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Development in Danish international air traffic

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Abstract

The paper is describing the development in international air traffic made by Danes and for all travellers out of Denmark in the period 2002 - 2012. Development in passengers, destination countries and prices is illustrated. The person kilometres by Danes have increased 80% or 7.2% per year in mean during the 10 years. This increase has been analysed by a panel data model. The conclusion found by modelling is the increasing travel activity first of all is driven by increasing income and to less extent by decreasing prices. The paper is furthermore showing how the international air traffic has got more effective and to what extent Low Cost Carriers have taken over an important part of the travel market.

Air traffic is together with car the most important mode on long distance travels. On short lasting international trips and travels to southern Europe and outside Europe air is nearly the only mode. The development in air traffic is at one hand very important for the travel opportunities, and at the other hand the passenger flow by air traffic is very important for the environmental impact and for the effect of long distance travels on economy.

Data sources

DTU Transport has got extracts from two databases with air travel activities for 2002 to 2012, The Airport Database from Trafikstyrelsen (Danish Transport Authority) including information about number of airplanes and passengers departing and arriving from / to Danish airports, and The Sabre Database including information from an international ticket database including number of passengers to and from Denmark. Both databases include macro data on monthly basis and no background information about the travellers. The main difference between the two databases is that the Airport Database is following the airplane to its final destination, and the Sabre database is following the passengers to their final destinations. Another important difference is that Sabre except for few exceptions only includes data from schedules air traffic whereas the Airport Database also includes charter travels.

The Airport Database is reporting the monthly number of passengers and airplane operations between a Danish airport and the airplane's final destination airport. The number of passengers and operations is divided into terminating, transfer, and transit passengers, and furthermore into scheduled and charter traffic. By inclusion of transfer and transit passengers air traffic to or from other countries landing in Denmark is included but are removed in the aftercare of the database. Some mistake is made in the

number of inbound scheduled passengers up till 2008 which has to be considered in analysing the data. However, the number of charter passengers and the number of outbound passengers seem correct.

The Sabre database is reporting the monthly number of passengers between Danish airports and the passenger's final destination airports. It mainly reports scheduled traffic. It reports for each pair of departure and arrival airport the number of passengers, the revenue of the travels and a calculated mean ticket price. Furthermore, the number of passengers and revenues are divided into which country the ticket is bought in, the marketing and the operating airlines, the cabin class, and the travel route classified by up to 3 connection airports.

Aftercare of the Sabre database

Sabre is a computerised reservation system used in the travel industry. The database includes ticket sales from member airlines, using the Sabre ticketing system. As this is only a part of the market, data is complemented with information on non-member airlines. The method to add this information is unclear and to a certain extent defective. To overcome the effect of this some modifications have been necessary in the aftercare of the data but still a number of shortcomings limit the analysis that can be carried out and also must be considered in the interpretation of empirical results based on them. The shortcomings and defectives is serious because a high share of passengers by non-member airlines are flying by big low cost airlines, especially Sterling, Norwegian, Easy Jet, and Ryanair.

One problem is that the overall number of travellers per country by the imputed airlines is developed from the number of passengers in the member airports. And it seems from the number of passengers per country that only the airports in Copenhagen, Billund, Aarhus, Esberg, and Roenne are members. Therefore, passengers from Aalborg airport and the rest of the small airports are removed from the Sabre database even though the overall number of passengers from Aalborg might be correct.

Another important problem recognised is related to the classification of the passengers to the country from which the tickets are bought. This information is used in the paper for analysing the behaviour of Danes. However, up till 2009 the passengers by the non-member airlines are classified by the country they are departing from (the outbound travellers are classified as Danes and the returning inbound passengers are classified as foreigners from the actual country. By using both inbound and outbound travels the number of Danes will be half of all travellers by the non-member airlines. This information is used in the analysis except that a few airlines only selling tickets outside Denmark are removed from the database. From 2009 the imputation of the non-member airlines is made in another way but it is not clear if it is more correct.

Other mistakes have been impossible to assess and to repair for. One problem is that it is unknown how the ticket prices for the non-member airlines are imputed into the system and how correct they might be. The problem is serious because a high share of the passengers by the non-members flies with Low Cost airlines. Another problem is that the number of passengers in the Sabre database is too low in 2011. Especially for the months March-September it is even lower than the number of passengers in Copenhagen according to the official statistics for the airport. There is no information on why or how this has occurred.

Development in overall international passengers

Figure 1 shows the number of outbound passengers from Danish airports according to the Airport Database. The number of international scheduled passengers by air traffic has doubled over the ten years whereas the number of charter passengers only has increased by 29% and the number of domestic passengers 22%.

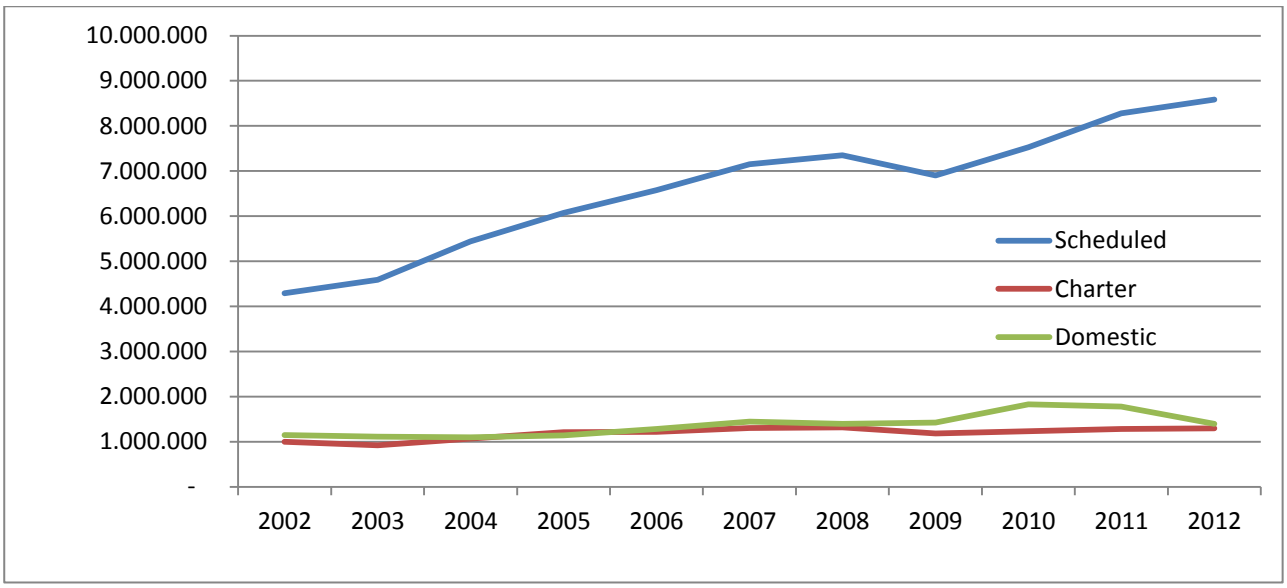

Figure 1 Number of outbound terminating passengers divided into scheduled international passengers, domestic passengers, and charter passengers. Source: Airport Data

The number of scheduled international passengers is not quite the same according to the two databases. A reason for this is that most of the domestic transfer passengers are international passengers. These are added to the terminating international scheduled passengers in Figure 2 from which it can be seen that there is a good agreement between the Airport data and the Sabre data for the overall number of passengers except for 2011. The Sabre database has for most years a little higher figure which can be due to 'other traffic' not included in the Airport data but included in the Sabre data, and some charter traffic in the Sabre data possibly registered as scheduled traffic. The low level of the Sabre data in 2011 seems to be an error.

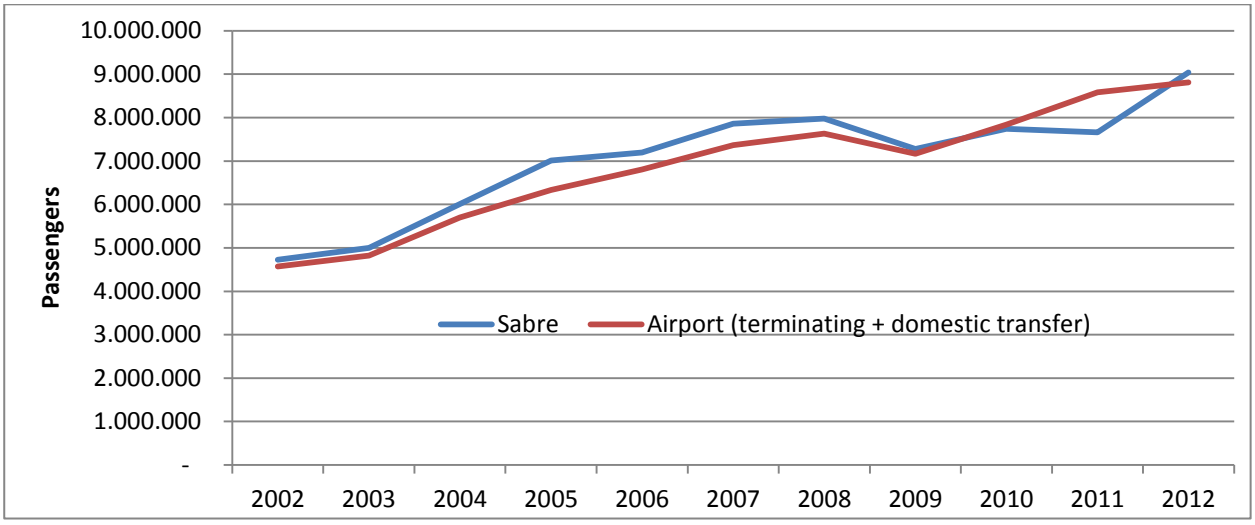

Figure 2 Number of outbound international passengers compared for two databases when domestic transfer passengers are added to the airport terminating passengers. Source: Sabre data, Airport data

The number of Danish and foreign passengers is shown in Figure 3. The share of Danes is higher than the share of foreigners, especially up till 2007. The top of the number of passengers in 2007 and decrease before the top of the world economic crises in 2008 might be explained by an earlier start of the crises in Denmark and eventually partly by the cease of Sterling in 2008.

