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The Role of Accessibility in Passengers' Choice of Airports

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ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

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TABLE OF CONTENTS

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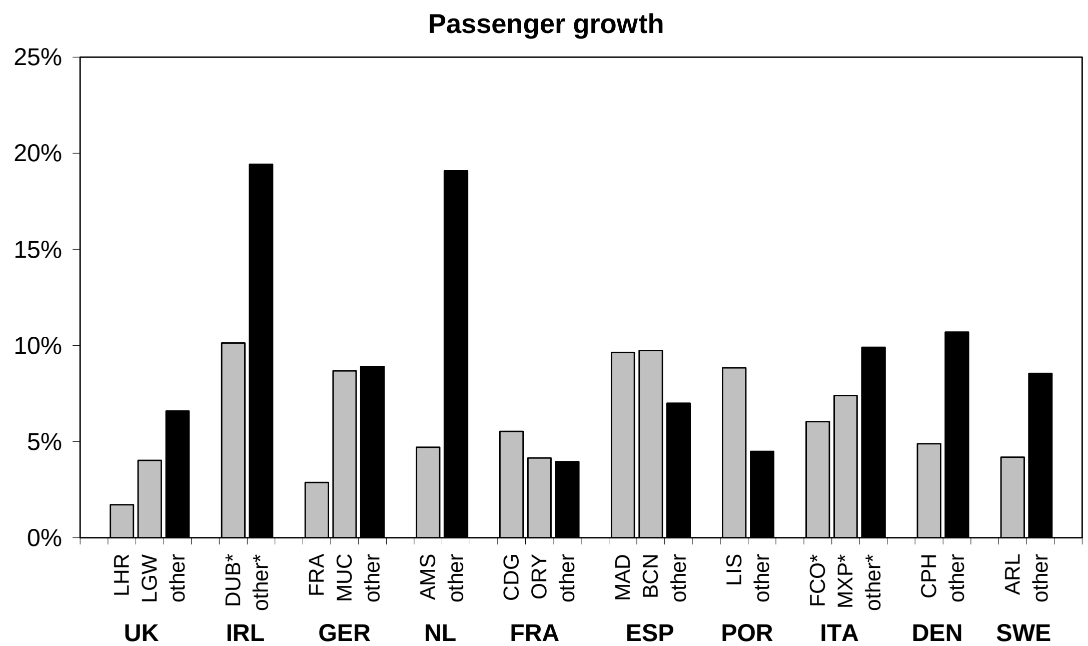
1. INTRODUCTION

1.1. Growth of regional airports

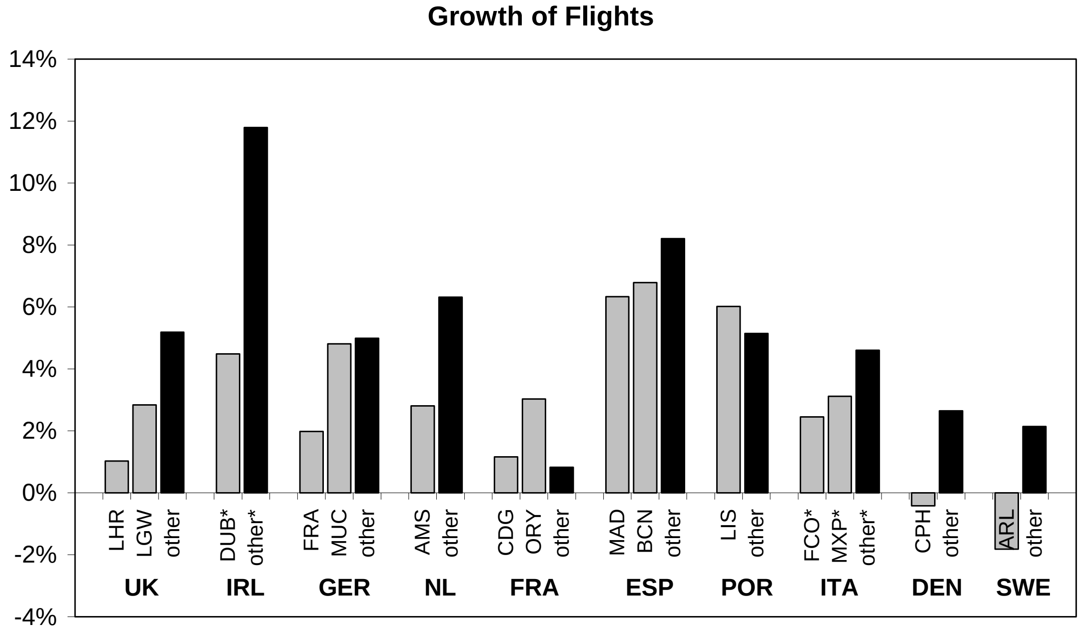
Until about two decades ago, the choice of airport was relatively easy for travellers. Within acceptable travel distances, usually only one airport provided flights to the preferred destination. However, nowadays people can choose between multiple airports when arranging a trip. Regional airports have grown very fast over the last decade(s) and are now providing flights to many destinations. The growth rates (both in terms of passengers and in number of flights) at the “smaller” airports in North-Western European countries are usually larger than at the largest airports in those countries (see Figure 1 and Figure 2 for the average growth rates in the last 5 years).

Figure 1 Annual growth rate of the total number of passengers (averaged between 2003 and 2007) at the major airport(s) in a selection of Western European countries compared to the same growth rate at the other airports in those countries. Data points indicated with *: averaged between 2003 and 2006.



Source: Eurostat 2008. Data from United Kingdom: London Heathrow (LHR) and London Gatwick (LGW); from Ireland: Dublin (DUB); from Germany: Frankfurt (FRA) and Munich (MUN); from the Netherlands: Amsterdam (AMS); from France: Paris Charles de Gaulle (CDG) and Paris Orly (ORY); from Spain: Madrid (MAD) and Barcelona (BCN); from Portugal: Lisbon (LIS); from Italy: Rome (FCO) and Milan Malpensa (MXP); from Denmark: Copenhagen (CPB) and from Sweden: Stockholm Arlanda (ARL)

Figure 2 Annual growth rate of the total number of passenger flights (averaged between 2003 and 2007) at the major airport(s) in a selection of Western European countries compared to the same growth rate at the other airports in those countries. Data points indicated with *: averaged between 2003 and 2006.



Source: Eurostat 2008, see Figure 1 for explanation of the abbreviations

An obvious reason for this enhanced growth at regional airports is the rise of low-cost airlines that have concentrated their business at particularly those airports. Though these airports might be further away from their departure address, the cheaper ticket fares are an incentive for people to travel from these airports (similarly for the arrival airport).

The development of the internet also contributed to the growth of low-cost airlines and hence, of regional airports. People can now book trips from their home and search for alternative travels themselves, instead of choosing the most obvious alternative. Websites that search for cheap flights also lists alternative departure airports. Yet another development is the increase of capacity problems at airports. This stimulates both airlines and airports to outplace part of their services to other airports. And more reasons can be thought of (new airports, conversion of military airports into civil airports, increase of car ownership, ground transport capacity around larger airports becoming increasingly constrained as growth outstrips ground transport capacity improvements, etc.)

1.2. Implications for policy makers

From a policy point of view, passenger choice of airports has become an important issue. Several airports in Europe are approaching their capacity limits (either physical limitations in terms of runway or handling capacity or environmental limitations in terms of amount of noise produced or amount of gases or particles emitted). Policy makers can respond to this situation in several ways by:

- doing nothing;
- reducing demand for air transport (e.g. by stimulating the use of alternative modes);
- stimulating more effective use of existing capacity; and
- expanding physical capacities (i.e. building more runways and/or terminals) or changing the limitations on emissions

However, since building new runways and/or terminals is a major investment and the physical space is not always available, alternative solutions are also considered. These include:

- building a new airport at another location;
- attracting more traffic to existing airports in the neighbourhood, either by attracting (new) airlines to these airports, by collaboration between the aiports, or by (actively) outplacing flights to these other airports; and
- making alternative airports more accessible (extra roads, better public transport, new high-speed rail connection).

Understanding the choice process of air travellers is key in understanding the effectiveness of these policy options.

The accessibility itself is another important issue from a policy point of view. Most airports are located close to large cities or metropolitan areas. As a result of the increase in ground traffic, congestion is becoming a major issue and hence, the accessibility (and the competitive position) of the airport. Improving the accessibility of the airport (by improving current infrastructure, or by introducing new access modes such as high speed rail connections) could be a option for policy makers. Again, understanding the choice process of the traveller is important for this.

1.3. Objective of this paper

This paper aims to give an overview of what is known about the role of accessibility in passenger choices. Particularly, it will look at the question to what extent passenger volumes might change if the accessibility of an airport changes. Obviously, two factors are important:

1. the passenger choice between the (available) modes; and
2. the passenger choice between the (available) airports.

