IMPACT OF AIRLINE BUSINESS MODELS, MARKET SEGMENTS AND GEOGRAPHICAL REGIONS ON AIRCRAFT CABIN CONFIGURATIONS

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ABSTRACT

Besides the significance of estimating aircraft seat capacity for airline operating cost and yield estimation as well as for the conceptual design of aircraft, airline fleet planning requires an understanding of aircraft cabin configuration. This paper presents the impact of airline business models, market segments in terms of flight distances, and geographical regions on aircraft cabin configuration, i.e. aircraft seat capacities and installed seats per cabin class. Using the historical databases of global low-cost carriers and airline flight schedules between 2000 and 2016, two ABM clusters – full-service network carriers (FSNCs) and low-cost carriers (LCCs) - were developed, while using seven already-developed passenger-aircraft clusters. Focusing on the jet commuter (JC), narrow-body (NB) and long-range (LR) aircraft clusters, studies were conducted on the historical development of aircraft cluster seat capacities at different abstraction levels: global, airline business model, intra- and inter-regional flight distances, as well as a combination of ABM and (inter)regional flights. Selected results were further analysed using statistical tests on the mean and regression analysis. The analysis results show that LCCs use aircraft that have less average scheduled and less average maximum possible seats than FSNCs. Specifically, FSNCs use significantly bigger aircraft types in LR cluster than LCCs, while LCCs use significantly bigger aircraft types in JC cluster than FSNCs. Furthermore, average cabin utilisation of aircraft clusters scheduled by LCCs are significantly higher than average cabin utilisation scheduled by FSNCs. With increasing distance, average cabin utilisation also significantly reduces.

KEYWORDS

Aircraft seat capacity, airline business model, aircraft cabin utilisation

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1. MOTIVATION

Over the past few decades, novel airline business models (ABMs) have been introduced to the air transport market in addition to that of the traditional full-service network carriers. One example is the low-cost business model on short-to-medium haul markets introduced by Southwest Airlines in 1971 in the US and later adopted in 1991 by Ryanair within Europe. In addition, long-haul low-cost carriers such as AirAsia X, Jetstar Airways and Norwegian Air Shuttle have recently increased their market share (Leigh Fisher, 2015), although similar services were offered mainly on the transatlantic routes by Icelandic Airlines in the 1960s and 1970s and then by Laker Airways. Other than business models targeting price-sensitive markets through cost leadership and the full-service network carrier business model, airline variations and specialisations currently exist.

A cluster analysis of selected low-cost and full-service network carriers resulted in seven clusters which further subdivide the two established ABMs: a point-to-point low-cost carrier, a hub-and-spoke low-cost carrier, a global hybrid carrier, a medium size network carrier, a global niche market network carrier, a high-quality network carrier and a large size network carrier (Klemm, 2015). Other studies have applied the cluster analysis methodology to specific markets (Heinz & O'Connell, 2013). For example, (Heinz and O’Connell, 2013) named the following airline clusters: full-service network carriers, established regional carriers, long-haul niche carriers, true low-cost carriers, emerging regional/low-cost carriers, emerging full-service network carriers, and small full-service carriers. It can be concluded that the two established ABMs, the low-cost carrier (LCC) and the full-service network carrier (FSNC), constitute a foundation on which more specific business model variations can be based. The former charter carrier business model has shifted towards the low-cost model (Bieger & Wittmer, 2006) which is why earlier studies considered it to a certain extent by analysing the low-cost carrier business model.

Nevertheless, irrespective of the business model chosen by an airline, the common unit of airline capacity is the available seat kilometre (ASK) or the available seat mile (ASM) and the available tonne kilometre (ATK) or the available tonne mile (ATM). Therefore, an evaluation of how aircraft cabins are configured is significant for many aspects of the aviation system, including airline operating cost and yield estimation, aircraft conceptual design and airline fleet planning.

1.1 Motivation for Airline Operating Cost and Yield Estimation

The offered products by an airline can be categorised into ground and on-board services, the latter mainly depending on the aircraft cabin with its installed cabin classes, offered seat configurations and other services such as infotainment, food and beverages. The main cabin classes were traditionally first class (F), business class (C) and economy class (Y), however, premium economy class (PY) has increasingly gained attention amongst both LCCs and FSNCs. The number of cabin classes, seats per cabin class and total installed seats offered by each ABM are essential for operating cost and yield estimations.

1.2 Motivation for Aircraft Conceptual Design

In the aircraft conceptual design phase, one of the first aircraft design parameters that needs to be fixed, is the design payload at the design range (Raymer, 1992). For a later refinement during the preliminary aircraft design phase, the number of cabin classes and number of installed seats per cabin class are essential information required for defining the fuselage cross-section and the overall length. Therefore, additional cabin information about design seat widths, seat pitches and additional cabin monuments (Nita & Scholz, 2010) is necessary. These vary with airline business models as well as for regional, short-haul and long-haul operations.

1.3 Motivation for Future Fleet Planning

To determine the future fleet needs of an airline, fleet planners consider the occupancy level (seat and freight load factors) as well as the level of competition on the markets they serve. Thus, with increasing competition in a certain market and airport capacity constraints, an airline would choose to increase the installed seats on its aircraft to retain its market share or claim a higher market share (Berster, Gelhausen, & Wilken, 2015). This will also occur when checking the break-even load factor of the planned aircraft (Clark, 2007).

