Luxembourg, Oostende and Liege. Köln/Bonn, East Midlands and Brussels are hubs for integrators. Frankfurt Hahn accommodates large full freighters but is also an important base of Ryanair. The two German airports that are located close to populated areas (Hamburg and Düsseldorf) have night-closure and (because of that) a low share of freight.

Conclusions and discussion

An airport offers a valuable contribution to the accessibility of a region. This offers advantages for regional travelers and a stimulant for the economy. The downsides are noise pollution and emissions.

This study shows that a growth of the transportation output can be combined with less noise. However, there are differences between airports. The production of noise is determined by the fleet mix, the number of flights and the time of flying. The number of flights differs from airport to airport. Some airports are intercontinental hubs, with more flights with larger planes and produce more noise as a logical consequence. There are also differences in fleet mix and in the share of flights in the evening and at night. The result from this is that noise-efficiency also varies. Moreover, not all airports have undergone the same development. Some have recently faced significant growth (rise of low cost airports at secondary airports, new runways) or decline (bankruptcy of carrier, partly closed). The same goes for the improvement of the noise-efficiency.

Not only the noise emission varies, also the spatial 'fit' of the airport. Some have many people in the vicinity, some don't. Whether an airport can grow depends on the available space, not only physical, but even more in terms of the noise burden. Airports are, therefore restricted from a spatial point of view. New developments in the aviation sector offer new opportunities for the development of airports. And as every region and airport is different – spatial, but also cultural and economic - , regional governments should make their own assessments on whether to facilitate or to resist.

We expect the following developments in the future:

1. Growing prosperity leads to growing propensity to fly but also to higher expectations for the quality of the environment and thus to more restrictions for aviation and airports.
2. Fuel-taxes will be applied on aircraft fuel and also TVA. The high taxation will not decrease aviation, only a slow-down in growth will be visible (like the effects of automobile-taxation).
3. There will be more specialization and differentiation of airports.
4. More airport systems will appear.
5. The hubs will remain very important for organizing efficient intercontinental transport by bundling traffic.
6. Regional airports will provide the connections to the main European destinations and European holiday regions.
7. City airports will provide efficient connections with important city centers for business travelers.
8. Integrators will concentrate on airports away from high density areas. There will be specialized night-flight airports in more sparsely populated areas.
9. The private-jets revolution will take place because of lowering prices, easy-access, privacy and the malfunctioning of airlines and congested airports. They will use local airports.
10. High-speed freight-trains will develop a market for time-critical goods, but will not slow down the growth in intercontinental air transport.

One thing does need to be kept in mind: in the future it is possible that the main environmental concerns (noise pollution and emissions) disappear due to technological advancements. Every region will want an airport in that case, like in the past. That's why sensible policy making is required. It's better to have harsh requirement on maximum noise production and opening times now than to give up international accessibility forever!

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