The paper focuses on these two choices. Section 2 starts with a general discussion on the concept of accessibility. The passenger access mode choice is discussed in section 3. The passenger choice between airports is dealt with in section 4. Section 5 discusses the effects of the introduction of new access modes on the access mode choice, while Section 6 discusses a case study on the effect of a local tax on the airport choice. Finally, conclusions are drawn in Section 7.

In general, air trips can be divided into direct and indirect trips and in case of indirect trips, travellers have a choice of transfer airport (e.g. for a trip between Germany and the United

States, travellers can transfer at Frankfurt, Paris, London, Amsterdam etc.). This choice is not discussed in this paper, since land-side accessibility does not influence that choice.

Several sections in this paper focus on access to airports and do not discuss egress. Generally, it is easier to collect data when travellers are departing from an airport (and just have made an access trip) than after arrival, and therefore more information is known about airport access behaviour. However, since many travellers use the same mode for access and egress, many statements are true for egress as well.

2. DEFINITIONS OF ACCESSIBILITY

Most people have an intuitive feeling for the concept of accessibility. However, it is not trivial to quantify this variable. Many definitions are around. Some are simple, others are more complex. We mention here three categories of definitions:

1. Accessibility measures that only take travel time into account. Examples of such definitions are:
   - the time to an airport
   - the area of all locations from where one can travel to the airport within a certain time;

   However, these simple definitions only take part of the accessibility into account.

2. Accessibility measures that also take other characteristics into account, such as travel costs, parking costs, reliability of travel times, service level. In these measures, these characteristics are usually monetised using a value of travel time, value of reliability, value of service level, etc. In this way, all components are converted in monetary values and can then be added together. The sum of all these values is called the “generalised travel costs”.
3. Accessibility measures that take multiple modes into account. The measures mentioned above only take a single travel mode into consideration, usually the car-mode. Accessibility measures that take multiple modes (car, train, bus, etc.) into account have to weigh the accessibility of the individual modes. This can be done by using the so-called LogSum as an accessibility measure (see e.g. Ben-Akiva and Lerman, 1985):

   $$LogSum = \log\left(\sum_{i=\text{mode}} e^{-\beta \cdot GenCost(i) + X}\right) \quad (1)$$

   where the sum is taken over all available modes. In this equation *X* indicates all other factors included in the utility function.

   This LogSum is a kind of inverted travel impedance: the more options you have to travel, the higher the LogSum value (and the better the accessibility is). Cheaper and faster options contribute more than slow and expensive options. The advantage of such a measure is that it is very good for relative comparisons (i.e. comparison of the the accessibilities of different locations) and it is a useful tool for the calculation of the consumer surplus changes for cost-benefit analyses of transport projects (de Jong et al. 2007). A disadvantage, however, is that the absolute value by itself does not have an intuitive meaning.

3. ACCESS MODE CHOICE

3.1. Observed access mode shares

In order to explore the passenger choice of access mode, we start with a very simple observation on chosen modes for a selection of major airports.

T

Table 1 provides access mode shares for the selection of airports. This table shows that for all these airports car, taxi, rail and bus are important modes of access. The selected airports are all international airports in the neighbourhood of large cities and metropolitan areas and can therefore not be representative for all airports, however, the wide range of market shares of each mode already indicate that the choice behaviour of air passengers is very different between airports.

Car shares within this selection range from 7.5% for Hong-Kong (due to a general policy to discourage car use, heavy congestion and the presence of toll roads) to 79% (including taxi) for Chicago O'Hare (due to cheap parking and a general low public transport modal share). Rail shares range from 4% for the CTA Blue Line (metro) in Chicago to 40% for the combined rail services in Tokyo (due to road congestion, limited parking and high taxi costs) and 41% for the successful high-speed Flytoget service in Oslo. Taxi shares range from 6% in Oslo (due to long distance to the airport and corresponding high prices) to 27% for Paris Orly, while bus shares range from 6% in Frankfurt to 47% in Hong Kong.

Access mode shares do not only differ widely between airports, they also differ significantly between travel segments within one airport. Figure 3 displays the access mode distribution for London Heathrow in 2001 for four segments split by location of residence (inside/outside UK) and by trip purpose (business and leisure). Non-residents have a much lower car share, which is logical since they usually cannot use their own private car and hence they use public transport more intensively. Business travellers generally have a stronger preference for taxi since they are willing to pay for this more expensive mode in order to save access travel time and prevent transfers.

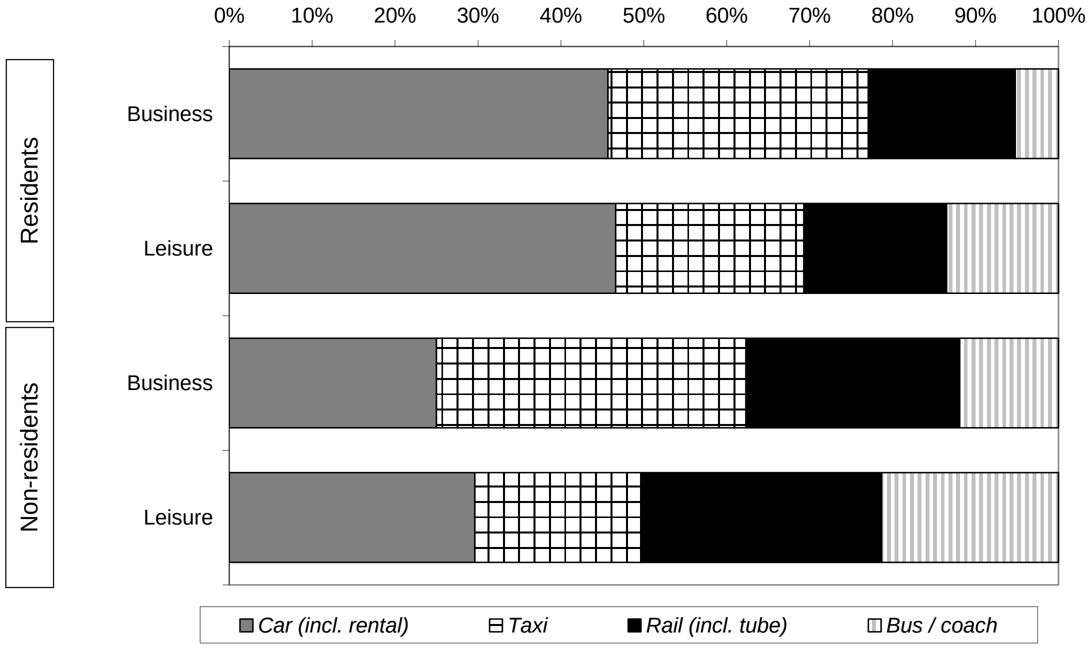
Table 1. Access mode shares for a selection of airports

	Hong-Kong Intern.	Tokyo Narita	Oslo Garder-moen	Stock-holm Arlanda	London Heath-row	Paris Orly	Amster-dam Schiphol	Frank-furt	London Gat-wick	New York JFK	Chicago O'Hare
	HKG	**NRT**	**OSL**	**ARL**	**LHR**	**ORY**	**AMS**	**FRA**	**LGW**	**JFK**	**ORD**
	(2004)	(2003)	(2005)	(2003)	(2004)	(2002)	(2002)	(2002)	(2004)	(2004)	(1998)
Car	7.5%		34%	35%	37.8%	43%	45.3%	46%	53.8%	56.2%	
private			*32%*		*35.0%*			*41%*	*51.4%*		
rental		17.6%	*2%*		*2.8%*			*5%*	*2.4%*		79%
Taxi	12.9%		6%	21%	25.9%	27%	9.3%	19%	14.6%	20.7%	
Rail	23.4%	40.8%	40%	19%	23.5%	13%	34.7%	27%	24.6%	12.1%	4%
high-speed	*23.4%*		*33%*	*19%*	*9.3%*			*8%*			
regional			*7%*					*8%*			
local					*14.2%*			*12%*			
Bus	47.4%	41.6%	19%	19%	12.4%	16%	8.9%	6%	6.8%	10.9%	17%
Other			*2%*	4%	0.3%		1.8%	2%	0.2%		

Source: HKG:Tam et al. (2004)
NRT: Hirota (2004)
OSL: Avinor (2006), TOI (2005)
ARL: Luftfartsverket (2006)
LHR:Civil Aviation Authority (2006), LeBlond (1999)
ORY: Air Transport Action Group (ATAG) data as published in RPB (2005)
AMS:Mott MacDonald (2003)
FRA: Scherz (2000)
LGW: Civil Aviation Authority (2006)
JFK: Port Authority of NY & NJ (2006)
ORD: TCRP (2000)