Furthermore, a proper description of the installed seats and cargo weights of the modelled aircraft types is necessary for longer-term fleet planning and the evaluation of global emissions by airlines (IPCC, 1999). Therefore, this study evaluates the factors affecting aircraft cabin configuration (mainly installed seats, but also seats per cabin class as well as the level of cabin utilisation) and the impact of these factors by the use of empirical data.

2. REVIEW OF EXISTING STUDIES

The most common passenger metrics, fuel burn per seat-kilometre and range, used in aircraft performance evaluation are dependent on the aircraft payload configuration, i.e. the seat to cargo weight ratios (IPCC, 1999). According to IPCC (1999), this configuration varies among airlines and is dependent on market considerations.

Kownatzki (2011) also identified airline business models as a main reason for differences in the number of installed seats and configurations of the same aircraft type. Other factors identified as affecting the number of seats and seat class mix are geographic considerations, competition level, flight timing, and target customers. Airlines thus adopt both high and low-end options, depending on the market segment, flight timing and the target customers.

Airline business models differ in several characteristics. One of the most significant characteristics is the number of installed seats since it affects the unit costs for an airline (Doganis, 2002). The seat density in the fleets of low-cost carriers (LCCs) is about 15-20% higher (Stimac, Vince, & Vidovic, 2012) giving them an operational advantage compared with full-service network carriers (FSNCs) (Vidović, Štimac, & Vince, 2013). Miyoshi and Mason (2009) confirmed this in their analysis on the carbon emissions of different airlines and aircraft types. For the European short-haul market, they identified significant differences in the carbon emissions per passenger kilometre between FSNCs and LCCs and concluded that the latter achieved lower carbon emissions due to an operation of new aircraft types, exceedingly high load factors, and a high seat density (Miyoshi & Mason, 2009).

Besides the lower carbon emissions per passenger kilometre, a higher seat density provides a cost advantage for the operating airline (Gillen & Gados, 2008). Thus, airlines with a cost-leadership strategy, i.e. LCCs, addressing a price-sensitive target group of passengers operate their aircraft with more seats compared to airlines with other business models.

Market size as well as route distance have a positive effect on the size of an aircraft operated by the airline, which leads to the conclusion that the number of seats increases with an increase in the route distance (Givoni & Rietveld, 2009). Pai (2010) also identified a positive correlation between route distance and aircraft size, arguing that larger aircraft are needed as the distance between two endpoints increases. However, the study only investigated the US airline industry, focusing on determinants for aircraft size and frequency of flights such as market demographics, airport characteristics, airline characteristics, and route characteristics (Pai, 2010).

Although, Givoni and Rietveld (2010) confirmed the general behaviour of airlines in preferring small aircraft and high frequency to larger aircraft and lower frequency on short haul routes, they also highlighted the likelihood of full-service network carriers opting for higher seat densities on their large aircraft when operating them on short-haul hub-to-hub routes. They argued that this occurs due to the low demand for first-class seats on such routes. One example supporting this concept is that of British Airways, where the B767 aircraft fleet in 2016 had more installed seats (259) on its UK domestic routes than on its European routes (244 seats) and its long-haul routes (189 seats) (British Airways, 2016). In addition, to compensate for an increase in seats, a corresponding reduction in belly-freight carried on short to medium haul routes is observed. The changes in seat to cargo weight ratios over changing distances underscores the importance of air cargo in long haul airline operations compared to short haul operations (IPCC, 1999).

With respect to longer term fleet planning, the IPCC reported a 1% per year growth in aircraft size as the current trend (IPCC, 1999). However, this value could be misleading when used for all aircraft types irrespective of the seating capacity. It is equally important to identify the latest value of this variable nearly two decades after it was first determined.

Thus, although these studies have identified that airline business models and route characteristics determine aircraft seat capacities, their area of study was not based on flight connections within and between all world regions. Furthermore, they do not focus on LCCs from across the globe or on an overall majority of the global aircraft fleet.

Two databases are used in this research work. Information on aircraft cabin configurations is obtained from historical databases of scheduled aircraft flights, while airlines are categorised into two main groups - FSNCs and LCCs - by use of a carrier type database. Airlines not belonging to the LCC classification are considered as FSNCs. Although other ABM clusters exist as earlier explained, as there is no comprehensive global database of airlines belonging to these clusters, a simplification in which all airlines are classified into two ABM clusters is adopted.

2.1 Historical Database of Scheduled Aircraft Flights

To evaluate the historical development of scheduled aircraft cabin configurations, the Official Airline Guide (OAG) database is used covering information on scheduled flights for years 2000, 2004, 2008, 2012, 2014 and 2016 (OAG, 2000, 2004, 2008, 2012, 2014, 2016). The database was cleaned up by excluding code-share flights, surface transport trips, multi-stop flights and non-aircraft trips.