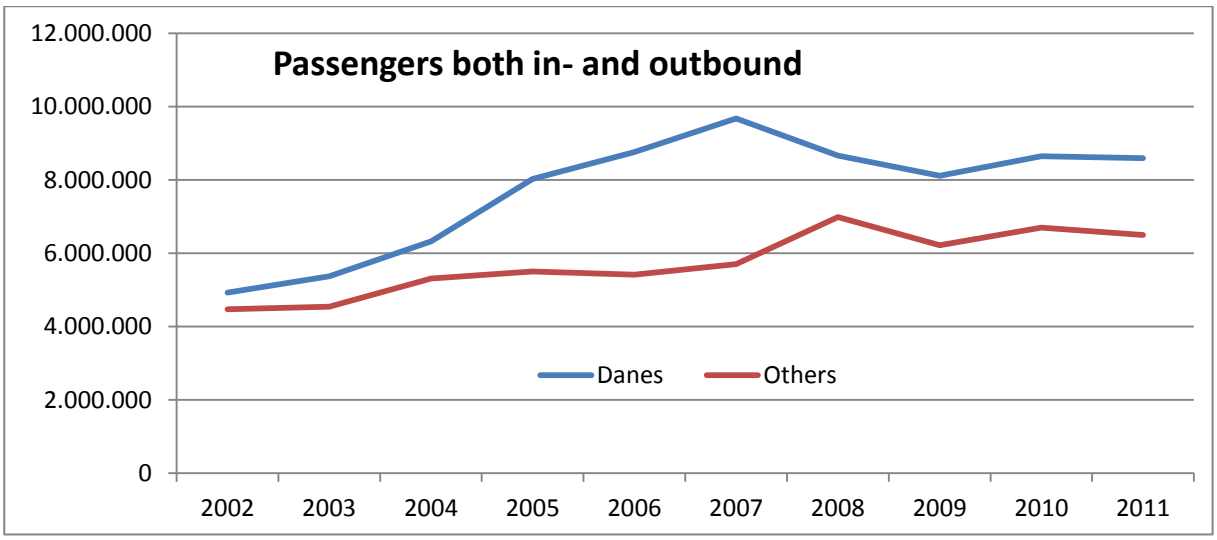

Figure 3 The overall number of scheduled international passengers registered as Danes and foreigners. Source: Sabre data, Airport data

Destinations and travel distances

This chapter should give an overview of the travel destinations by Danes during the 11-years period. The Sabre data only includes scheduled air traffic. To get a full picture of all travels it is needed to include charter traffic for which the only data source is the Airport data. This includes no information about the nationality of the traveller. It is assumed that all charter travellers from and to Denmark are outbound and returning Danes. This is of course not fully correct, however it is assessed that foreigners traveling to Denmark by charter is very few. The biggest non-Danish group is expected to be Swedes crossing the Oresund link by train or car. These cannot be removed from the data.

Figure 4 is showing the order of the 19 most important international air travel destination countries for Danes in 2012 representing 80% of all international air travel by Danes. In 2002 these countries also represented 80% whereas they in some years in between represented slightly less. It is assumed that the first destination country of the charter flights is also the final destination country. For the Sabre database the final destination is known.

In whole the period the two most important destination countries representing 22% of the air travels are Spain as number one and United Kingdom as number two. Norway, Turkey, Germany, and United States have moved up the list to be between the top 6. This group has increased their share from 42 to 45% of all air travels. Italy, Greece, France and Sweden have at the other hand moved down the list but are still in the top 10. All together the top 10 represents a constant share of 64% of the air travels. Turkey has replaced Greece as number two Mediterranean summer resort country. The traditional holiday countries France and Italy have been replaced by the two more business oriented neighbour countries Germany and Norway. United States has as the only overseas country entered the top 10 group. In the top twenty we find 3 more overseas countries, Thailand as number 11, and Egypt and China as number 15 and 19, respectively.

The changes show that the destinations have been more concentrated around Denmark with Sweden as the only neighbour country not being in top 5. It seems as if people are flying more than earlier to countries close at as Germany and Norway. The opposite is the case for Sweden.

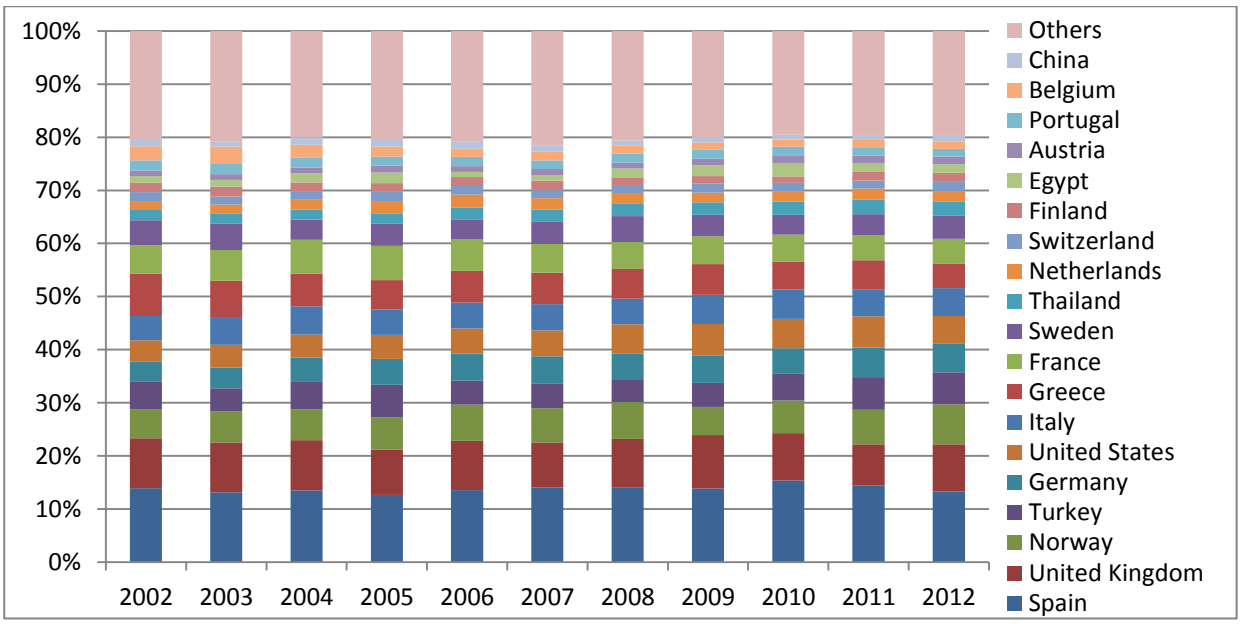

Figure 4 Share of Danish passengers to the 19 most visited countries and the rest, scheduled and charter travels. Source: Sabre data, Airport data

Scheduled or charter?

An aspect of the development in travel destinations is the different development in scheduled and charter traffic. This is illustrated in Figure 5 which shows the development in the air traffic to the 19 most important destinations by scheduled and charter traffic. The charter traffic is increasing from 1.5 mio. travels (both outbound and inbound) to 2 mio. in 2005 after which it is constant. The scheduled traffic is slightly more than doubled over the period.

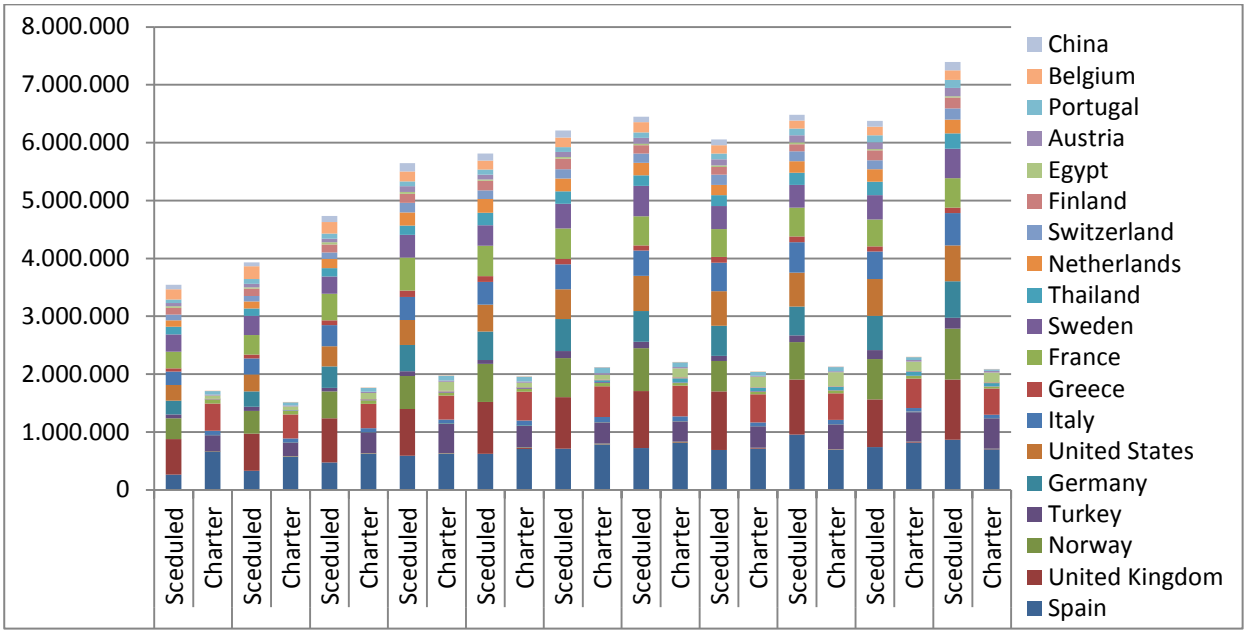

Figure 5 Number of Danish passengers by scheduled and charter traffic; sum of outbound and inbound passengers. Source: Sabre data, Airport data

3 countries, Spain, Turkey, and Greece, represent 75% of all charter traffic in 2002 and the share has only decreased slightly. Figure 6 shows that Cyprus+Malta, Bulgaria, and the Emirates which are not in the top 19 travel destinations are included in the top 12 charter destinations (Cyprus and Malta are taken together as a country group and are number 20 on the overall air travel list). Egypt has moved up from a position as number 9 charter destinations to a position as number 4 and Thailand and the Emirates have moved in

from nothing to a position as number 6 and 12. Italy, Portugal, France, and Austria are with position number 8-11 smaller charter countries with decreasing number of charter travellers.

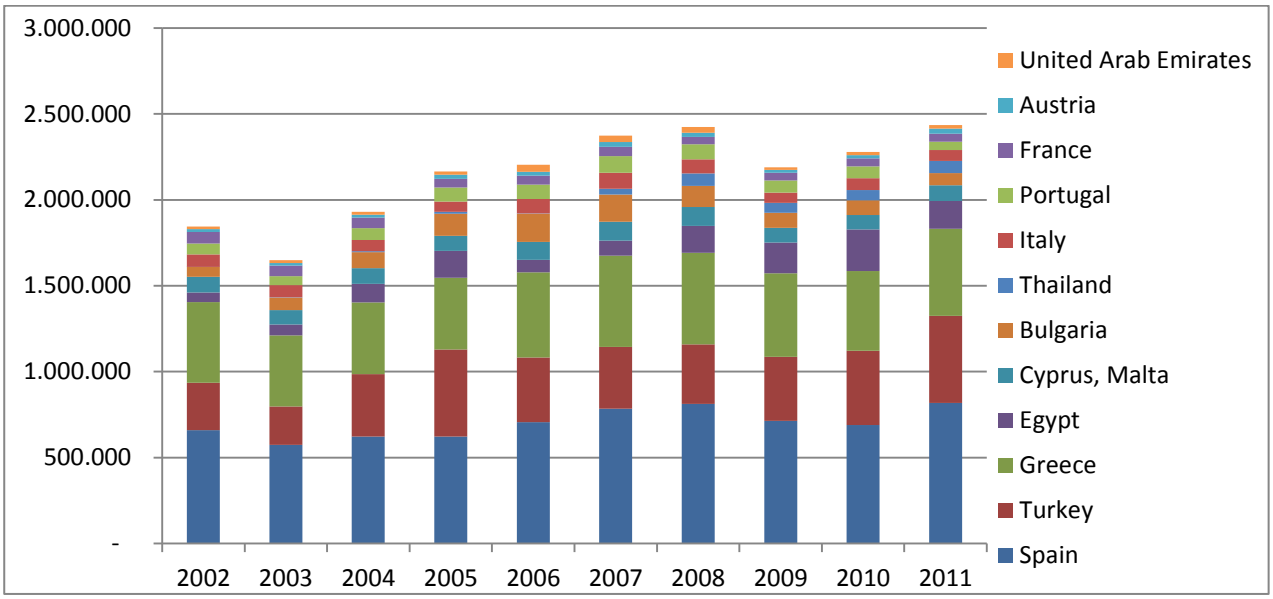

Figure 6 Number of passengers by the top 10 charter traffic nations. Source: Airport Data

For Greece, Turkey, and Egypt, Bulgaria, and Cyprus / Malta the scheduled air traffic only represents 15-22% of the overall passengers for the 10 years. Except for Greece and Turkey the share is a little decreasing. For Spain the share of scheduled traffic has fluctuated around a little more than half of the travels. Charter travel has never been dominating for Italy, Portugal, France, and Austria, the charter traffic has decreased and the scheduled traffic increased resulting in a decreasing charter share. For both Thailand and the Emirates scheduled traffic is most important, and for United States and China charter traffic is non-existing.