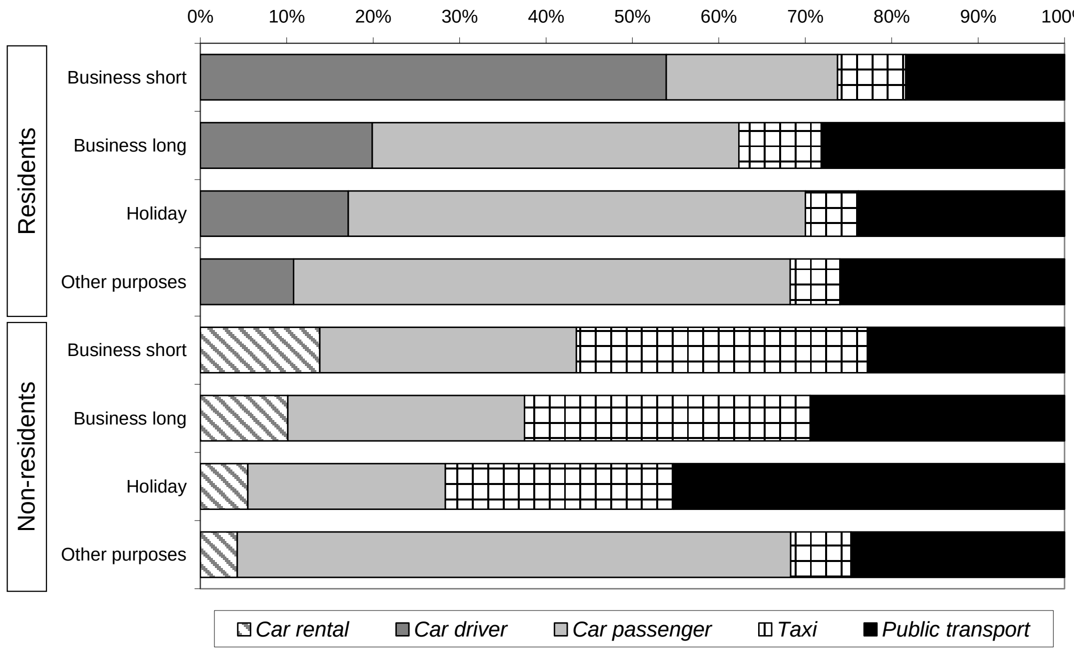
Similar preferences can be observed in Amsterdam (Figure 4). In this figure, business trips are also split between short (less than 3 days) and long trips (more than 3 days). Residents have a strong preference to use their own car when going on a short business trip, but for long business trips the share of this mode is clearly lower and travelling as car passenger (kiss-and-ride) is the preferred alternative. For non-residents, the difference in access mode shares between short and long business trips is small.

Figure 3 Access mode distribution for travellers (split by segment) departing from London Heatrow (2001).



Source: Mott McDonald 2003

Figure 4 Access mode distribution for travellers (split by segment) departing from Amsterdam Schiphol (1991).



Source: Hague Consulting Group 1998

3.2. Factors influencing access mode choice behaviour

The previous subsection demonstrated the large differences in access mode choice between travellers and airports. This subsection and the following one try to build a more fundamental understanding of the underlying reasons for the choice of access mode.

First, we make an educated guess about which factors might play a role in the choice of access mode. In the next subsection, we check these assumptions with choice behaviour as reported in the literature.

Factors that might play a role in access mode choice are:

- availability: which access modes are available? Does the traveller own a car? Does he have relatives or friends that are willing to bring him to the airport? Is public transport available for his departure, is it available when he returns?
- access time: how long does it take to reach the airport? This also includes any time needed to find a parking space (if applicable) and to travel from the parking location to the airport terminal.
- access cost: how much does it cost to reach the airport? This also includes any parking costs if applicable.
- frequency (for public transport alternatives): how often is the service provided? How much will the travel time increase if you just miss your bus or train?
- comfort (for public transport alternatives): how easy is it to travel, how often do you have to make a transfer, what is the probability of having a seat, can you check-in your luggage already at the station, are extra luggage facilities available?
- reliability: how reliable is your travel time, how reliable are the transfers (for the public transport alternative), how much earlier do you need to depart in order to be (reasonably) certain that you will not miss your flight?

3.3. Modelling access mode choice behaviour

Gosling (2008) provides a review of the airport ground access mode choice models that are currently available. This review is based on a comprehensive review of relevant literature, supplemented by findings from an extensive survey of airport authorities, metropolitan planning organisations, consulting firms, research organisations an other relevant government agencies. He identified nine (recent) air passengers mode choice models (Atlanta, Boston, Chicago, Miami, Oakland, Portland, San José, Toronto, UK South East and East of England). These models are based on either observed access mode choices (so-called revealed preference data) or on hypothetical mode choices (so-called stated preference data which is collected by giving respondents two or more hypothetical mode alternatives and asking them which option they would choose in a certain situation) or on both.

Besides availability, all models indeed use access time and access cost as explanatory variables. Time variables are usually split into components (in-vehicle time, split my mode; waiting time, walking time etc.). Public transfer frequency variables are included by means of average waiting times. Some models include terms that refer to the number of transfers (interchange penalties etc.) and others include variables referring to luggage services. None of the models have explicit variables that refer to the travel time reliability of the modes.

Available modes usually differ both in travel time and travel cost. Some travellers prefer a more expensive but faster mode, while others choose a cheaper but slower mode. A common indicator to describe this choice behaviour is the value of time (or value of travel time savings). Technically, this is the ratio of the travel time coefficient to the cost coefficient from the access mode model. This ratio describes the (maximum) costs that an average traveller is willing to make to save e.g. one hour of travel time. However, the values of time that were derived from the models differed widely: from about 10 US$/hour for Atlanta to 78 US$/hour for Miami (averaged over all traveller segments).

Gosling (2008) concluded that no clear consensus has yet emerged on which explanatory variables should be included or how the various modes and sub-modes should be nested in the model. A number of issues are still open, including how to treat rental car use and what the influence of traveller income is. Because of this, he believes that it is not possible to transfer these models to other airports for which they were not specifically developed.

4. AIRPORT CHOICE

4.1. Factors influencing airport choice behaviour

Again, we first make an educated guess about which factors might play a role in the choice of airport. In the next subsection, we check these assumptions with choice behaviour as reported in the literature.

Factors that might play a role in departure airport choice are:

relating to flights and airlines

- availability of flights towards a certain destination;
- availability of flights from a certain preferred airline (frequent flyer memberships);
- the frequency of flights (a higher frequency results in a wider choice of departure and arrival times);
- ticket price;
- flight time (indirect flights results in longer travel times. Furthermore, an indirect flight implies a transfer at a certain airport, which results in extra waiting times and possibilities of missing connections. All these factors result in a negative valuation of transfers by travellers).
- quality of available flights (on-board service, punctuality).

relating to the airport

- check-in facilities (including: how long does it take between arrival at the airport and arrival at the gate);
- shopping / lounge / restaurant facilities;
- baggage/customs/immigration facilities;
- accessibility of the airport (access time, access costs, and all other factors discussed in the previous section, but also: is it possible to park a car at an acceptable location (in terms of parking cost, distance to the airport, security, etc.).

4.2. Modelling airport choice behaviour

One of the first models by Skinner (1976) was used for the for the Baltimore-Washington DC area (three airports) and had significant coefficients for flight frequency and accessibility. Windle and Dresner (1995) found significant effects for flight frequency, airport access time, but they also found a significant inertia term: the more often a traveller uses a certain airport in a year, the more likely he is to choose the same airport again.

Innes and Doucet (1990) derived a model for airport choice in Canada and they found that the type of aircraft can also play a role: travellers prefer jet services to turboprop services. Thomson and Caves (1993) studied airport choice in England and also found a significant effect for the number of seats on the aircraft (a possible reflection of comfort).

Studies using revealed preference commonly do not find significant coefficients for ticket price. The revealed preference data is not always complete, since it usually lacks information on which other airport alternatives have been considered by the travellers, and especially the ticket price of alternative options (at the time of buying the ticket) are not available. Stated preference surveys usually find significant ticket price coefficients (e.g. Bradley (1998), see discussion below).

However, these stated preference surveys generally do not capture the complexity of the real choice process by air travellers. Collins et al. (2007) are experimenting with a new SP survey design that present the choice questions in format similar to online air travel booking websites. Respondents are given a more realistic choice situation in this way, providing them with much larger choice sets and attribute levels.

Little is known about the impact of quality of the airline service (on-board service, punctuality etc.). At best, this is part of a standard airline-specific constant. Likewise, the quality of the airport (check-in facilities, shopping facilities etc.) are usually included in an airport-specific constant. In this way, it is not (yet) possible to isolate the effect of these factors on the passenger choice behaviour.