In selecting the aircraft to be investigated, the aircraft clustering methodology adopted by Randt (2016) was used. Randt developed this methodology for use in longer-term fleet planning studies (Randt, 2016; Randt, Jessberger, & Ploetner, 2015). In this methodology, the OAG database of 2008 (OAG, 2008) was analysed, then passenger aircraft types listed in the database with a minimum individual share of 0.1% ASK in the global provision of ASKs were selected. Similarly, freighter aircraft with a minimum individual share of 0.1% ATKs in the global provision of ATKs were selected. In total, 86 aircraft types were selected that contributed roughly 98% ASK and ATK of the global ASK and ATK in 2008. Furthermore, using a k-medoids-based clustering tool, the aircraft types were clustered based on available seat and freight capacity, available overall payload capacity, average flight distance flown, and type of propulsion. This resulted in seven clusters of passenger aircraft and two clusters of cargo aircraft. As this study is focussed on aircraft seats, the two clusters of cargo aircraft are excluded. The selected clusters and constituent aircraft types are shown in Table 1. Based on the OAG database, the selected aircraft types provided 87% and 86% of the total globally planned available seat-kilometres (ASK) in 2000 and 2016 respectively.

Also, based on the OAG classification of world regions, seven main regions were identified, these are: North America (NA1), Europe (EU1, EU2), Latin America (LA1, LA2, LA3, LA4), Africa (AF1, AF2, AF3, AF4), Middle East (ME1), Asia (AS1, AS2, AS3, AS4) and South West (SW1) (Giarratani, Hewings, & McCann, 2013). The South West region was merged into the Asian region. This is because, unlike the Middle East region, it is more of a destination region than a global aviation intersection. This results in six geographical regions. When considering single-leg flights within the regions as well as between region pairs, 21 route groups result. Thus, the classification of all flights globally into route groups used by Randt (2016) was adopted. This is shown in Figure 1. This classification is used in the definition of regions and route groups1, as later used in this study.

Figure 1. 21 Route groups evaluated, based on Randt (2016)

2.2 Historical Database of Low-Cost Carriers

For the evaluation of the historical operation of low-cost carriers (LCCs), a database of LCCs is adopted based on information provided by the International Civil Aviation Organisation (ICAO, 2014). The database was verified to ensure that the IATA codes are correct and further updated for the year 2016 using the ICAO's definition of a low-cost carrier as

"an air carrier that has a relatively low-cost structure in comparison with other comparable carriers and offers low fares and rates. Such an airline may be independent, the division or subsidiary of a major network airline or, in some instances, the ex-charter arm of an airline group" (ICAO, 2013 p.7).

[1] A route group refers to flights within a geographic region or between a pair of regions.

Table 1. Evaluated aircraft clusters and constituent specific aircraft names (Randt, 2016)

Aircraft Cluster Name	Constituent Aircraft OAG-Specific Aircraft Name
Long-range Combi (LRC)	Boeing (Douglas) MD-11 Passenger, Boeing747 (Mixed Configuration), Boeing 747-400 (Mixed Configuration)
Long-range heavy (LRH)	Airbus A380-800 Passenger, Boeing 747 (Passenger), Boeing 747-300/747-100/200 Sud (Pax), Boeing 747-400 (Passenger), Boeing 777-300 Passenger
Jet commuter (JC)	Airbus A318, Avro RJ100, Avro RJ85, Boeing 727 (Freighter), Boeing 737 (Freighter), Boeing 737-200 Passenger, Boeing 737-600 Passenger, Canadair Regional Jet, Canadair Regional Jet 200, Canadair Regional Jet 700, Canadair Regional Jet 900, Embraer 170, Embraer 175, Embraer 190, Embraer RJ 135/140/145, Embraer RJ 145, Fokker 100, Tupolev TU134
Turboprop commuter (TC)	ATR 72
Mid-range (MR)	Airbus A300-600 Passenger, Airbus A310 Passenger, Airbus A330, Airbus A330-300, Boeing 757 (Passenger), Boeing 757-200 (winglets) Passenger, Boeing 757-200 Passenger, Boeing 757-300 Passenger, Boeing 767-300 Passenger, Tupolev TU-204 /tu-214
Long-range (LR)	Airbus A330-200, Airbus A340, Airbus A340-200, Airbus A340-300, Airbus A340-500, Airbus A340-600, Boeing 767-400 Passenger, Boeing 777-200 Passenger, Boeing 777-200LR, Boeing 777-300ER, Ilyushin II-96 Passenger
Narrow-body (NB)	Airbus A318 /319/ 320 /321, Airbus A319, Airbus A320, Airbus A321, Boeing (Douglas) MD-80, Boeing (Douglas) MD-81, Boeing (Douglas) MD-82, Boeing (Douglas) MD-83, Boeing (Douglas) MD-88, Boeing (Douglas) MD-90, Boeing 717-200, Boeing 737 Passenger, Boeing 737-300 Passenger, Boeing 737-400 Passenger, Boeing 737-500 Passenger, Boeing 737-700 (winglets) Passenger, Boeing 737-700 Passenger, Boeing 737-800 Passenger, Boeing 737-900 Passenger, McD- Douglas DC9 30 /40 /50, Tupolev TU154