Travel distances

An important aspect in development in the air traffic is the travel distance. The mean travel distance from Denmark by air has been rather stable. In 2002 it was 2,200 km. The highest level in the years 2009-2011 was only 80-90 km higher.

The mean distance travelled by Danes is 2,521 km for a one-way. This distance has neither changed much over the years (Figure 9). In 2012 is was 21 km longer than in 2002 and in the years 2009-2011 it was 100-130 km longer. The mean distance for travels in Europe as well as overseas is fluctuating but the tendency is a constant level.

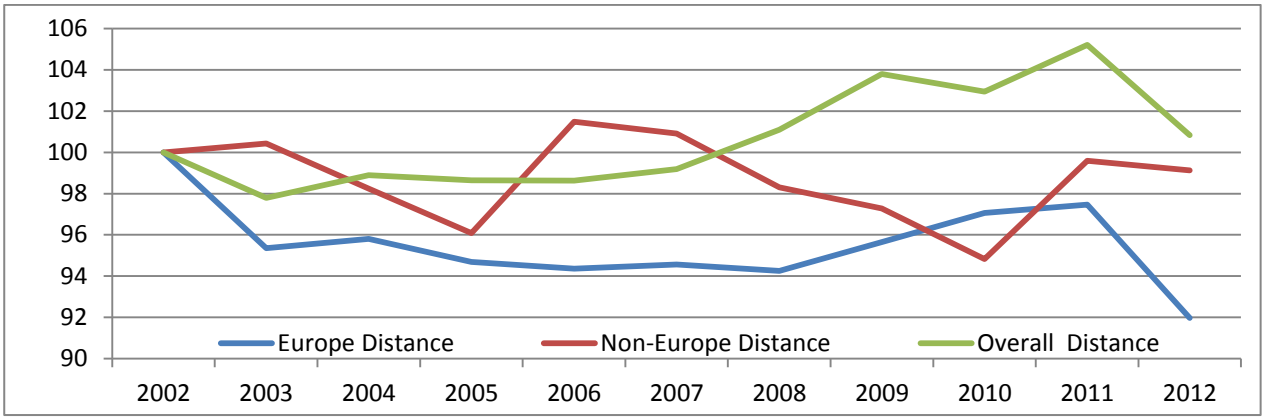

Figure 7 Mean travel distance for Danes for all travels and for European and non-European passengers separately. Shown as index with 2002 as 100. Source: Sabre data, Airport data, and distances from the Transtools project and several home pages.

The overall tendency of travel distances is however a slow increase due to change in the destination of the passengers. Travels to destinations outside Europe have increased more than travels in Europe (Figure 8).

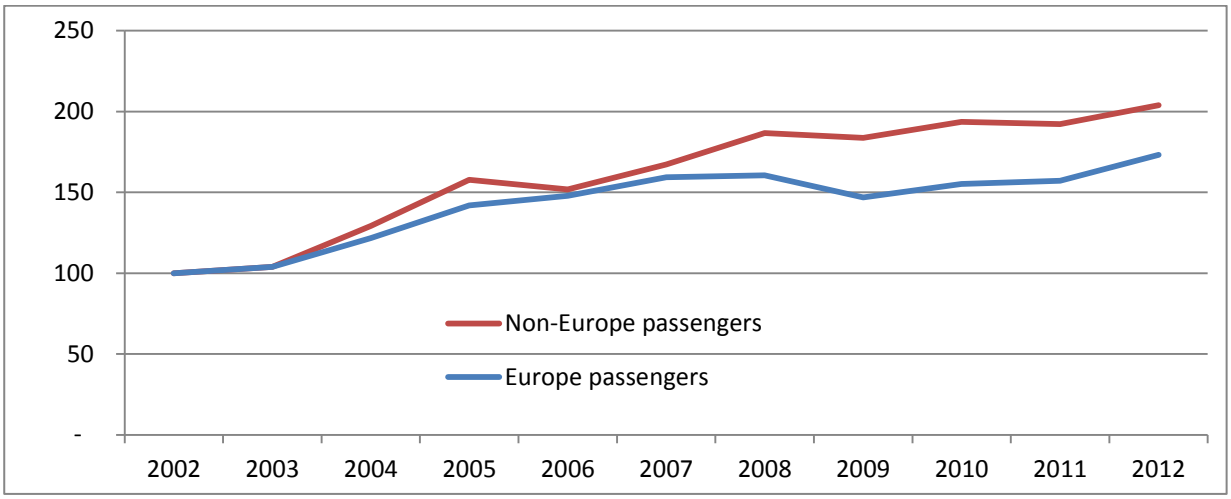

Figure 8 Number of Danish passengers (scheduled and charter) for Europe and outside Europe. Shown as index with 2002 as 100. Source: Sabre data, Airport data

A slightly higher level of the mean distance after the crisis in 2008 might be explained by the fact that the most wealthy part of the population has a little higher share of long haul travels and they are least effected by the crisis. The lower income groups might have postponed their next European holiday by air – typical till 2012. A higher level of the mean distance for Danes than for all travellers shows that the guests to Denmark come from much closer countries than where the Danes travels. Many more of the guests are probably business travellers.

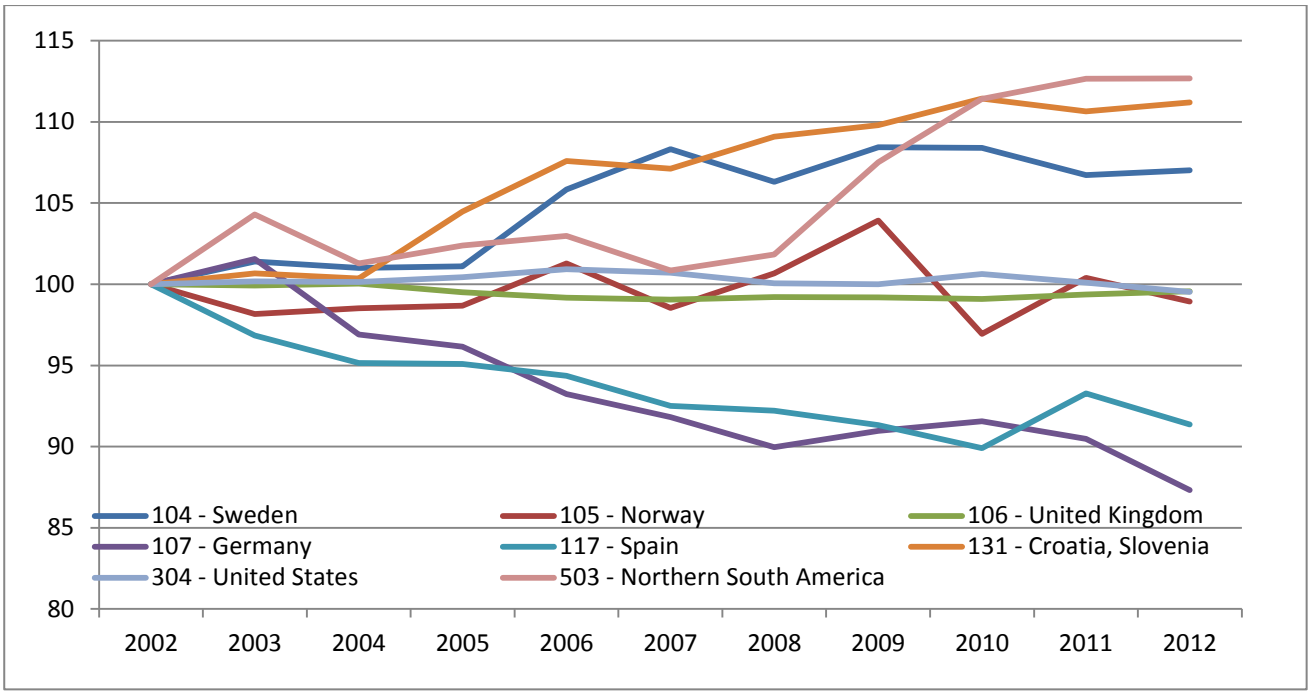

Figure 9 Mean travel distance for Danes (scheduled and charter) for some picked out countries and groups of countries. Shown as index with 2002 as 100. Source: Sabre data, Airport data, and own calculations of distances based on Trantools and several homepages

For most of the countries the mean travel distance is only changing very little, typically 1-2 percent lower or higher for one or a few years than for the rest of the years.

Decreasing mean travel distances are observed for Germany and Spain. For Germany it is obviously explained by more tourists to Berlin, in 2012 ten times as many as in 2002, and a slower increase for the rest of the big German cities, which are typically visited for business. For Spain the change is an increasing number of passengers to Barcelona and Madrid, a constant number to Malaga and other airports in southwest. The number of passengers is increasing to the Canarian Islands, but slower.

Bigger increases are observed for Sweden, Croatia+Slovenia and for the countries in the Northern part of South America, see Figure 9. The explanation for Croatia+Slovenia is increasing interest in the beaches and heritages in southern Croatia with 10 times as many passengers and the capitals with slower passenger increase. In South America the change is explained by decreasing interest in Venezuela and more travels to especially Peru, Ecuador, and Columbia.

The change for the Swedish market happens at once in 2006. It might be related to the Oresund Bridge which opened in 2000 and ceases of some Swedish airlines serving the Scandinavian market. The airports close to Denmark seems to close down whereas the number of passengers to Stockholm, Gothenburg and the airports further to the north increases. As shown above the overall number of air travel to Sweden decreases. The explanation seems to be the bridge across Oresund which makes travel by car (and train) easier and cheaper. The same was observed for domestic travels when the Great Belt link opened in the nineties. It is rather possible that the same will happen for Germany when the tunnel is finished. Especially most of the travels to Berlin and Hamburg might disappear.

Service level of air traffic

The service level can be measured by both the number of destinations served and the frequencies. The service level can furthermore be related to the demand at the destinations. In the following the service level at the destinations is measured by the number of city pairs served. This measure considers both the departure airport and the destination airport. Only city pairs with at least 100 passengers per year are considered.