4.2.1. Example of a study based on SP data: Amsterdam Schiphol

Bradley (1998) collected about 12,000 binary SP choices from 1,000 respondents. He found significant coefficients for the fare, frequency, access time and transfer time and a significanct transfer constant. A model specification with a logarithm of the fare was statistically better than a model with a linear fare term, indicating that people are less sensitive to a small fare change at high fare levels than at low fare levels. Also, a logarithmic frequency term outperformed a linear frequency term. This is in agreement with other models that use the frequency of flights as a logarithmic "attraction variable".

Bradley found some indications for airport "loyalty": the resistance to switching to an alternative airport increased with the number of flights made by the respondent in the previous year. However, this could also be interpreted as loyalty to specific airlines associated with those airports. Students, pensioners and part-time workers are slightly more price-sensitive than full-time workers. Tourist class users are more price-sensitive than travellers in First or Business Class

4.2.2. Examples of studies of the best choice model structure: San Francisco Bay area

The San Francisco Bay area is served by three major airports: San Francisco International (SFO, about 15 mppa[1]), San Jose Municipal (SJC, about 4 mppa) and Oakland International (OAK, about 8 mppa). Airport choice in this area has been studied by several researchers, mainly thanks to the availability of good data. This data not only allows for studies on which factors play a role in the airport choice, but also allows for studies into which model structure describes the passenger choice behaviour best (e.g. a multinomial logit model (MNL), a nested logit model (NL), etc.).

Harvey (1987) used a MNL model for airport choice and found significant coefficients for both flight frequency and access time. Both factors were added to the utility function in a non-linear way to indicate the diminishing marginal utility.

It should also be recognised that passengers not only choose an access mode choice and an airport, but also choose an airline. Pels et al. (2001) used NL models for airport and airline choice. They concluded that both business and leisure travellers choose the departure airport and airline sequentially (first airport, than airline). This implies that travellers are more likely to switch between airlines than between airports.

Hess and Polak (2005a,b) have investigated whether there was any evidence of random taste heterogeneity in the traveller choice behaviour. They found significant heterogeneity for the in-vehicle access time coefficient, the access cost coefficient and the flight frequency coefficient. Accounting for heterogeneity prevented a bias in the trade-off ratios that are found when using fixed coefficients for all passengers: the values of time decreased and the trade-off ratio between flight frequency and in-vehicle access time increased.

[1] mppa = million passengers per annum

5. CASE STUDY: THE EFFECTS OF THE INTRODUCTION OF NEW RAIL MODES

5.1. Introduction

Airport rail links are increasingly seen as a means of providing high capacity, fast and convenient access to airports from the conurbations they serve. Of the 150 largest airports by passenger numbers[2] some 58 (39%) have a rail link connecting directly to the airport while another 18 (12%) are at an advanced stage of planning or constructing a rail link (data collected in 2006 from airport and rail authority websites by the author and colleagues).

As shown in Table 2, European airports have been very actively pursuing airport rail links, with 64% of European airports in the top 150 already having a rail link and another 9% actively pursuing such a link. By comparison, in North America only 22% of airports have rail links. Within regions there are also significant differences by country. For example, in Japan all 8 airports that are in the top 150 globally have rail links while in China only one (Shanghai Pudong) has a rail link of 8 airports in the list (excluding Hong Kong). It is notable however that another three Chinese airports are currently constructing airport rail links.

Table 2. Airport rail links by continent (top 150 airports by passenger numbers)

Continent	Existing		Proposed		No. of Airports	
Oceania	2	(40.0%)	0	(0.0%)	5	(3.3%)
Asia	14	(40.0%)	8	(22.9%)	35	(23.3%)
Europe	29	(64.4%)	4	(8.9%)	45	(30.0%)
North America	12	(20.3%)	6	(10.2%)	59	(39.3%)
South America	0	(0.0%)	0	(0.0%)	4	(2.7%)
Africa	0	(0.0%)	0	(0.0%)	2	(1.3%)
Total	58	(38.7%)	18	(12.0%)	150	(100.0%)

Source: Data collected in 2006 from airport and rail authority websites by the author and collaegues

The types of rail links vary significantly, from fast dedicated links such as to Stockholm Arlanda and Oslo Gardermoen, to regional links that form an extension of the suburban rail network (for example, Sydney and Minneapolis/St Paul) and part of the metro system (for example, Frankfurt Main and Chicago O'Hare). As shown in Table 3, regional rail connections are the most common type of connection. However, fast dedicated systems are increasingly being developed across Europe and Asia in particular. None of these fast dedicated systems existed in their current form 10 years ago, and most (such as Stockholm

[2] Passenger numbers include transit movements as a single movement, although they do not contribute to ground transport movements. Data is from 2004; the top 150 airports representing all airports with passenger numbers above 6.4 mppa.

Arlanda, Oslo Gardermoen and Shanghai Pudong) have involved major new infrastructure and rolling stock.

Table 3. Breakdown of rail links by type and continent

Continent	Fast dedicated		Regional		Metro	
Oceania	0	(0.0%)	2	(5.6%)	0	(0.0%)
Asia	2	(28.6%)	6	(16.7%)	5	(35.7%)
Europe	5	(71.4%)	20	(55.6%)	5	(35.7%)
North America	0	(0.0%)	8	(22.2%)	4	(28.6%)
South America	0	(0.0%)	0	(0.0%)	0	(0.0%)
Africa	0	(0.0%)	0	(0.0%)	0	(0.0%)
Total	7	(100.0%)	36	(100.0%)	14	(100.0%)

Source: Data collected in 2006 from airport and rail authority websites by the author and colleagues

In the remainder of this section, we will concentrate on four rail links that have been introduced or upgraded recently. The objective of this case study is to assess the impact of a new or improved access mode on the access mode choice behaviour: what mode share might such a mode attract and which are the success factors? Ideally, we would also like to discuss the effect on airport choice behaviour. However, no information is available on this.

5.2. London Heathrow – Heathrow Express

London Heathrow Airport is the largest of the five London airports with 67.7 mppa (2005). The first rail service to Heathrow Airport was the Piccadilly line extension to Terminals 1/2/3 completed in 1977. This was followed by a loop under the airport to Terminal 4 opened in 1986. While this service proved convenient and well patronised by airport employees and passengers alike, a number of studies had indicated the need for a faster express service. Approval was given for the construction of what had become known as Heathrow Express in 1993 which opened in 1998. The line follows the existing fast Great Western mainline rail alignment from London Paddington for 18 km before branching into the airport for a further 7 km of newly built track (much of it in tunnel) that loops under the airport.

Heathrow Express is heavily marketed as a premium service, offering a fast, reliable and comfortable journey between central London and Heathrow Airport. The trains are of a high internal standard and emphasise the branding around the station terminals. The express service operates every 15 minutes for a 15 minute journey time (to Terminal 1/2/3, 22 minutes to Terminal 4). The Piccadilly line of the London Underground runs standard 'tube' rolling stock but with extra provision on trains for large baggage near doors, as well as information on which terminal flights depart from. The service runs every 5 minutes throughout the day, taking some 49 minutes to central London.

That the price of the Heathrow Express is much higher than the underground (£14.50 versus £3.50, 2006 prices) does not seem to act as a substantial deterrent when the journey time saving is at least 30 minutes. This journey time saving alone however does not appear to explain the service's success. It is likely that the lack of crowding (compared with the underground) and more dedicated luggage space on the Heathrow Express are additional attractions.

The Civil Aviation Authority (CAA) undertakes continuous surveys of departing air passengers to Heathrow airport which include recording the last three modes of access to the airport. Data up until 2004 (the most recently available year) are given in Table 4 along with mode split information reported by Le Blond from 1996 and the forecast for 2003 made by BAA prior to the opening of the Heathrow Express in 1998.

Table 4. Mode shares to Heathrow Airport (percentages)

Mode	1996	2001	2002	2003		2004
				Forecast	**Actual**	
Private car	43	35.0	36.0	*44*	35.9	35.0
Rental car		3.2	3.2		3.1	2.8
Taxi / minicab	24	26.5	26.1	*16*	25.3	25.9
Underground	16	13.1	13.3	*10*	14.0	14.2
Heathrow Express	-	8.4	8.8	*19*	8.9	9.3
Bus / coach	17	13.1	12.3	*11*	12.6	12.4
Other	-	0.7	0.3	-	0.3	0.3
Total	100	100.0	100.0	*100*	100.0	100.0

Source: CAA surveys and le Blond (1999)

The forecasts for 2003 provided by BAA prior to the opening of the scheme assumed a substantially higher car mode share (44% versus 36%) than actually occurred, but –more critically– assumed that the Heathrow Express would capture 19% of the market, as opposed to the 8.9% it had actually captured by 2003. This is a very substantial shortfall, but not unique – the Arlanda Express service similarly experienced market penetration far below forecasts. Comparing the actual and forecast mode splits, it appears the forecasts overestimated the time sensitivity (and underestimated the cost sensitivity) for underground passengers, who did not shift to the Heathrow Express in the numbers predicted. Equally, the capture of taxi journeys was not as great as had been predicted, perhaps because of underestimating the penalty associated with getting to Paddington with luggage against a taxi journey direct from anywhere in London to the airport. This latter effect suggests that taxi users are not overly price or time sensitive, but rather value the convenience of a direct service over connecting in London. For groups of 2 – 3 people the taxi can be more cost effective as well.