Table 2. Validation of LCC database

<table>
<tr><th rowspan="2">Year</th><th colspan="2">LCC Global market share</th></tr>
<tr><th>Own values (% difference)</th><th>Published values</th></tr>
<tr><td>1997</td><td rowspan="3">n/a</td><td>6% seats (Airbus, 2008)</td></tr>
<tr><td>1998</td><td rowspan="2">n/a</td></tr>
<tr><td>1999</td></tr>
<tr><td>2000</td><td>5% ASK, 37600 flights/week (31%), 8% seats</td><td>28640 flights/week (Magill, 2004)</td></tr>
<tr><td>2001</td><td rowspan="3">n/a</td><td rowspan="2">n/a</td></tr>
<tr><td>2002</td></tr>
<tr><td>2003</td><td>7% ASK, 42490 flights/week (Boeing Commercial Airplanes, 2014; Magill, 2004)</td></tr>
<tr><td>2004</td><td>10% ASK, 70795 flights/week, 15% seats</td><td rowspan="3">n/a</td></tr>
<tr><td>2005</td><td rowspan="3">n/a</td></tr>
<tr><td>2006</td></tr>
<tr><td>2007</td><td>20% seats (Airbus, 2008)</td></tr>
<tr><td>2008</td><td>15% ASK, 109590 flights/week, 22% seats</td><td rowspan="5">n/a</td></tr>
<tr><td>2009</td><td rowspan="3">n/a</td></tr>
<tr><td>2010</td></tr>
<tr><td>2011</td></tr>
<tr><td>2012</td><td>25% seats</td></tr>
<tr><td>2013</td><td>n/a</td><td>26% seats, 16% ASK (Boeing Commercial Airplanes, 2014, Boeing Commercial Airplanes, 2015)</td></tr>
<tr><td>2014</td><td>20% ASK, 149979 flights/week, 28% seats</td><td>n/a</td></tr>
<tr><td>2015</td><td>n/a</td><td>28% seats (ACI, 2016; ICAO, 2015)</td></tr>
<tr><td>2016</td><td>28% seats (0%)</td><td>28% seats (ICAO, 2017)</td></tr>
</table>

In updating the database for 2016, airlines listed in the OAG 2016 database which were not included in previous OAG databases were identified and evaluated for compliance to the ICAO LCC definition. Sources consulted in updating the database include airline websites, Ishka (2017), and DLR (2016). Table 2 below shows the results of the validation check on global ASK, flights per week and percentage of total seats flown by LCCs globally, comparing own values with published values. The list of LCCs used in the analysis for the respective years is presented in the appendix.

3. PRELIMINARY ANALYSIS

In this section, representative clusters in the small, medium, and large aircraft categories, based on the highest total seats transported, (namely, JC, NB and LR aircraft clusters) are focused on. Similarly, where geographic world regions are discussed, the analysis covers intra-regional as well as inter-regional flights for the three biggest regions in terms of total departing seats on intra-regional flights in 2016. The regions are Asia, North America and Europe. Results for all aircraft clusters and route groups are presented in the appendix.

The historical development of seat capacities of the selected aircraft clusters is evaluated for both global and route group dimensions. In addition, the historical development of seat capacities of the aircraft clusters operated by the two ABM clusters is also investigated both for global and route group dimensions.

In computing average annual growth rates over the analysis period for use in longer-term fleet planning, values from each data point or analysis year were assumed to change linearly until the next available data point. Furthermore, in computing average differences in the number of aircraft installed seats over the analysis period, comparing ABMs, values from each data point were assumed to remain constant until the next available data point. To include the effect of flight frequencies, the average seats and average distances shown are weighted by flight frequency. Moreover, for each year and group of flights being analysed, a distinction is made between the average seat capacities scheduled, weighted by flight frequency, and the average maximum possible seat capacity for each aircraft cluster, also weighted by flight frequency. The former was determined from the number of seats on scheduled flights available from the OAG databases, weighted by flight frequency while the latter was analysed by determining the maximum seat capacity possible for each aircraft type analysed in the database and finding the average of these maximum possible values, weighted by flight frequency.

Sources consulted in determining the maximum seat capacity for each aircraft type include aircraft manufacturer websites2, Pitt & Norsworthy (2013), DVB Aviation Research (2015) and other sources3. The average maximum possible seat capacity was determined as a reference frame against which values of average scheduled seat capacity are compared, thus accounting for the differences in the mix of aircraft constituting an aircraft cluster for a given analysis year and group of flights. Moreover, given that one maximum possible seat capacity is given for a specific aircraft which was scheduled with a variety of installed seats depending on the airline, the average maximum possible seat capacity metric gives an insight into the prevailing or less prevailing constituent aircraft in each cluster per analysis year. Furthermore, using this metric makes it possible to estimate the aircraft cabin utilisation for each aircraft cluster. Aircraft cabin utilisation is here defined as the ratio, in percent, of the average scheduled seat capacity and the average maximum possible seat capacity for each aircraft cluster.

3.1. Historical Global Development of Aircraft Cluster Seat Capacities

Over the 17-year analysis period, aircraft cabin utilisation was found to grow at average annual growth rates of 0.4%, 0.6% and 0.5% for the JC, LR and NB aircraft clusters respectively. There was also an increase in the average number of installed seats on the three aircraft clusters. Average annual growth rates of 0.6%, 1.1%, and 0.3% were found for the JC, NB, and LR aircraft clusters respectively. Considering maximum possible seat capacity within the JC and NB clusters, there was a shift to larger dominant constituent aircraft types with larger maximum possible seat capacities since average maximum possible seat capacity increased at average annual growth rates of 0.2% and 0.5% respectively between 2000 and 2016. On the other hand, average maximum possible seat capacity for the LR cluster decreased at about 0.2% per year between 2000 and 2016. This development can be seen in Figure 2 below.