Density of routes

International air traffic

The number of city pairs served by an airline from Denmark has increased by 60% from 223 to 316 over the 11 years (refer to Figure 10). The number of operations has fluctuated some, but it has not increased after 10 years. This means that the same number of operations have been spread out to several more destinations giving the travellers much more destinations to choose between but lower service at each destination. Some of the new opportunities have been direct flights from Jutland from where it was earlier necessary to travel through Copenhagen.

At the same time the number of passengers increased 30%. After a drop in 2003 the mean number of passengers per city pair has been constant. With fewer operations per city pair the result has been an increasing number of passengers per flight. With all other constant this should have improved the economy of the airlines and made room for reduced prices and/or higher profits.

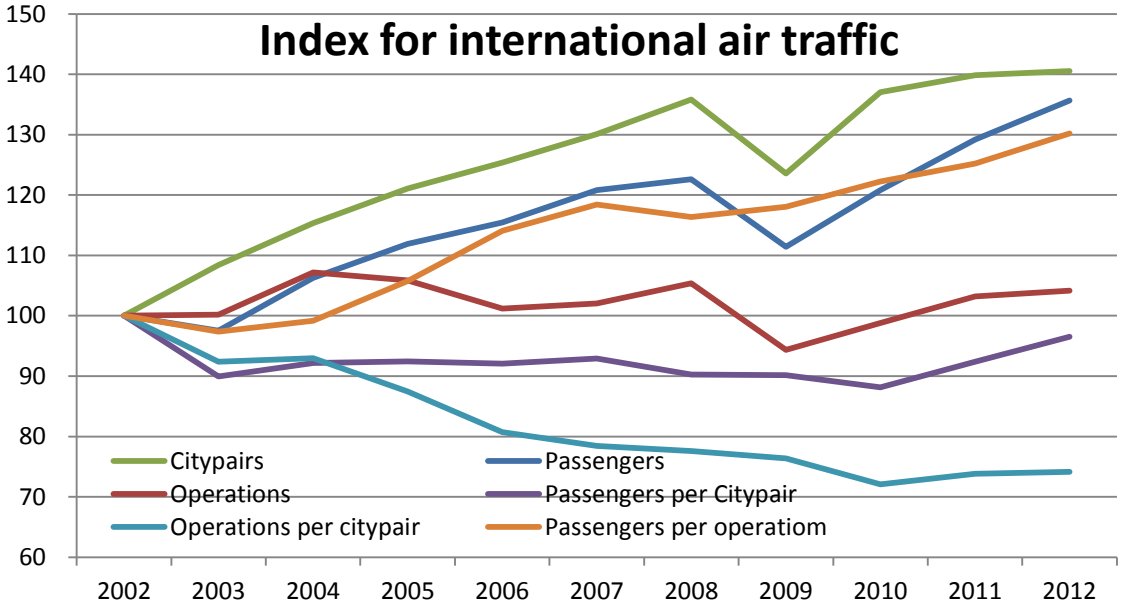

Figure 10 Index for the mean number of city pairs served by scheduled or charter flights between Denmark and international destination. Index for number of passengers and operations at these city pairs. Source: The Airport database.

National air traffic

The picture of the national traffic is rather different. The number of served city pairs increased even more and already up to 2006 (refer to Figure 11). The number of passengers didn't follow up and the number of operations increased a little. It seems to make a worse economy. From 2006 the situation was changed so that less city pairs were served, the number of operations per city pair increased which improved the service level for the main connections. The result was an increasing number of passengers and increasing number of passengers per city pair and per operation. A guess is more competition at the main destinations from first of all Norwegian resulting in reduced prices. A development which ended in 2012 with the cease of Cimber Sterling.

A drop in served city pairs, operations and passengers also occurred for the international travels in 2008 when Sterling ceased. The traffic was not fully recovered until the first part of 2010. Norwegian first of all took over a lot of served city pairs.

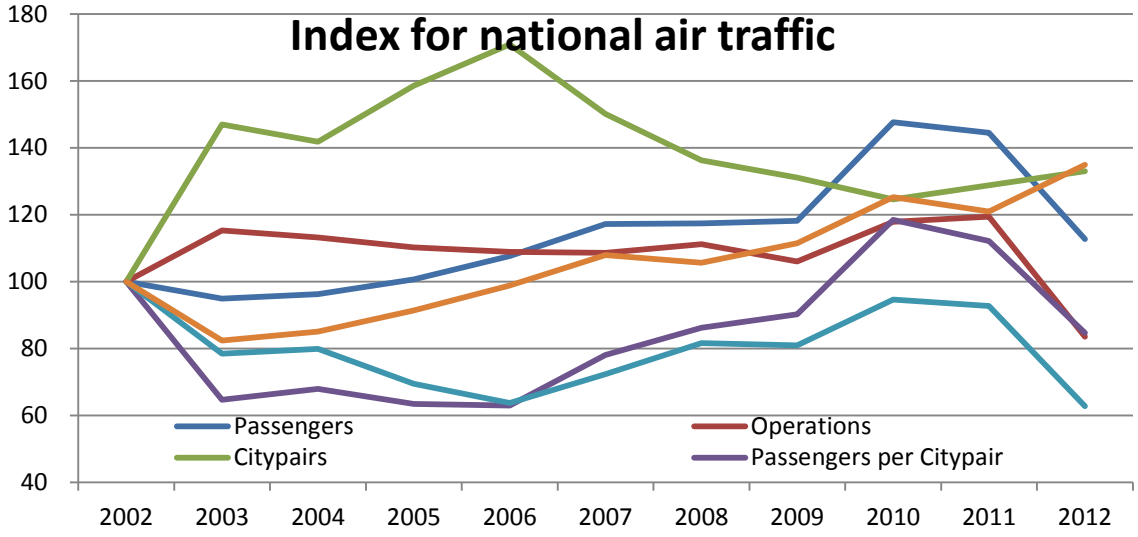

Figure 11 Index for the mean number of city pairs served by scheduled or charter flights between Denmark and international destination. Index for number of passengers and operations at these city pairs. Source: The Airport database.

Concentration and the Gini coefficient

The Gini coefficient for number of travellers and number of operations at the city Pairs are calculated to show if a concentration has taken place over the period (Figure 12). The Gini coefficient is calculated as:

$$Gini\ coeffcient = \frac{1}{2n^2}\frac{1}{\bar{Y}}\sum_i\sum_j |Y_i - Y_j|$$

where Y_i and Y_j represent the number of operations/passengers for each city pair, $\bar{Y}$ is the mean traffic for all the city pairs and n is the number of city pairs. The Gini coefficient is 1 in a situation with only one city pair and 0 if all city pairs have the same traffic.

The Gini coefficients are calculated for both all outbound traffic from Denmark and for Copenhagen alone. For Copenhagen it is furthermore calculated for scheduled traffic alone. The Gini coefficients for all outbound traffic are high indicating a very concentrated travel pattern (Figure 12). Coefficient is higher for all traffic than from Copenhagen alone. This is due to a very high concentration of traffic in Copenhagen. This has only changed very slightly over the period.

The concentration is a little higher for passengers than for operations indicating that those who are not travelling at the main destinations are offered a little – very little – better service relative to the number of passengers than those travelling to the main destinations. However, the number of operations are often very low, less than once a week for instance at many charter destinations.

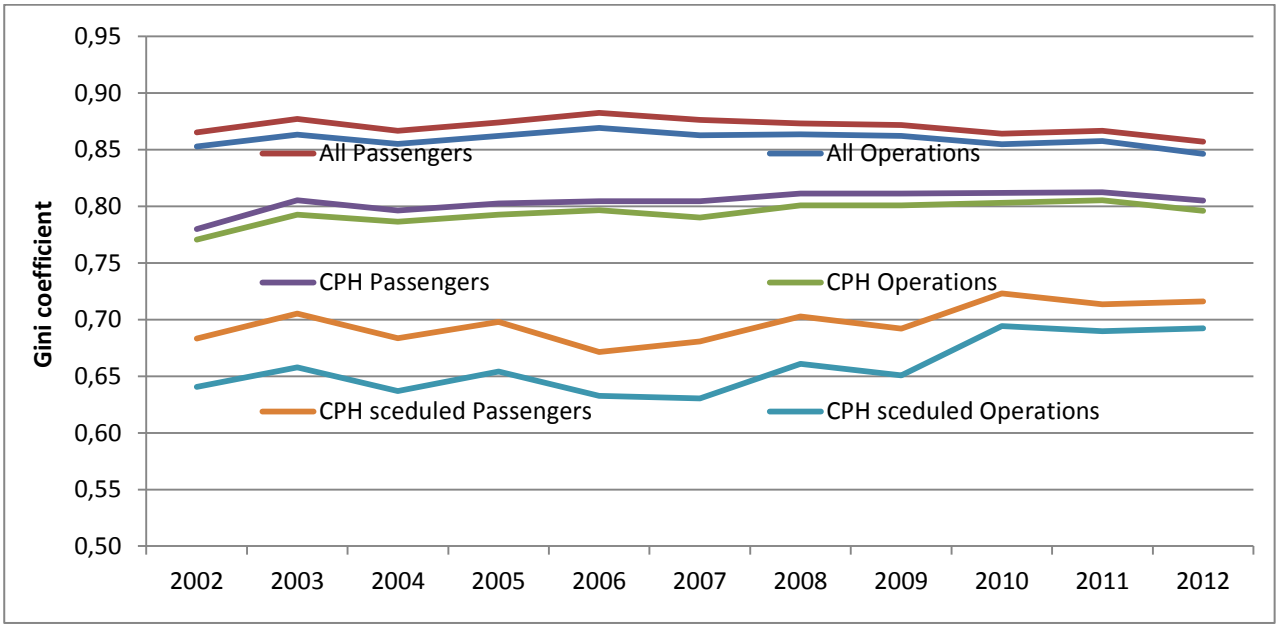

Figure 12 The Gini coefficient for passengers and operations at all city pairs. The Coefficient is shown for all international travel and for Copenhagen alone. For Copenhagen it is also shown for scheduled traffic alone. Source: The Airport database

For the scheduled international traffic from Copenhagen the concentration is less and there is more difference between the Gini coefficients for passengers and for operations. Since 2007 the concentration of the scheduled traffic has increased and the number of operations has got closer to the number of passengers. This is result of less operations per city pair in mean and indicates that extra service is cut away to increase the efficiency of the travel network.

Passengers per flight

The number of passengers per flight has increased during the years. Figure 13 which shows results for direct flights from Denmark illustrates how the number of passengers per flight is higher the longer distance. Only for the long haul the number of passengers per flight is not increasing. For the United States it even seems to decrease a little.