5.3. London Gatwick – Gatwick Express

London Gatwick Airport is the second largest of the London airports after Heathrow (32.7 mppa in 2005). A rail link was first established at Gatwick Airport in 1959, the airport being located directly along the busy north-south line linking Brighton on the south coast with London. A service under the name of Gatwick Express was first established in 1984. During 2000/01 the by then very dated rolling stock was replaced with new rolling stock and much stronger branding was introduced both on the trains, at the airport and London Victoria station and substantial investment made in marketing the service to air passengers. The system has thus been given an identity similar to the Heathrow Express as a fast, premium service.

Determining the proportion of the rail mode share that is attributable to each of the rail services, and particularly to Gatwick Express, is difficult. Based on information from CAA (2006) and BAA (2005), we estimate that of the 24.6% mode share of all rail services to Gatwick in 2004 around 15% would be attributable to the Gatwick Express.

This new Gatwick Express service is recognised as one of the more successful airport rail links. The Gatwick Express service is competing with slower, commuter rail services. The commuter rail services, however, do not start at the airport, but rather further south from London and so they can be very busy in the morning peak period by the time they reach the airport on their journey into London. That this is a disincentive to air passengers is clear given the 80% rail share that the Gatwick Express service has to London's West End, despite charging 50% more than the Southern service and being only 3 minutes faster.

The advantages of the Gatwick Express link are the following:

- Strong branding and high quality rolling stock
- Availability of a train on the airport platform at most times (avoiding the need for passengers to wait on the platform)
- Dedicated rolling stock with ample baggage storage
- No crowding over most of the day.

The main disadvantage of the service is that it does not offer any substantial journey time improvement over the competing rail services (although all rail services are very substantially faster than competing road-based modes). This is due to the lack of dedicated high speed track and the need to fit with existing stopping services on an alignment that is operating at and beyond capacity. Should the Gatwick Express service be upgraded to offer a shorter journey time than competing rail modes it may reasonably be expected that the service's rail share would increase. To what extent this would happen, and to the detriment of which modes, is uncertain. Given the already high public transport share to London (greater than 70%) and existing time advantage of rail it is possible that a faster service would serve only to extract journeys from the competing rail modes.

5.4. Oslo Gardermoen – Flytoget

Oslo Gardermoen Airport was opened in October 1998 to serve as a replacement for Fornebu, which was operating at capacity and could not be expanded further due to its suburban location. The Flytoget is a dedicated high-speed rail link operating between central

Oslo and the new airport, some 50 km northeast of central Oslo. The service operates dedicated high speed rolling stock, which operate every 10 minutes during much of the day for a journey time of 19 minutes. The fare is 160 NOK (€20) one way from central Oslo.

Flytoget has maintained a very high modal split since Gardermoen opened, although it has decreased somewhat with time (Table 5). Since 2001 Flytoget's mode share has been stable between 31 – 35%, suggesting the very high mode split in the opening year was due to a number of external factors related to the opening of both the airport and rail link.

Table 5. Mode shares to Oslo Gardermoen

Mode	1999	2005	Change
Taxi	4	6	+2
Rental car	2	2	0
Private car – parking	14	18	+4
Private car – Meet & Greet / Kiss & Fly	7	14	+7
Bus	21	19	-2
Flytoget	41	33	-8
Other train (NSB)	5	7	+2
Other	7	2	-5
Total	100.0	100.0	0

Source: Avinor (2006) and TOI (2005)

The Flytoget service has one of the highest mode shares for an airport rail link anywhere in the world, this being attributable to a number of factors:

- The location of the airport some distance from the city, making a high speed rail connection inherently more viable (allowing for very substantial improvements in journey time compared to competing modes)
- High frequency, highly reliable and very fast service between the airport and Oslo city centre (almost twice as fast as any other mode)
- Pricing strategy for the product, that while not the cheapest, is not much more expensive than the bus alternative.
- Extensive marketing and branding of product, resulting in a perception of a premium product. Significant expenditure has been allocated by Flytoget AS to promote the rail service, it being positioned as the highest quality, fastest and most reliable means of getting from Oslo to the airport. Ongoing marketing campaigns have been supported by rolling market research of passengers to quantify various service attributes. The Flytoget brand is one of the most widely recognised and highly regarded in Norway. Onboard passenger surveys have indicated that 94% of passengers agree with the statement that Flytoget is the 'fastest, easiest and most effective way of getting to and from Oslo Airport' (Flytoget AS 2005).

5.5. Stockholm Arlanda – Arlanda Express

Four commercial airports serve the Stockholm area; Arlanda is the major airport, serving the majority of domestic and international flights. This airport was built some 43 km north of Stockholm on a greenfield site about two-thirds of the way between Stockholm and Sweden's fourth largest city, Uppsala. The Arlanda Express is a high speed rail link operating between central Stockholm and the airport.

Patronage and modal split of the Arlanda Express service has fallen very considerably below forecasts. Actual patronage in 2004 was 2.865 mppa it while the forecast demand for 2005 was 5.10 mppa.

A number of factors may serve to explain, at least in part, why patronage has been so far below forecast. Firstly, the downturn in global aviation following 9/11, the SARS outbreak and more recent terrorist incidents have all had an adverse impact on air passenger growth at Arlanda. In addition, increased competition from other airports in the region – primarily Oslo Gardermoen and Copenhagen Kastrup and from low-cost carriers operating from other Stockholm regional airports have further suppressed passenger growth. Other factors that have resulted in much lower patronge may include the pricing strategy, which positions the rail service at a much higher price than the alternatives, particularly the 'Flybussarna' bus alternative, which has similar service frequencies, twice the journey time but half the cost.

The Arlanda Express link shares many commonalities with the Oslo Flytoget service in that they are both high-speed rail services operating on largely dedicated lines to airports some 40 – 50 km from the cities they serve. Differences emerge however when comparing the mode shares of rail (31% at Oslo, 19% at Stockholm), the financing (Oslo was and remains wholly government owned) and profitability (the Oslo system has returned an operating profit in all but one year of operations).

The lessons learned from the Arlanda Express can then be contrasted with the comparative successes of the Oslo Flytoget system:

- A high quality, fast rail service is not in itself sufficient to ensure profitability nor a very high mode share.
- Rather, the cost relative to competing modes is an important determinant of demand, particularly for leisure travellers. While it is true that business travellers remain a core part of the market for such services (and essential to profitability) the additional volumes that leisure travellers bring (at little marginal cost) seem an important determinant of profitability.
- Pricing differentiation is not always effective, particularly when the perception amongst potential users is that the service is expensive – and thus they fail to even consider the rail alternative. The Oslo ticket structure is very simple and has not changed significantly since inauguration, whereas the Arlanda service has many ticket types that are continually changing.
- Integration into the wider transport network becomes more difficult in a PPP such as Arlanda Express, where the rail network to the airport is effectively vertically integrated in the hands of the private sector provider.

5.6. Conclusions

The cases have made it clear that a substantial mode share can be attracted by a new rail mode (up to more than 30% as achieved by the Oslo Flytoget service). The success or failure of the rail systems is dependent on a number of factors. The following characteristics are the most important, roughly in decreasing order of importance:

- *Journey time advantage over other modes*
  This, along with journey time reliability of rail and/or competing modes, appears to be a very significant factor as air passengers have high values of time.

- *Direct access to the city centre*
  avoiding the need to interchange.

- *Size of the catchment area with direct rail access.*
  Direct services from the airport catchment are critical.

- *Product positioning*
  Critical, both to building brand awareness and to be able to sustain market share while charging a substantial premium over competing modes. All of the rail links with high mode shares actively market their systems as a premium product, have dedicated branding and spend significant sums on marketing their product.

- *Composition of airport passengers*
  particularly the proportion of business travellers (who are more likely to be prepared to pay for a premium, high speed service) and local passengers (who are more likely to have a car available or be able to obtain a lift to or from the airport).