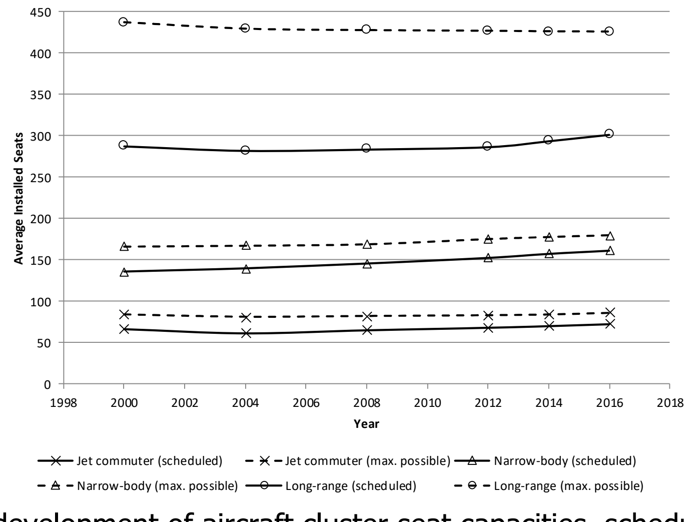

Figure 2. Global development of aircraft cluster seat capacities, scheduled and maximum possible

[2] For Airbus, Boeing, Bombardier, Embraer, Fokker, Ilyushin, and Tupolev aircraft
[3] www.airliners.net and www.angelwingsva.com

Therefore, the strong growth of the NB aircraft cluster average maximum possible seat capacity reflects the penetration of larger variants of the B737 and A320 family in the global fleet market. On the other hand, the decrease in the LR aircraft cluster average maximum possible seat capacity suggests a shift to, or prevalence of, constituent aircraft of the aircraft cluster with lower maximum possible seat capacities. For example, there could be less prevalence of the A340 and Boeing 777-300ER and more of the A330-200 and B777-200 aircraft. It is to be noted that although average maximum possible seat capacity of the LR aircraft reduced, the average distance flown by the aircraft cluster fleet increased over the analysis period.

3.2. Differences in Aircraft Seat Capacities Depending on Airline Business Models

In addition to determining the developments in average aircraft cluster seat capacity (scheduled and maximum possible) over time, these developments were also evaluated based on airline business models. Figure 3 presents the average maximum possible seat capacities of the three aircraft clusters as operated by the two ABM clusters over the analysis period. The results show that the average maximum possible seat capacities of NB and LR aircraft used by LCCs were 7% and 5% lower than those operated by FSNCs, whereas the maximum possible seat capacities of JC aircraft of LCCs are higher than those of FSNCs. This implies that globally, LCCs operated smaller constituent aircraft4 of the NB and LR aircraft clusters compared to FSNCs, whereas FSNCs operated smaller constituent aircraft of the JC cluster as compared to LCCs.

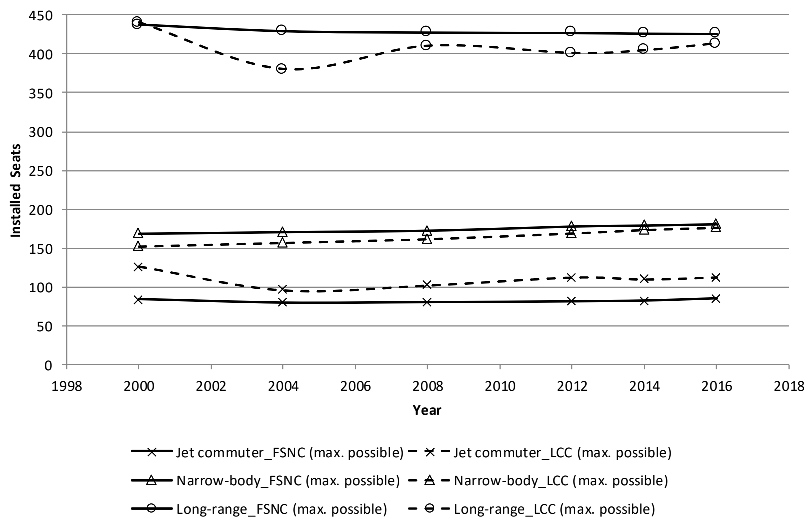

Figure 3. Global development of aircraft cluster average maximum possible seat capacities, FSNCs and LCCs

[4] (i.e. aircraft with lower maximum possible seat capacity)

In addition, Figures 4 and 5 present the historical development in seat capacities and aircraft cabin utilisation of the selected aircraft clusters as operated by FSNCs and LCCs, respectively, within the analysis period.

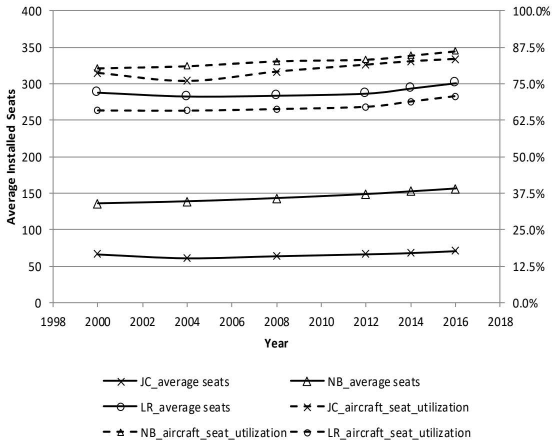

Figure 4. Global development of FSNC aircraft cluster seat capacities and cabin utilisation