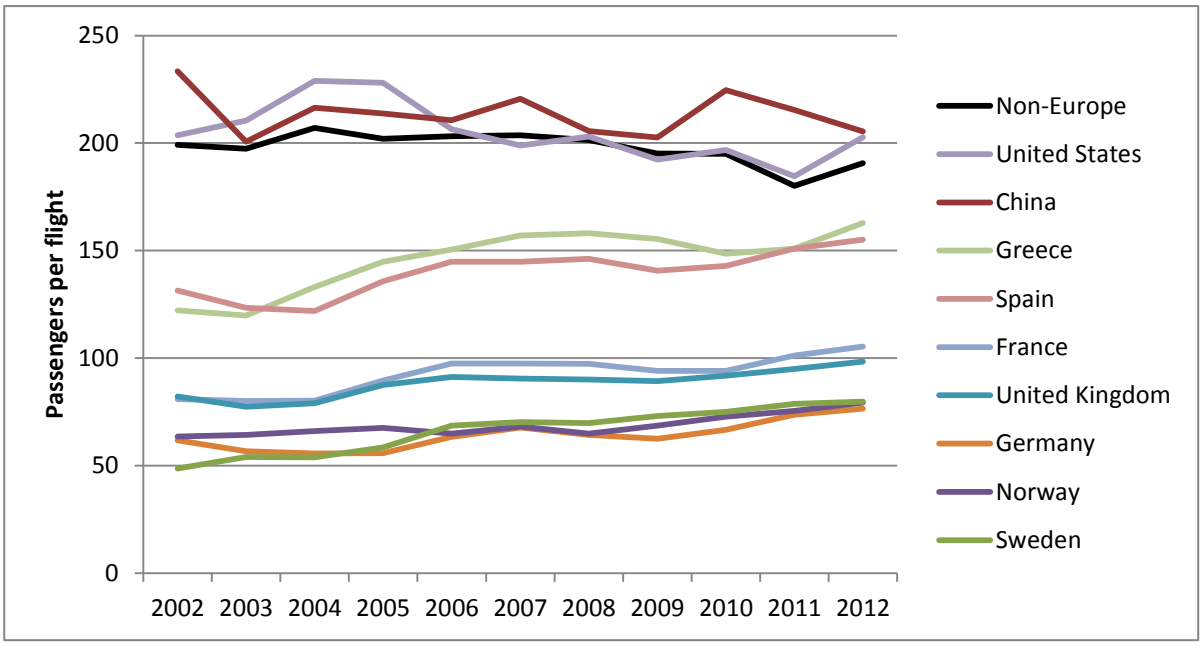

Figure 13 The development in the number of passengers per flight for some countries. Both scheduled and charter traffic is included. Only direct flights from/to Denmark. Source: The Airport database.

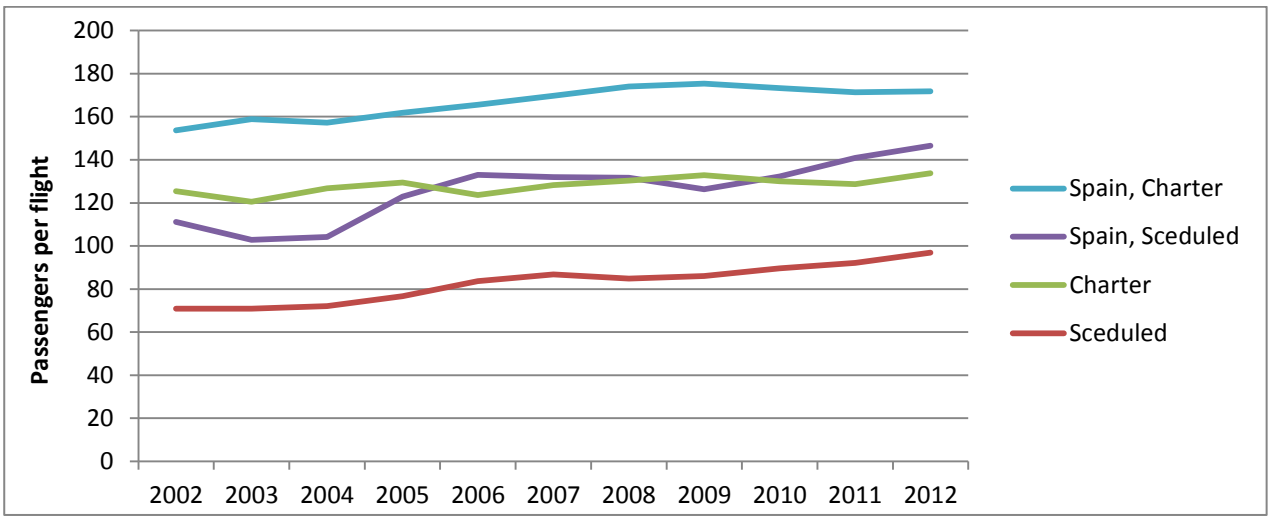

Figure 14 The development in the number of passengers per flight for scheduled and charter traffic. Only direct flights from/to Denmark. Source: The Airport database.

The number of passengers per flight is much higher on charter travels than on scheduled flights (Figure 14) even when distance is taken into consideration. Finally, the number is higher to the main destination in a country than to the rest of the country (not shown).

Competition and prices

In this chapter is illustrated the importance of competition for prices and number of travellers in the international air traffic from Denmark. Both the existence of Low Cost Carriers (LCC) and the number of competing airlines illustrated by the Hirchman-Herfindahl Index (HHI) are considered.

The effect of Low Cost Carriers

The general knowledge is that prices have fallen during the period since 2002 first of all due to development in Low Cost Carriers. Figure 15 confirms this. The prices of the LCC are at both the European

and the non-European market lower for the LCC than for other airlines. The differences are much bigger at the Non-European market than at the European. The effect according to Figure 17 is a much faster increase in number of passengers for the LCC at the Non-European market than at the European.

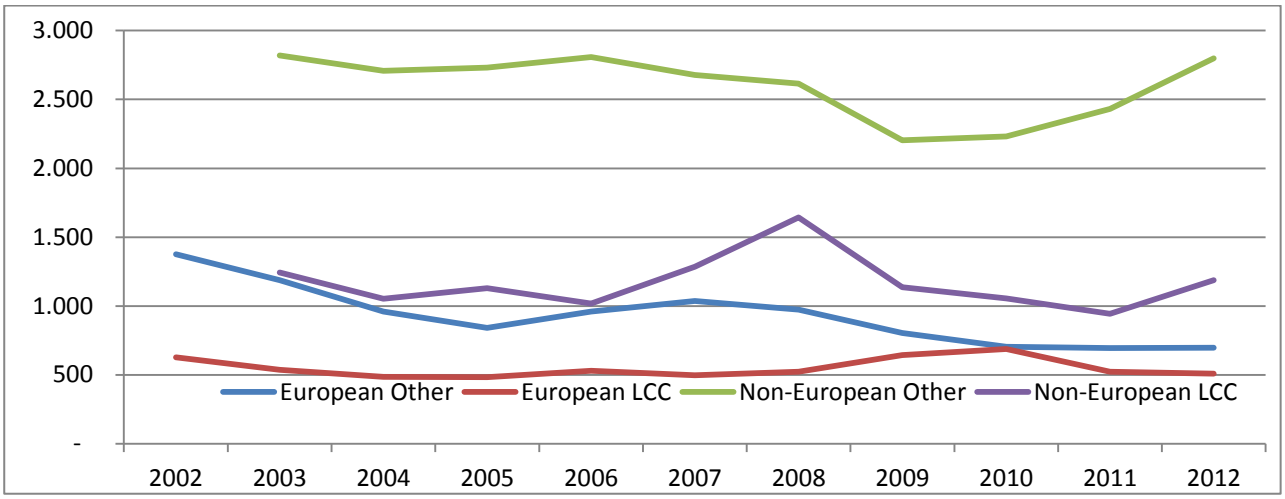

Figure 15 Development in prices for Low Cost Carriers and other airlines at European and Non-European destinations. Source: Sabre database, scheduled connections

At the European market the prices fall 30% up till 2005 for other airlines than the LCC. Afterwards it increased up till 2007 but fall again in 2008-10 when it stabilised at a level 40% under the 2003 level. 2007 was a year with maximum passengers especially for Danish travellers (refer to Figure 2 and Figure 3). It was furthermore a period with increasing incomes in Denmark (refer to Figure 16). As a reaction to the crises from 2008 the prices for other airlines than LCC decreased.

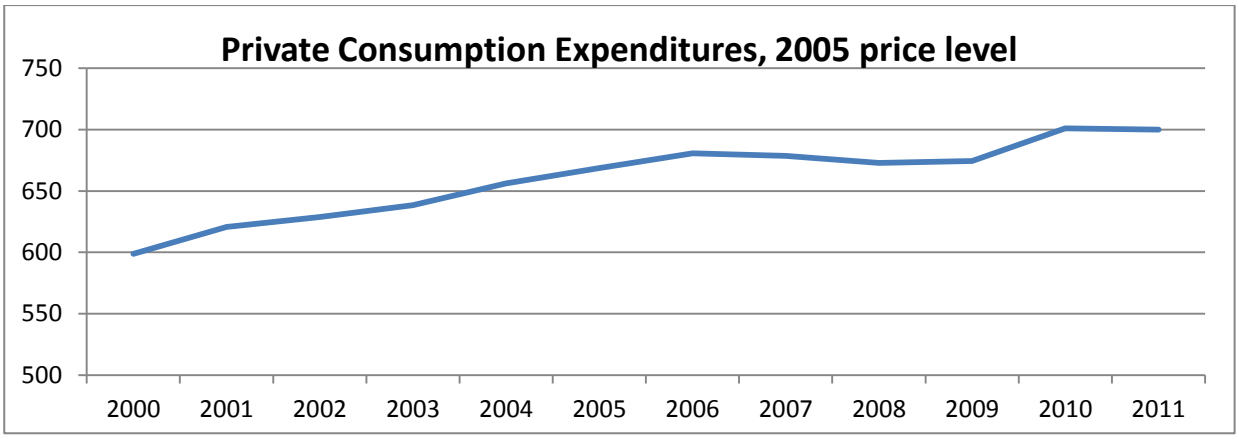

Figure 16 Development in Private Consumption Expenditures in 2005 fixed Price Level. Source: Danmarks Statistik: Statistikbanken

For the Low Cost Carriers the prices were stable until 2009 at the European market. It increased in 2009 and 2010 but fall back at the former level in 2011. The two years 2009-10 are specially influenced by the cease of Sterling by the end of 2008 and the changes in prices might not necessarily be a reaction to the crises.

At the non-European market prices were more or less stable for other airlines up to 2008. In 2009 and 2010 they fall, but are back again at the former level in 2012. For the LCC the prices fluctuate more and are especially high in 2008. However, destinations with LCC service are few so prices might very well be influenced much by the combination of airlines and destinations.

Figure 17 show the changes in passengers for the same 4 groups. For other airlines than the LCC the number of passengers increased up to 2005. However when the prices at the European market increased the number of passengers stabilised. Not until 2011 the number of passengers increased again (bear in mind that the passenger level is too low in 2011 so the increase might have happened already in 2011). For the LCC the number of passengers increased over whole the period except for the European market in 2008-10.

For 2008-10 the number of European passengers is influenced by the cease of Sterling. However, from 2011 the number of passengers increases again. The disappearance of Sterling in 2008 might very well be an explanation for the constant number of passengers by other airlines after the crisis. They clearly took the advantage of the cease of Sterling in the two years resulting in less LCC destinations and higher prices.

For the Non-European market the number of passengers increased over whole the period even though the prices did not change must. The pace of increase was reduced in 2005-2008 and the number of passengers was stable in 2008-10. For the Non-European market the increase in number of LCC passengers is much faster than at the European market but the development did not start until 2006. A good explanation of this is that the gap between the prices at the European market is much smaller than at the Non-European.