- *Fare*
  There is clear evidence from a number of systems that air passengers are less price sensitive than passengers for other journeys. However, a price premium over other modes must be combined with superior journey times and product positioning. There is evidence that there is an upper limit to what price can be charged; for example Oslo charges a premium over other modes that is some 30% above the bus fare and still achieves a very high mode share. By comparison, the Arlanda and Heathrow services cost more than twice the cheapest modes (bus and underground respectively), and as a consequence of this they lose price sensitive passengers to competing modes.

- *Terminal access*
  The importance of integrating the airport rail station/s into the airport terminal/s is widely recognised.

A number of other relevant factors exists that have not been mentioned explicitly above. One of them is *information provision*. This is clearly very important, particularly when service delays occur. The premium services tend to be more proficient at service provision and customer service in general, as would be expected of their product positioning. While this is undoubtedly important, the requirement for remote *baggage check-in* facilities does not appear to be seen as so important by passengers. While most of the premium rail links have offered baggage check-in facilities at their city terminus in the past, most have subsequently removed the service on the basis that the take-up was poor for a service that was costly in terms of labour and space utilisation at the station. The Oslo Flytoget has never offered baggage check-in at the city stations but instead have focussed on providing ample luggage space on trains, luggage trolleys and accessible platforms at both the city and airport stations.

6. CASE STUDY: TICKET TAX IN THE NETHERLANDS

6.1. Introduction

The current Dutch government decided in 2007 on the introduction of a tax on air tickets. This tax measure should generate 350 million Euro annually, but the exact implementation was still under discussion: it was not yet specified which travellers would pay and which would be exempt from this tax. Sixteen different implementation variants were suggested. The effects of each of those on passenger volumes have been calculated with the AEOLUS model. In this section, we discuss five of these alternative implementations. The objective of this case study is to assess the impact of a change in accessibility (the ticket tax) on the passenger choice of airports.

6.2. AEOLUS model

Dutch government policy allows the continuing growth of air traffic within strict safety and environmental limits. In order to assess the impacts of new policies on the development of Schiphol airport, a model to forecast demand for air travel under a wide range of scenarios was developed for the Ministry of Transport, Public Works and Water Management. This model was developed between 2004 and 2007 and was originally named ACCM – Airport Catchment area and Competition Model, see Kouwenhoven et al. 2006). In 2008, several improvements were implemented and the model was renamed AEOLUS, after the Greek god of the wind.

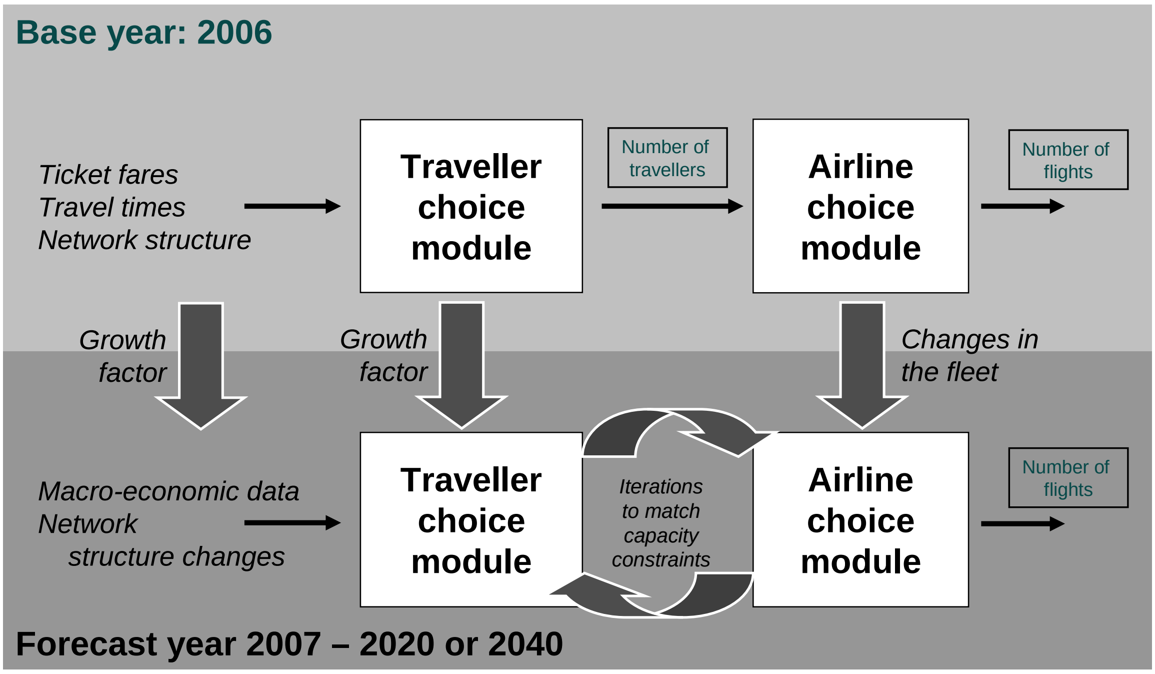
The model considers world wide traffic flows from, to, and through the airports within the catchment area of Schiphol airport (Netherlands, Belgium, northern part of France, western part of Germany, see Figure 5). The model considers traffic flows to/from 56 zones in the world. These zones are relatively small within the catchment area of Schiphol airport, more aggregated in the rest of Europe and very large in the rest of the World.

The architecture of the simulation system consists of two modules: a module to forecast traveller choices and a module to forecast airline choices (see Figure 6). In the first step of a model run, all traffic flows in the base year (i.e. 2006) are simulated. The traveller choice module calculates the number of (one-way) trips that travellers make between an origin and a destination zone in a certain year and it calculates the distribution of these trips over the available alternatives. The market shares of the available travel alternatives are determined by simulating traveller choices at one to three levels (Figure 7): choice between main modes (car, train, or aircraft), choice between available routes (specified by departure airport, airline, and route (direct flight or indirect via a hub)), and choice between access modes to the airport (car or train). We use random utility models of the logit type to define traveller choices (Ben-Akiva & Lerman 1985). Travel and transfer times, travel costs and service frequencies are the main determinants for the utility functions. The module requires current passenger counts and level-of-services for calculating travellers' preferences for the available alternatives in the base year (see Kroes et al. (2005) for more details on how a complete OD-matrix was derived from a partially observed database).

The airline choice module converts the passenger numbers into number of yearly flights per type of aircraft and per period of the day. Calibration factors were determined so that the calculated number of passengers and number of flights match the observed numbers.

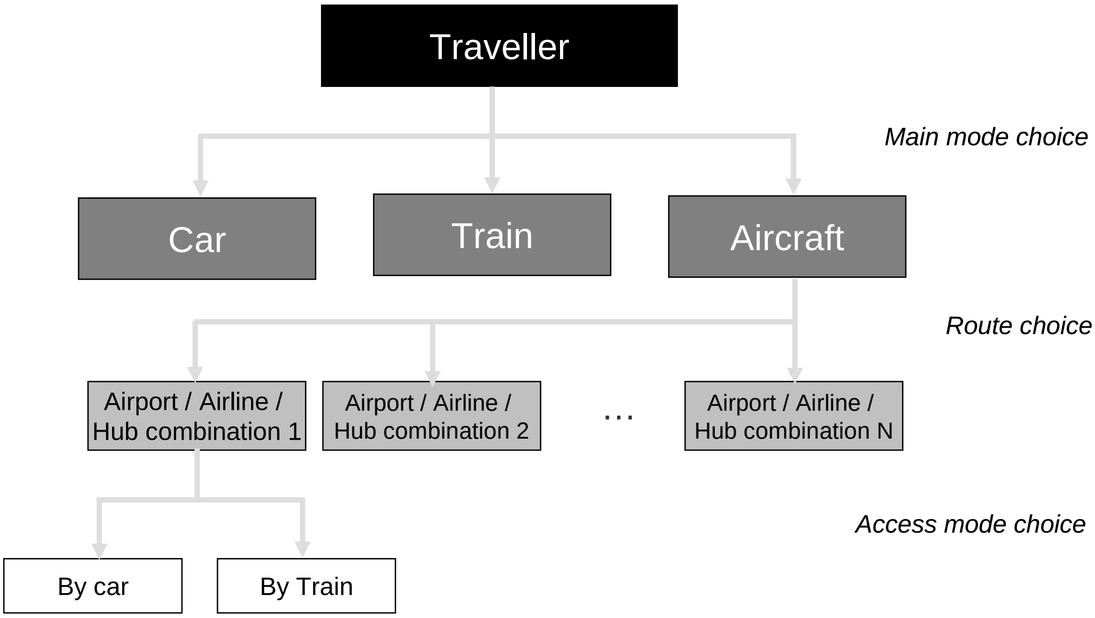
Figure 5 Relevant airports in the catchment area of Schiphol airport

Figure 6 Structure of the AEOLUS model



For each traffic flow, the number of travellers in the base year is extrapolated towards the forecast year (up to 2040) using a growth factor that depends on economic and price developments. The distribution over the available alternatives in the forecast year is calculated again in the travellers' choice module using a level-of-service for the forecast year. If the capacity constraints are exceeded, scarcity costs are added (both for passengers and airlines) in an iterative loop in order to reduce the demand and redistribute the passenger flows so that the total number of flights and the amount of noise produced does not exceed the limitations.