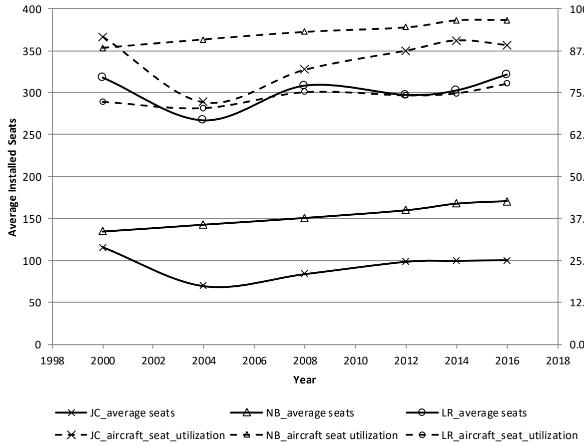

Figure 5. Global development of LCC aircraft cluster seat capacities and cabin utilisation

Therefore, although the average maximum possible seat capacities of NB and LR aircraft operated by LCCs were less than those operated by FSNCs, LCCs still installed more seats on their "smaller" aircraft than the number of seats installed by FSNCs on their "larger" NB and LR aircraft. Furthermore, LCCs operated JC aircraft that were larger on average (i.e. aircraft with greater maximum possible seat capacity) and installed more seats than FSNCs.

Considering installed seats per cabin class, for the JC and NB there was an increase in the share of first class and business class seats (F+C seats) of FSNCs, whereas the reverse was found for LCCs. The share of economy seats on these two aircraft clusters was about 92% and 99% for FSNCs and LCCs, respectively in 2016.

However, for the LR aircraft cluster, there was a growth in the share of premium seats for the two ABMs until 2008 after which the share of these seats slightly reduced for both business models. This is in agreement with a CAPA report that claimed a loss of share in premium traffic relative to economy traffic since the 2009 recession (CAPA, 2013). The share of economy seats in the LR aircraft cluster was about 87% and 94% for FSNCs and LCCs, respectively in 2016. This confirms the reduced focus of LCCs on business passengers in comparison with FSNCs over their operated routes. The development in the share of premium seats (F+C seats) and economy seats (Y seats) on LR aircraft operated by the two ABM clusters is presented in Figure 6.

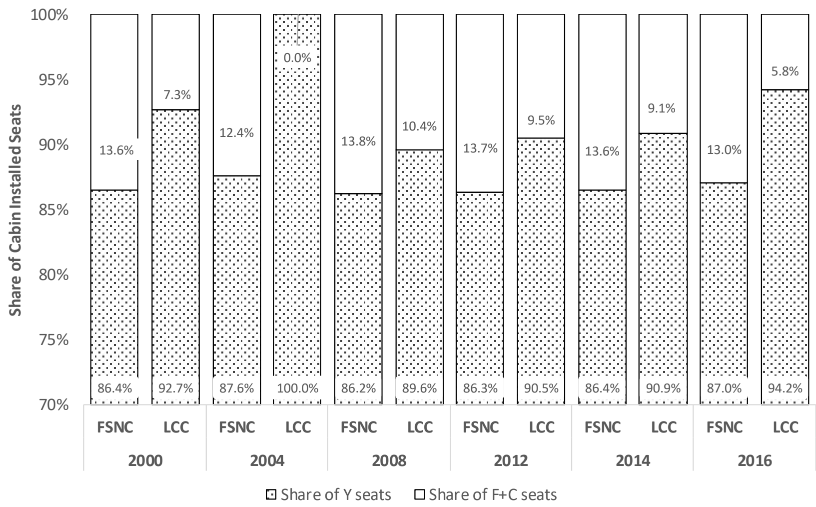

Figure 6. Globally installed seats per cabin class on LR aircraft by FSNCs and LCCs

3.3. Historical Development of Aircraft Cluster Seat Capacities between and within Geographical Regions and Airline Business Models

Frequency-weighted average scheduled and maximum possible seats of the evaluated aircraft clusters operating the selected inter-regional and intra-regional flights from 2000 to 2016 are shown in Appendices 8 and 9. The corresponding average annual growth rates in average installed seats are shown in Table 3.

Over the 17-year period, for the three aircraft clusters considered, the highest average annual growth rate in aircraft seat capacity was found on intra-European flights. However, the average maximum possible seat capacity did not increase accordingly. As a result, for the three aircraft clusters, the highest cabin utilisation on intra-regional flights was in Europe. (see Appendix 5).

In addition, the highest average scheduled seat capacities on aircraft belonging to the JC and NB aircraft clusters were found in Europe, while the highest scheduled seat capacity on aircraft belonging to the long-range aircraft cluster was found on flights in Asia. This reflects the contribution of high-density short haul routes within Asia. On the other hand, the lowest average annual growth rate summed up for the three clusters was on flights in Asia.

On inter-regional routes, where the long-range aircraft cluster is designed to operate, a growth in the average installed seats was also observed over the analysis period. The highest annual growth rate for the LR and NB aircraft cluster was on North Atlantic or North America-Europe routes with an average of 0.8%, while the lowest was on Trans Pacific or Asia-North America routes with an average of 0.5%. In addition, LR aircraft on Trans Pacific routes had more seats (average scheduled and maximum possible) than comparable aircraft on North Atlantic routes. These results correspond to historic and forecast trends in aircraft installed seats presented by the IPCC for these routes (IPCC, 1999). Focusing more on inter-regional flights using LR aircraft, Figure 7 below the development of average scheduled seats and average maximum possible installed seats for the LR aircraft cluster (both weighted by frequency) with distance flown (also weighted by frequency), when operating intra- and inter-regional flights for the Asian, North American and European geographical regions. The average number of scheduled seats, weighted by frequency, on LR aircraft was more when operating intra-regional flights than when operating inter-regional flights. However, the average maximum possible seat capacity was higher on inter-regional flights than on intra-regional flights. This result reflects the strategy identified previously in which airlines install more seats on their wide-body aircraft when flying shorter missions, whereas less seats are installed for longer-range missions to enable the transport of more belly-cargo. This correlation was not observed for the jet commuter and narrow-body clusters.