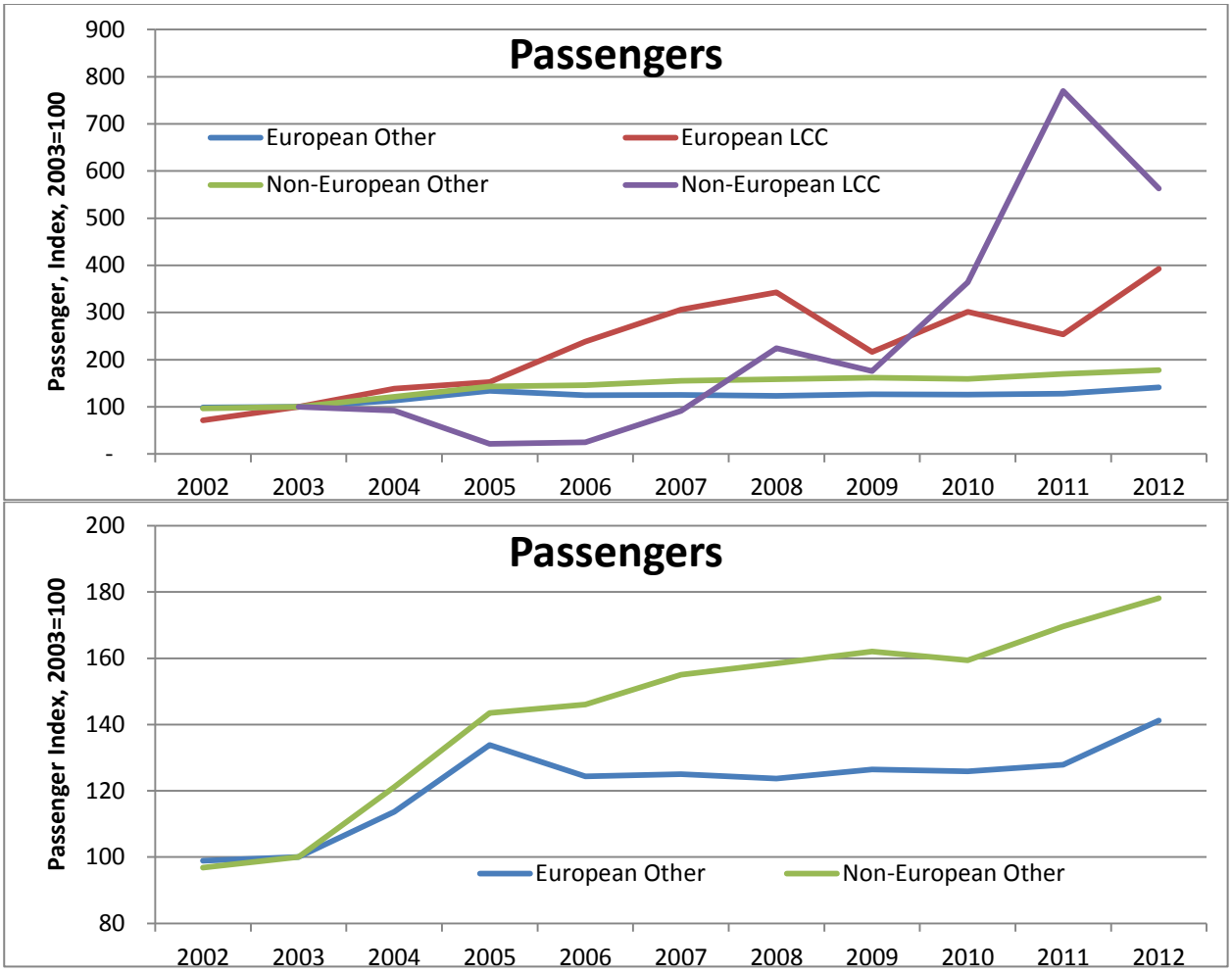

Figure 17 Development in passengers for Low Cost Carriers and other airlines at European and Non-European destinations. Index with 2003=100. Source: Sabre database

The effect of competing airlines

However, not only the existence of LCC influences prices and number of passengers. The number of competing airlines on a connection might also have an effect. The competition is normally analysed by the

Hirchman-Herfindahl Index (HHI). For a certain connection HHI is calculated as the sum of the square of the shares each of the airlines represent at the connection. If an airline is alone on a connection HHI is 1. The more completion the smaller HHI is. The share of the biggest airline is of more importance for HHI than the number and distribution of the rest of airlines. For instance if two airlines share a connection evenly HHI is 0.5, but if the distribution is 0.8 / 0.2 HHI is 0.68. With 3 airlines sharing 0.8 / 0.1 / 0.1 HHI is 0.60. If three airlines share evenly HHI is 0.333.

HHI is often used as an indicator for the number of passengers. Therefore it is preferred to calculate it based on number of connecting operations during for instance a moth. However, this information is not available for this project except for direct connections. Instead HHI is calculated based on number of passengers during a month. HHI for a country or other groups are calculated as a weighted mean of the connections in the group eighted by number of passengers.

For travels between pairs of airports not only direct connections are considered all travels are included. If a city is served by several airports (the case for London and Paris and several other big cities) it is assumed that the airlines to all the airports serving the city compete so HHI as calculated based on the number of passengers to all the airports. Finally it is assumed that two airlines in an alliance are not competing. They are often flying co-sharing which means that passengers who book at one airline in an alliance very well can fly by an airplane operated by another airline in the alliance. By this cooperation the airlines offer their customers more daily connections with the lowest number of flight operations and they do not need to fly parallel in peak periods. In practise some airlines in an alliance still compete especially in the beginning of an entrance of a new airline to an alliance. Because it is unknown in which situations airlines compete it is assumed that they always cooperate fully if they are in the same alliance.

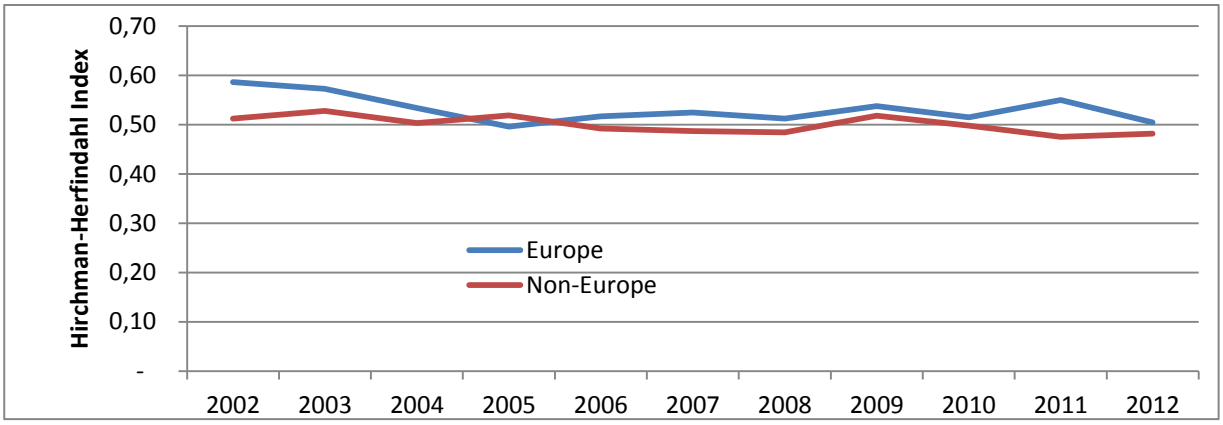

Figure 18 The development in the mean HHI for European and Non-European scheduled connections from Copenhagen. Source: Sabre data.

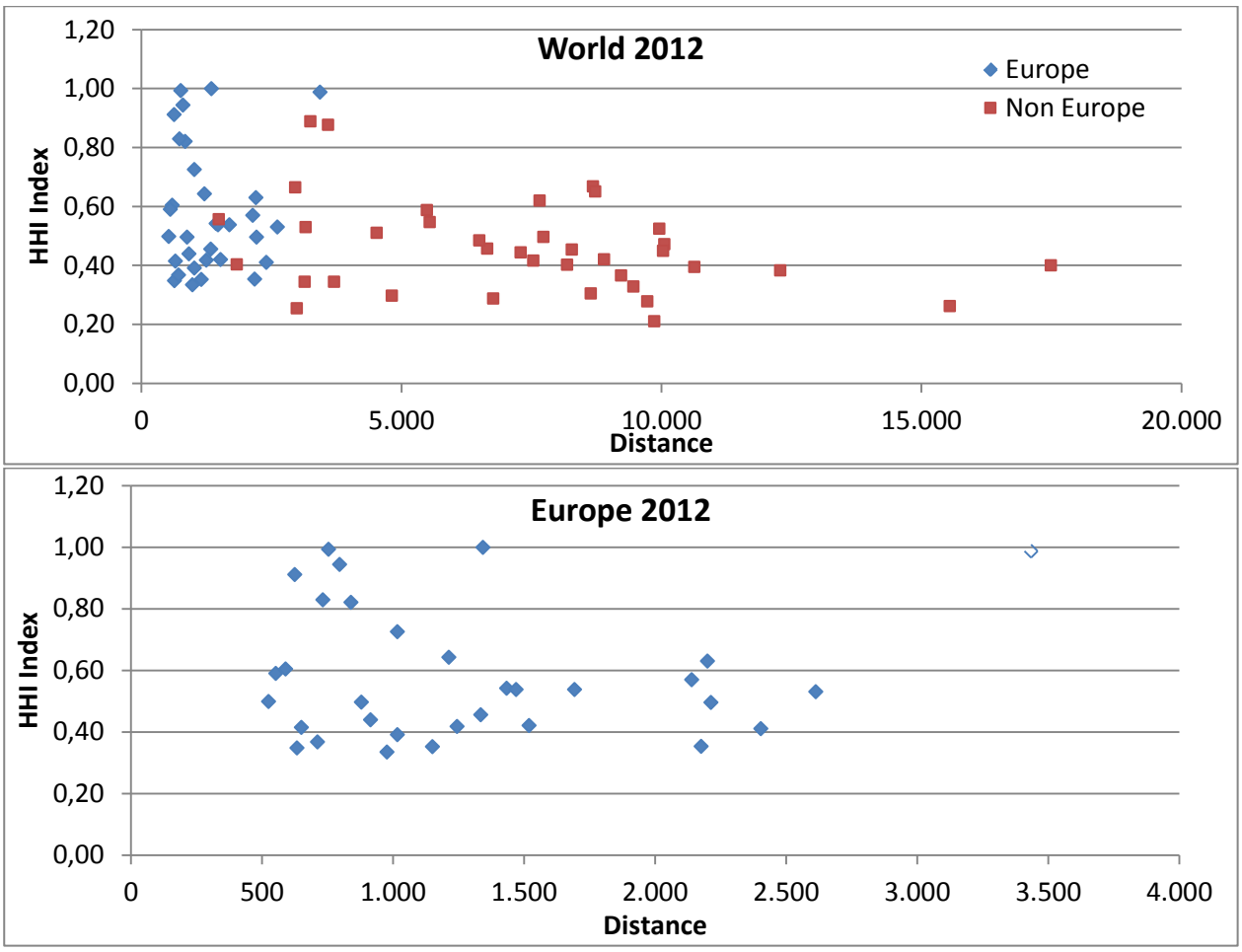

Figure 19 The HHI per country dependent on the mean distance to the country from Copenhagen. Source: Sabre data and own calculations

Figure 18 shows that the competition measured by HHI is a little higher for Non-European connections than for European. Furthermore, it shows that the competition has increased a little for the European connections from 2002 to 2005. After 2005 only small fluctuations are observed. For Non-European connections the competition has only increased marginally if at all.