Figure 7 Structure of traveller choice module



6.2.1. Access mode choice

There are two alternatives: car and train. Generalised costs for the car mode are determined by fuel cost, parking cost and travel time. Travel times are converted into generalised cost by means of multiplication by an assumed value-of-time, depending on the travel purpose (business or non-business). Generalised costs for the train mode are determined by the train fare and generalised train travel time. Travel fares and times are taken from an input file with level-of-service information.

The same model is used to model the egress mode in case the destination of the trip is in the catchment area.

6.2.2. Route choice

Alternatives are defined by airline (Skyteam, Star Alliance, OneWorld, low-cost airlines, other airlines), by hub (direct flight, or one of 64 international hub options), and by access/egress airport (only if origin or destination is in the catchment area). The utility of each alternative is the sum of the logarithm of the number of flights per week, a generalised cost term (determined by an assumed ticket fare and flight time (with an extra penalty for an indirect flight)) and an accessibility term for the airport (only in catchment area). This accessibility term is the logsum of the access mode choice model.

6.2.3. Main mode choice

Main mode choice is only included if the origin is in the catchment area of Schiphol and the destination is somewhere else in Europe (or vice-versa). There are three alternatives:

car, train and aircraft. The utilities for the first two modes are determined by travel cost (fuel or train fare) and travel time; the utility of the air alternative is determined by the logsum of the route choice model.

6.3. Simulation of a ticket tax

Sixteen alternative versions of the ticket tax have been studied. These versions differed in the amount of tax that each of the segments (departing passengers, transferring passengers, freight) had to pay. In all versions, the total amount of tax collected per year was 350 million Euro. In the remaining of this section, we discuss five of these versions. Since this paper concentrates on passenger choices, we have only selected versions with no tax on freight (Table 6). The names of the versions correspond to the names in the original report (Signicance & SEO 2007). The simulations have been done with the third version of the ACCM model (ACCM-III) in 2007. The results have been confirmed with new simulations done with the AEOLUS model.

The AEOLUS model simulates the effects of the ticket tax by increasing the fare of air travel starting from the year of introduction of the tax (i.e. 2008), for each of four macro-economic scenarios. These scenarios were developed by the Netherlands Bureau for Economic Policy Analysis (de Mooij and Tang 2005) and they differ in the amount of economic growth (slow – fast) and in the focus on globalisation (small – high).

For the discussion on the effects of the ticket tax, we distinguish between departing and transferring passengers. Arriving passengers do not pay a tax. However, since most passengers buy a round trip ticket, we assume that half of the tax applies to the outward journey and half of it applies to the return journey. Therefore, the effects on arriving passengers are in the model identical to the effects on departing passengers. Note that a transfer passenger has to pay the tax twice per journey, since he makes a transfer both during the outward trip and the return trip.

6.3.1. Version 1: tax on departing passengers only

Each passenger departing from a Dutch airport (except transfer passengers) has to pay a tax of € 23. As a result, fewer travellers will use a Dutch airport as their departure airport. The number of departing passengers at Schiphol airport decreases by 10 to 12% in 2011 (depending on the macro-economic scenario, see Table 6). As a result, the number of flights will go down. This affects transfer passengers since they will have fewer options to travel via Amsterdam. This results in a decrease of transfer passengers of 5 to 8%.

For European destinations the relative increase in air fare is larger than for intercontinental destinations. Hence, the decrease in the number of travellers that depart from Schiphol for a European destination is larger than for intercontinental (15 to 16% versus 8 to 9%). Since the Dutch regional airports offer mainly European flights and do not serve the segment of transfer passengers that is exempted from the tax, regional airports are affected more than Schiphol airport (decrease in the total number of passengers of 18 to 20% for regional airports versus a decrease of 10 to 12% for Schiphol).

6.3.2. Version 1E: differentiation between European and intercontinental destinations

In this version of the ticket tax, departing passengers with a European destination have to pay a tax of € 16.67, while passengers with an intercontinental destination have to pay a tax of € 37.50. As a result, the decrease of the European market at Schiphol is similar to the decrease of the intercontinental market (about 12%).

6.3.3. Version 1E-B: further differentiation between European and intercontinental destinations

In this version of the ticket tax, departing passengers with a European destination have to pay a tax of € 12.50, while passengers with an intercontinental destination have to pay a tax of € 47.50. As a result, the decrease of the European market at Schiphol is less than the decrease of the intercontinental market (9 to 10% versus 14 to 18%). Regional airports are less affected than in versions 1 and 1E: the decrease in the total number of passengers for the Dutch regional airports is about the same as for Schiphol airport (11 to 13% for regional airports versus 8 to 10% for Schiphol).

6.3.4. Version 2: tax on departing and transferring passengers

Transfer passengers pay the same amount of tax (per transfer) as departing passengers. In order to raise 350 million Euro per year, the tax is € 13.75. This results in a very strong decrease in the number of transfer passengers (37 to 39%). This is due to the fact that these passengers have to pay the tax twice per round journey, since they will make a transfer both during the outward and the return trip. Furthermore, these passengers have very good alternatives, because most of them can also choose to make a transfer at London Heathrow, Frankfurt or Paris Charles de Gaulle without paying extra tax or having to make a detour.

Table 6. Effect of ticket tax (2011)

	Version 1	*Version 1E*	*Version 1E-B*	*Version 2*	*Version 2E*
Tax per departure					
European destinations	€ 23.00	€ 16.67	€ 12.50	€ 13.75	€ 9.50
Intercont. destinations	€ 23.00	€ 37.50	€ 47.50	€ 13.75	€ 21.38
Tax per transfer					
Europe – Europe	-	-	-	€ 13.75	€ 9.50
Europe – ICA	-	-	-	€ 13.75	€ 15.44
ICA - ICA	-	-	-	€ 13.75	€ 21.38
Schiphol					
Total passengers	-10 to -12%	-8 to -11%	-8 to -10%	-19 to -22%	-20 to -26%
- departing total	*-13* to *-14%*	*-11* to *-12%*	*-10* to *-11%*	*about -10%*	*about. -9%*
- departing Europe	*-15 to -16%*	*about -12%*	*-9 to -10%*	*-11 to -12%*	*about -9%*
- departing intercont.	*-8 to -9%*	*-11 to -14%*	*-14 to -18%*	*-6 to -7%*	*-9 to -10%*
- transferring	*-5* to *-8%*	*-5* to *-7%*	*-4* to *-8%*	*-37* to *-39%*	*-44* to *-48%*
Total flights	-9 to -12%	-8 to -9%	-8 to -9%	-17 to -20%	-17 to -23%
Dutch regional airports					
Departing passengers	-18 to -20%	-14 to -16%	-11 to -13%	-13 to -15%	-9 to -12%
Emissions (Schiphol)					
Noise (dBA)	about -0.3	-0.2 to -0.3	-0.2 to -0.3	-0.7 to -0.8	-0.9 to -1.0
Particles	-5 to -10%	-5 to -9%	-3 to -9%	-14 to -19%	-17 to -23%

6.3.5. Version 2E: differentiation between European and intercontinental destinations

This version is similar to version 2, but the amount of tax depends on the destination (tax for intercontinental destinations is about 2.25 as high as for Europeans destinations). This has an even larger effect on transferring passengers (that are predominantly passengers with a intercontinental origin or destination. The decrease of the total number of passengers at Schiphol airport is 20 to 26%, while the decrease at regional airports is limited to 9 to 12%.