Table 3. Average annual growth rates in aircraft cluster seat capacity between 2000 and 2016, all airlines

Route Group	Aircraft Cluster	Average Annual Growth Rate 2000-2016 [%]	Average Annual Growth Rate 2008-2016 [%]
Intra North America	JC	0.7	1.1
	NB	0.8	1.4
	LR	0.4	0.3
Intra Europe	JC	1.4	2.4
	NB	1.2	1.3
	LR	1.0	0.8
Intra Asia	JC	-0.7	1.6
	NB	0.8	1.2
	LR	-0.4	0.5
North America-Europe	JC	-6.1	-6.1
	NB	1.1	7.3
	LR	0.5	0.5
Europe-Asia	JC	-1.1	-2.2
	NB	0.6	1.6
	LR	0.6	0.2
Asia-North America	JC	0	0
	NB	0.5	1.9
	LR	0.5	0.2

Analysing the developments in installed seats over time, geographic region, and airline business models, the development of average scheduled aircraft cluster seat operated by FSNCs and LCCs over time on intra-regional routes is presented in Appendices 10 to 13. In addition, Table 4 shows the development in aircraft cluster average seat capacities over the analysis period.

In 2016, LCCs had a market share of 41%, 32%, and 24% on European, North American and Asian regional flights, respectively. From Table 4, it can be seen that LCCs had different approaches to competing with FSNCs in terms of increasing the number of seats on their aircraft between 2000 and 2016 on the 3 intra-regional routes. For example, within North America, they operated the single-aisle cluster aircraft while at least matching the growth rate of the FSNCs. Within Europe, LCCs reduced growth in JC aircraft seats while ensuring slightly higher growth in NB cluster seats, while within Asia they doubled the growth rate of NB cluster seats compared to FSNCs. Where the LR cluster is concerned, LCCs maximised growth in average scheduled seats in Asia while no growth occurred in this cluster in the other two route groups.

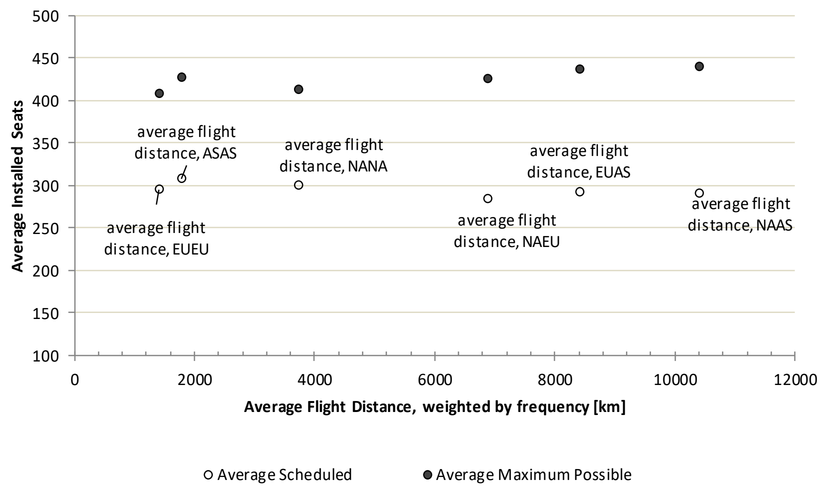

Figure 7. Development of average and maximum possible seat capacities with flight distance, for selected inter- and intra-regional flights using LR aircraft cluster in 2016

The historical development in the seat share of FSNCs and LCCs on intercontinental routes between the three regions is shown in Figure 8 while Table 5 shows the corresponding average annual growth rates on the route groups. From Figure 8, over the analysis period, LCCs had a lower but increasing market share on these inter-regional route groups, with the highest market share being on North Atlantic routes. In 2016, LCCs had a market share of 3.9%, 1.6%, and 0.4% on the North Atlantic, European-Asian and Trans Pacific routes respectively.

LCCs did not operate JC aircraft on the three inter-regional routes due to the payload-range limitation of the aircraft cluster. However, this aircraft cluster was operated by FSNCs on Europe-Asia routes. Furthermore, in the study of the differences in installed seats by the different ABMs on these inter-regional routes, the focus is on LR aircraft since the design characteristics of this aircraft cluster is most suitable for both ABMs operating on these three routes. Table 5 shows the average annual growth rates of average seat capacity of aircraft belonging to the LR cluster operated by the different ABMs on the observed route groups.

Similar to the observation made concerning intra-regional flights, LCCs operate their LR cluster aircraft with different configurations on the different inter-regional route groups. On the North

Atlantic market, LCCs grew their market share from 0.2% in 2000 to 3.9% in 2016. They also operated LR aircraft with about 14% more seats than LR aircraft operated by FSNCs, using constituent aircraft with 2% higher average maximum possible seat capacity.