Figure 19 shows a tendency to a higher competition with longer distances. This is a natural consequence of offering the longer distances more alternative routes to choose to the final destination. However, the variation is very high at both European and Non-European connections.

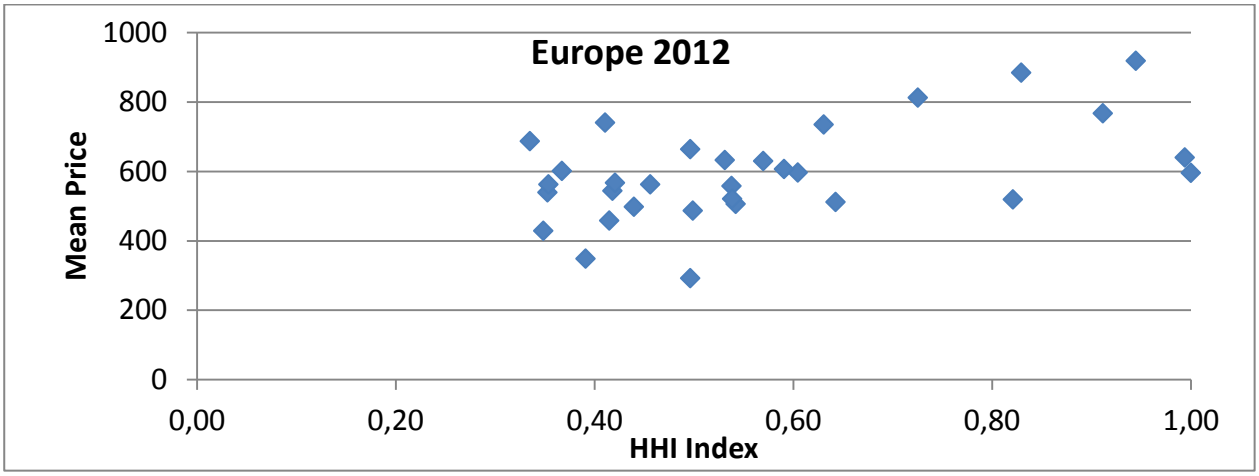

Figure 20 The mean price per country dependent on the mean HHI for the country. Source: Sabre data

According to Figure 20 prices are as expected higher the less competition. The variation is however very big indicating that other factors are of more importance. One of these factors is as discussed above existence of a LCC airline at the connection. Other factors could be distance to the destination and the size of the market.

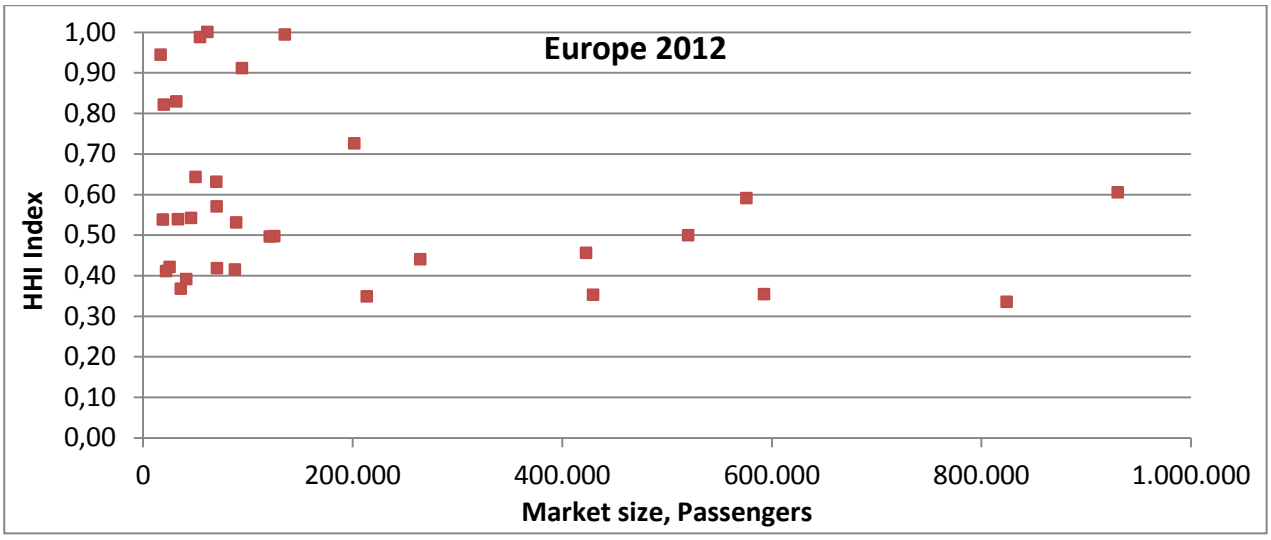

Figure 21 Mean HHI index for countries dependent on the market size of the country. Source: Sabre data

Figure 21 shows that HHI is lower with a bigger market. The figure is shown at country level. At city level the tendency is still more clear. However, several big markets even with more than 100,000 passengers have a HHI index close to 1. Cities with most competition have a HHI index only little over 0.2.

It should furthermore be expected that prices increase by distance to the destination because fuel consumption as well as time use by airplane and crew increase by distance. The relation is clear according to Figure 22 at the long haul to non-European countries but inside Europe the relation is close to non-existing at least when calculated at country level.

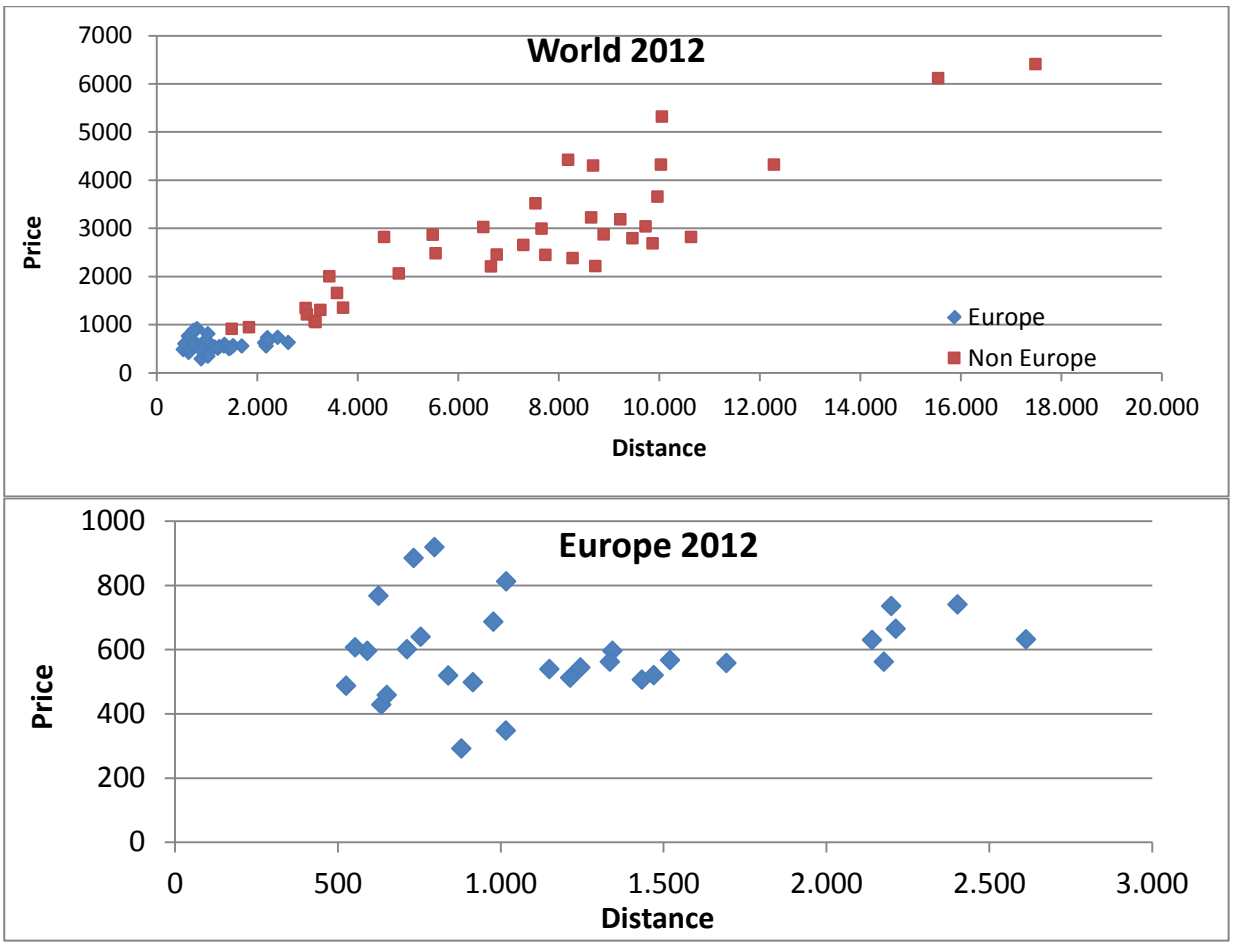

Figure 22 The mean price of tickets to a country dependent on the mean distance to the country from Copenhagen. Source: Sabre data, Own calculations of distances based on Transtools and several home pages.

The Demand for International Air Travel from Denmark

The object of this chapter is to examine the demand for international air travel by Danish residents. A major problem in estimating the demand for air travel has for many years been lack of suitable data.

The Sabre data

As we are only interested in the travel of Danish residents, we limit the analysis to tickets purchased in Denmark, which we assume to be purchased predominantly by Danes. In addition, we are only concerned with travels originating or terminating in Denmark, which may or may not include connecting flights. Because of inconsistencies in the data, which are discussed elsewhere, flights originating and terminating in Denmark are taken together.

Although the data are on the individual airport level, the airports are aggregated to the country or country group level to increase the number of observations in each group. This is necessary as individual fares can vary substantially. This aggregation results in 66 country groups. The most popular country destinations are taken separately (most European countries, the US, Japan, Brazil etc.) while others are combined in larger area groups containing a number of countries (e.g. Africa other than Egypt is divided into North, South, West, East and Central).

The Sabre data are available on a monthly level for the years 2002 to 2012. In the analysis, the monthly data are aggregated by year, again to increase the number of observations and the accuracy of the fare data. Using annual data also removes the seasonality in the data, which simplifies the modelling. Because of errors in the 2011 data, 2011-12 is omitted so that the analysis is limited to the 9 years, 2002 to 2010.

As mentioned elsewhere charter travels are not in the Sabre Database. Furthermore, it is not possible for the traveller to separate air travel costs from the rest of the price of the travel package. Charter travels are included from the Airport Database. Because travel prices are needed the average price from Sabre for low cost and discount coach to the actual destination is used.