6.4. Effects by segment

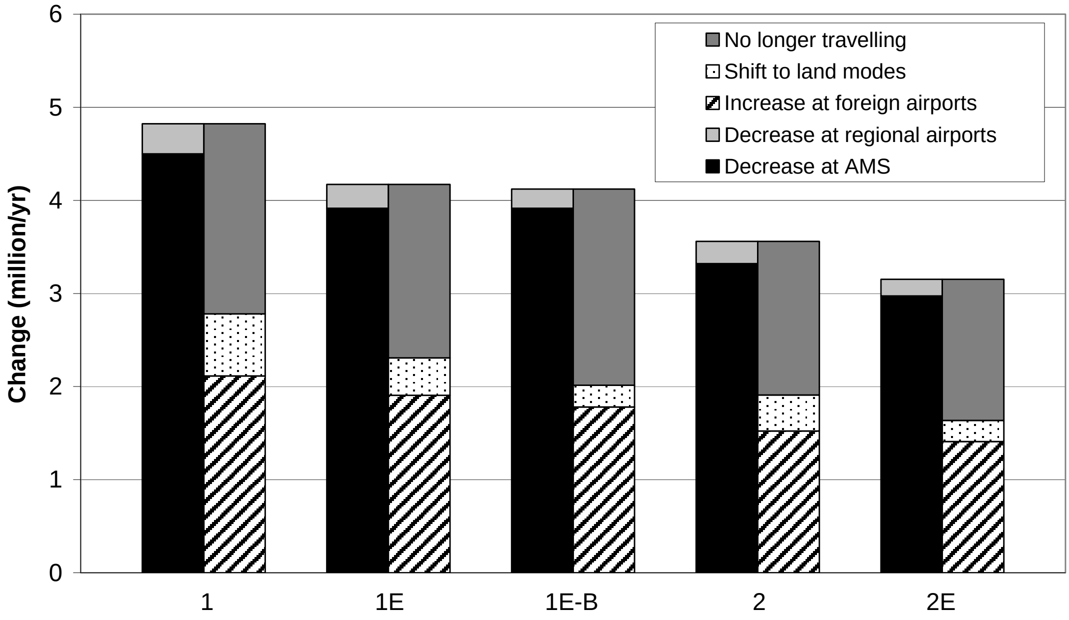
6.4.1. Departing passengers

In all versions, the number of passengers departing from Dutch airports will decrease. Instead, they will

- depart from a foreign airport, where they do not have to pay the ticket tax;
- travel using another mode (either train or car). This is only an alternative for travel within Europe;
- not make the trip.

Figure 8 displays the number of passengers (absolute number of passengers, as determined after averaging over the four macro-economic scenarios), that change their travel behaviour for each version of the ticket tax (departure and arriving together). The total number of passengers that no longer departs from/arrive at a Dutch airport (either Amsterdam Schiphol, or at one of the regional airports) is equal to the number of passengers that either shift their departure/arrival to a foreign airport (about 45%), or shift to a different mode (about 10%) or no longer travel (about 45%).

Figure 8 Effect of ticket tax on passengers departing/arriving at Dutch airports (2011)



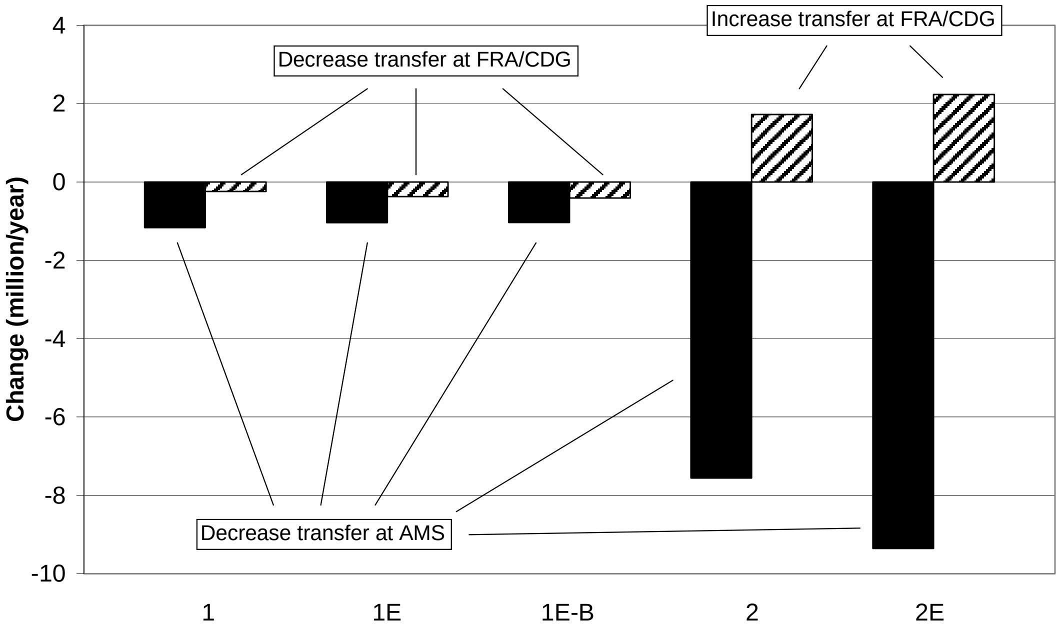
6.4.2. Transfer passengers

Travellers that stop transferring at Schiphol airport as a result of the introduction of the ticket tax will in stead

- transfer at another airport;
- shift to a direct flight;
- not make the trip.

Figure 9 displays the effect on the number of transfer passengers at Schiphol, Frankfurt and Paris Charles de Gaulle. In versions 1, 1E and 1E-B, the number of transfer passengers at Frankfurt and Charles de Gaulle reduces as well. These are travellers that would have departed from a Dutch airport and would have transferred at FRA or CDG if there would not have been a ticket tax. In versions 2 and 2E, the number of transfer passengers at Frankfurt and Charles de Gaulle increases. These are travellers that have diverted their route due to the ticket tax at Schiphol airport.

Figure 9 Effect of ticket tax on passengers transferring at Amsterdam Schiphol airport (2011)



6.5. Final implementation

In order to mitigate the effects of the ticket tax on the airlines and airports (particularly on Dutch regional airports), the government decided to implement a version that is very similar to version 1E-B. It was decided that the tax would be € 11.25 for all destinations within 2500 kilometre, including all EU member countries) and € 45 for other destinations. An exception is made for countries with destinations on both sides of the 2500 km border. The low tax of € 11.25 also applies for other destinations in those countries, provided that they are not further away than 3500 km.

This tax took effect on 1 July 2008 and its consequences are already noticeable. The number of passengers departing from foreign airports is increasing according to travel agencies. One of these agencies (D-reizen) reports an increase of this number of 350% (Volkskrant, 2008a). Schiphol airport expects that passenger growth will stagnate (NRC 2008). KLM expects to loose half a million to a million passengers in 2008 (Volkskrant 2008b).

6.6. Conclusion

A change in the accessibility of a single airport (or a group of airports) can have large effects on the passenger choice of airports, especially if good alternatives are available. In this specific situation, the average ticket price for journeys departing from/arriving at a Dutch airport increases by about 5%. Since the reduction in the number of passengers departing/arriving at Dutch airports is about 10%, the elasticity of demand is about -2 (of which about half is attributed to a switch to a foreign airport, while the other half is attributed to travellers that cancel the trip).

7. CONCLUSIONS

Understanding the choice process of air travellers is key in understanding the effectiveness of policy options regarding airport development. Two important factors in this choice process are the access mode choice and the airport choice.

Access mode choice has been studied extensively and several models are around. However, no clear consensus has yet emerged on which explanatory variables should be included or how the various modes and sub-modes should be nested in the model (Gosling 2008). Because of this, it is not possible to transfer these models to other airports for which they were not specifically developed.

A change in the attributes of an access mode can have large impacts on passenger access mode choice. Most important attributes that determine the mode choice are access travel time and access cost. Some travellers prefer a cheaper but slower mode, while others (especially business travellers) choose a more expensive but faster mode. Other factors, such as the reliability of travel times/predictability of arrival times might be important as well, but have been less studied yet.

Introducing a new access mode (e.g. a fast rail connection) can substantially change the access mode shares. Factors that determine the success of such a scheme include that the journey time should clearly be shorter than that of competing modes, and the fare should be in accordance with the travel time savings and the positioning of the product.

A relative change in accessibility of one airport to another airport can have large impacts on passenger airport choice behaviour. The case study on the introduction of a ticket tax in the Netherlands demonstrated both a high total demand elasticity and a high elasticity for airport switching. The total demand elasticity (at al airports) in the case study was shown to be about -1 (i.e. a 1% increase in ticket price results in a 1% reduction in the number of departing/arriving passengers). In addition, the airport switch elasticity was also shown to be about -1 (in case of a 1% increase of ticket price, an additional 1% of travellers will switch airport).

Though very little research has been done into this, it is likely that a deterioration of car accessibility as a result of increasing congestion, can have a large impact on airport choice behaviour. This not only results in longer access times, but also in a decrease of reliability (i.e. a decrease of predictability of arrival times). Especially in multi-airport regions, this might result in a substantial switch in airport market shares. But also other factors impacting airport market shares can be thought of, especially fast, easy and cheap parking, fast and easy travel within the terminal etc. Very little research into the impact of these factors has been done as well.

Further quantitative research remains necessary to really understand the choices that air travellers are making. Given the large investments that are made to improve accessibility of airports and to increase their capacity, objective analysis is essential. New stated preference design techniques make it possible to provide respondents with realistic choice situations. This will improve the quality of the results. Other factors that have not yet been studied, such as reliability and the impact of congestion around airports, need to be included in these studies as well.

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