The initial intention was to analyse the individual cabin classes separately. The reason for this was to examine differences between business and leisure travel. However, there appeared to be inconsistencies in the cabin-class data and the estimates obtained were questionable. In addition, it was noted that there is not necessarily a correspondence between cabin class and travel purpose and that information on travel purpose was required. It was thus decided to aggregate all cabin classes together.

The determinants of air travel

The model defines air travel on a per-capita basis as the number of passengers for each o/d pair and year divided by the Danish population for that year. As illustrated in many empirical studies, the main determinants of air travel are air fares and income. We would expect air travel in general, and to a given destination, to increase with increasing income and to decline with increasing fares. Two measures of income are examined: GDP and Private Consumption Expenditures, both in per-capita terms in agreement with the specification of the dependent variable, passengers per capita. Fares and income variables are expressed in real terms (2005 prices) using the consumer price index.

The choice of destination is determined by a wide-range of factors relating to the characteristics of the individual locations, some of which are exceedingly difficult to quantify. However, given the lack of information on these possible factors and the aggregate nature of the data, only simple measures are employed. These basically have to do with the size of the market: physically, by population, and economically, by GDP per capita. GDP in the destination country is expressed in DKK using current exchange rates. We would expect both measures to have a positive influence on air travel.

Another important economic factor that may affect destination choice by Danish travellers is the relative price of goods and services between Denmark and the destination countries. Relative price is defined as the ratio of consumer prices in the destination country relative to Denmark divided by the exchange rate (destination currency per DKK) and is thus a measure of the overall effects of differences in inflation and exchange rate movements. An increase in this variable implies that the destination country has become more expensive for Danish residents, either because consumer prices have risen more than in Denmark or because the exchange rate has become less advantageous. Air travel by Danes should thus be negatively related to this variable.

Finally, the convenience or inconvenience of air travel to a given destination will also affect destination choice. As measures of this, two variables are used: the average number of connections for flights on the given route and the annual number of direct operations, or flights serving the route. We would expect the number of passengers to be negatively related to the number of connections and positively related to the number of operations.

Econometric model

Since we only have a small number of times-series observations (9 years), we cannot estimate separate models for travel to each country individually. Instead, we pool the time-series observations for all countries, thus forming a panel data set. By combining the data in the estimation procedure, the number of observations (and degrees of freedom) is increased, thus improving the accuracy of the estimated parameters. It also provides more variation in the data, since air travel and fares vary more between countries than over time. The disadvantage of this technique, however, is that it assumes that the demand relationship and the elasticities are the same for travel to all countries.

The model assumes that the long-run equilibrium demand for air travel, in terms of trips per capita, Q^*_{Rt}, by Danes to country (group) *R* in year *t* can be expressed as a function *f* of the real air fare, F_{Rt}, between Denmark and country *R* in DKK, real Danish per capita income, I_{Dt}, GDP per capita and population in country R, G_{Rt} and M_{Rt}, the relative prices in country *R* compared to Denmark, P_{Rt}, the average number of connections between Denmark and destination R, C_{Rt} and the annual number of direct flights or operations between Denmark and destination R, O_{Rt}.:

$$Q^*_{Rt} = f\left(F_{Rt}, I_{Dt}, G_{Rt}, M_{Rt}, P_{Rt}, C_{Rt}, O_{Rt}\right). \quad (1)$$

For the estimation, *f* is specified as a linear function and all variables are in logarithmic form, resulting in a constant elasticity model.

In order to account for lags in the adjustment of demand to changes in the explanatory variables, two different dynamic specifications are estimated: a lagged-dependent variable model and an error-correction model.

Unobserved differences between countries are represented by both Fixed Effects (FE) and Random Effects (RE) specifications. The FE model controls for all time-invariant differences between destinations through country-specific intercepts, so the effects of individual time invariant variables, such as distance, cannot be analysed, while the RE model does not have this limitation.

Estimation results

The models described above are estimated from the pooled time-series cross-section data for air travel between Denmark and the 66 countries for the time period 2002 to 2010. Models are estimated including all countries together and separately for European countries (36 countries or country groups) and non-European countries (30 countries or country groups). The models are estimated using Generalised Least Squares procedures using cross-section weights to account for possible heteroscedasticity. Generalised Method of Moments (GMM) estimation is also used for the lagged-dependent variable model to account for autocorrelation.

Firstly, in all cases, statistical tests (Hausman) reject the RE model in favour of the FE model. The general trends of the estimated elasticities are largely comparable using the lagged dependent variable and error-correction models, although they are less-well determined with the error-correction model. This is likely due to the greater number of parameters to be estimated in the error-correction model (15 compared to 8, excluding fixed-effects). For this reason, we report only the results for the Fixed Effects lagged dependent variable model.

As mentioned earlier, two income variables were used for Denmark: GDP and Private Consumption Expenditures. It is not possible to choose between the two on either theoretical or statistical grounds. The major difference between the estimates using the two variables is that the income elasticity using GDP is slightly greater than that using Consumption (by about 10%), as is the fare elasticity (by about 50%). Although the two income variables are highly correlated, GDP has increased by only 4% over the period while Consumption has increased by 11%, so it's not surprising that estimated income elasticity is greater using the GDP variable. For both income variables, the income elasticity is rather greater than expected (2.0 or greater in the long run), but this is not surprising given the considerable increase in air travel over the period, with per capita journeys increasing by 60% over the 9 years. With the exception of the fare and income elasticities, the estimated elasticities do not differ substantially using the different income variables. In the tables and discussion that follow, Danish income is defined as Private Consumption Expenditures.

Table 1 Estimation Results for International Air Travel by Danish Residents. Fixed-Effects Lagged Dependent Variable Model. Danish Income defined as Private Consumption Expenditures.

	All Destinations		European Destinations		Non-European Destinations	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
Passengers pc (t-1)	0.26	0	0.20	0	0.30	0
Fare	-0.22	0	-0.20	0	-0.23	0
Income pc Denmark	1.48	0	1.67	0	1.31	0
GDP pc destination	*0.05*	*0.27*	0.24	0.05	*-0.01*	*0.90*
Population destination	0.46	0	*0.62*	*0.17*	0.48	0
Relative Prices	-0.14	0.06	*-0.26*	*0.18*	-0.15	0.09
Connections	-0.33	0	-0.32	0	-0.40	0
Direct operations	0.03	0	*0.04*	*0.15*	0.02	0.01
Number of destinations	66		30		36	
Adjusted R-squared	0.996		0.995		0.995	
F-statistic	1901	P=0	1125	P=0	443	P=0
Observations	528		240		288	

The estimated coefficients (apart from the fixed effects) and related statistics for the lagged dependent variable model with fixed effects and Danish income defined as Private Consumption Expenditures are shown in Table 1. The results for all destinations are reported first, followed by those for Europe and non-Europe separately. The estimated parameters are generally of the expected signs, and most are highly significant. The coefficient of the lagged dependent variable is positive and of a reasonable order of magnitude, which suggests a rapid rate of adjustment (70% to 80% of total adjustment occurs within one year). Fares have a negative impact on demand and Danish income a positive effect, both highly significant. Regarding the characteristics of the destinations, per capita GDP is significantly positive only for the European countries, while population is significantly positive for non-European countries. The coefficients of relative prices are negative, as expected (if prices in a destination country increase relative to those in the Denmark, or the exchange rate becomes less advantageous, the country becomes more expensive and travel to that country decreases). The number of connections has a negative and highly significant effect, while the number of direct operations (flights) has a small positive effect, which is significant for non-European destinations. Demand increases on a given route when the number of needed connections decreases and increases a little when the number of direct flights increases.

Finally, as shown in the statistics at the bottom of the table, the model explains the data very well, although the high R-square is to be expected in a model containing a lagged dependent variable.

The resulting short- and long-run elasticities are shown in Table 2. The overall fare elasticity is -0.22 in the short run and -0.29 in the long run. European destinations appear to be slightly less price-sensitive than non-European destinations. The long-run income elasticities are above unity, suggesting air travel to be a luxury good. In all cases, the long-run elasticity is in the region of 2.0, a comparatively high value. For both European and non-European destinations the income elasticities are of a similar order of magnitude, being marginally greater for European destinations. This is contrary to expectations as one would expect non-European travel to be more of a luxury than European travel and thus be more income elastic.

Of the remaining variables, population at the destination, relative prices and the number of connections have a greater impact on air travel demand than do the remaining variables. Finally, the dynamic structure indicates that the long-run elasticity is about 40% higher than the short-run elasticities and that adjustment occurs relatively rapidly.

Table 2 Estimated short- and long-run elasticities for International Air Travel by Danish Residents. Fixed-Effects Lagged Dependent Variable Model. Danish Income defined as Private Consumption Expenditures.

	All Destinations		European Destinations		Non-European Destinations	
	Short run	Long run	Short run	Long run	Short run	Long run
Fare	-0.22	-0.29	-0.20	-0.25	-0.23	-0.33
Income pc Denmark	1.48	2.00	1.67	2.09	1.31	1.86
GDP pc destination	*0.05*	*0.07*	0.24	0.30	*-0.01*	*-0.01*
Population destination	0.46	0.62	*0.62*	*0.77*	0.48	0.68
Relative Prices	-0.14	-0.19	*-0.26*	*-0.33*	-0.15	-0.22
Connections	-0.33	-0.45	-0.32	-0.41	-0.40	-0.57
Direct operations	0.03	0.04	*0.04*	*0.05*	0.02	0.03

Conclusion

Based on the analyses it can be concluded that the overall person kilometres made by Danes as air traffic has increased 80% over ten years making an increase rate of 7,2% per year in mean. It should be mentioned that person kilometres by car at international travels has increased too resulting in an increase in the environmental burden which is several times higher than the increase in national travels in the same period. The increase in Dane's air travel is due to a 73% increase in European travels, 104% increase in non-European travels and an 8% increase in the mean travel distance due to the changed composition of travel destinations. The increase in the mean distances has happened even though the mean distance has decreased both inside Europe and at overseas destinations.

The destinations for the long distance travels are rather stable with Spain and Great Britain as the two most important destination countries representing around 22% of the travels. The typical business air travel destinations Germany and Norway has increased in importance and Sweden has decreased as an air destination due to the Oresund Bridge. For the overseas travels Egypt and United States have increased in importance. Charter travel still plays a role to the Mediterranean countries for which Turkey has taken over some of the attraction from Greece. The 19 most important destination countries represent just around 80% of the travel market in 2002 as well as in 2012.

The efficiency of the network of air traffic out of Denmark has increased with more passengers per flight, except for the long-haul flights. The number of destinations has increased, but with less operations per destination. Concentration in the scheduled network from Copenhagen has increased since 2007 offering less daily or weekly departures to small destinations. This has resulted in a slight concentration of passengers.

The competition measured by number of airlines and their market share has increased very little, for non-Europe 6%, for Europe less and only up to 2005. The number of passengers by Low Cost Carriers has increased 300% for Europe and 600% for non-European destinations. The increase in Low Cost destinations has resulted in decreasing prices for other airlines for European destinations for which the mean price today is close to Low Cost prices. For non-European destinations development in low cost has not yet affected the prices of the flag carriers.

A model analysis shows that air travel first of all is affected by increasing income for which the long run elasticity is 2.0 (little higher for Europe than non-Europe). Prices are not quite as important for the increasing number of travels, the fare elasticity for Europe is -0.25 and for non-Europe -0.33.