Table 4. Average annual growth rates in aircraft cluster seat capacity of FSNCs and LCCs on regional routes, between 2000 and 2016

Route Group	Aircraft Cluster-ABM	Average Annual Growth Rate 2000-2016 [%]	Average Annual Growth Rate 2008-2016 [%]
Intra North America	JC-FSNC	0.5	1.1
	JC-LCC	0.6	2.4
	NB-FSNC	0.8	1.3
	NB-LCC	0.8	1.4
	LR-FSNC	0.4	0.3
	LR-LCC	0	0
Intra Europe	JC-FSNC	1.4	2.3
	JC-LCC	-0.3	3.0
	NB-FSNC	1.0	1.3
	NB-LCC	1.3	0.8
	LR-FSNC	1.0	0.8
	LR-LCC	0.0	-12.3
Intra Asia	JC-FSNC	-0.5	3.6
	JC-LCC	0	0
	NB-FSNC	0.6	1.0
	NB-LCC	1.2	1.3
	LR-FSNC	-0.5	0.5
	LR-LCC	4.2	4.5

On Europe-Asia inter-regional routes, LCCs increased their market share from 0.3% in 2000 to 1.6% in 2016. They operated LR aircraft with 3% less seats on average than FSNCs. They use constituent aircraft with about 5% less average maximum possible seats than those of LR aircraft operated by FSNCs. LCCs also increased the seat capacities of their LR aircraft by 1.8% as compared to FSNCs with average annual growth rates of 0.6%. In the Trans-Pacific market segment, LCCs operated LR aircraft at 35% higher seat capacity than LR aircraft operated by FSNCs, using constituent aircraft with equal average maximum possible seat capacity to those operated by FSNCs.

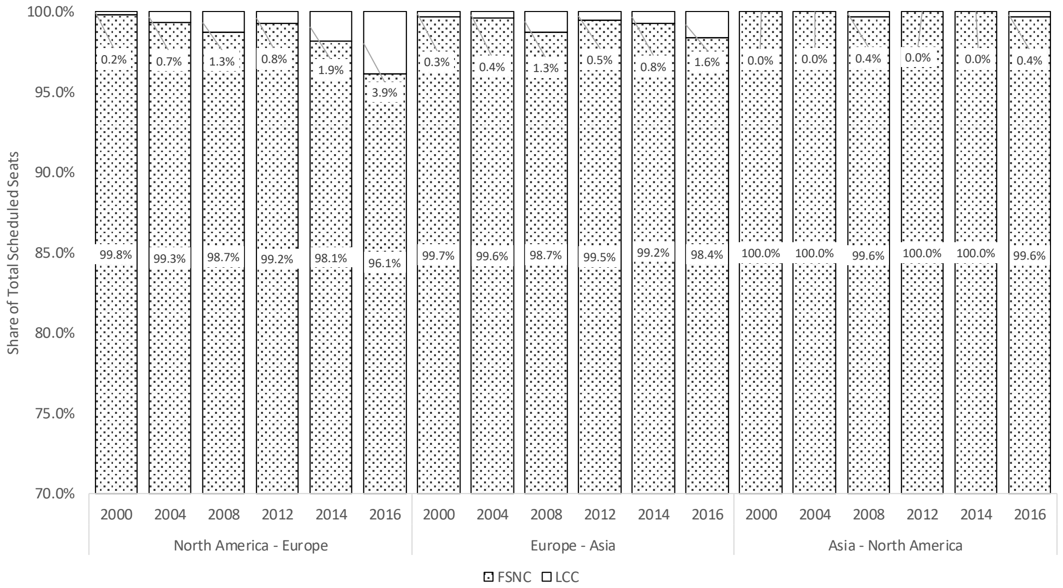

Figure 8. Historical development of inter-regional routes seat share, FSNCs and LCCs

Table 5. Average annual growth rates in LR aircraft seat capacity on inter-regional routes between 2000 and 2016, FSNCs and LCCs

Route Group	Aircraft Cluster_ABM	Average Annual Growth Rate 2000-2016 [%]	Average Annual Growth Rate 2008-2016 [%]
North America - Europe	LR_FSNC	0.5	0.5
	LR_LCC	0.4	0.4
Europe – Asia	LR_FSNC	0.6	0.3
	LR_LCC	1.8	3.7
Asia – North America	LR_FSNC	0.5	0.1
	LR_LCC	0	0

Therefore, in general, LCCs operated their LR aircraft with an average of 15% higher seat capacity than LR aircraft operated by FSNCs. They also used constituent aircraft with 1% less maximum possible seats than LR aircraft operated by FSNCs on these inter-regional routes. However, at a route group level, LCCs had different approaches to competing with FSNCs in terms of increasing the number of seats on their aircraft between the analysis period.

4. HYPOTHESIS-DRIVEN DATA ANALYSIS

In this section, selected results from the previous section are analysed using statistical tests on the mean. Statistical tests on the means are used to verify statistical significance while drawing conclusions regarding differences in means of average maximum possible seats and average scheduled seats of LCCs and FSNCs. The tests are conducted first for the ABMs generally, then by aircraft cluster. Furthermore, a regression analysis is carried out to determine the variables that significantly affect cabin utilisation of the aircraft clusters.

In carrying out this analysis, a unit of observation is defined as the average aircraft cluster flight per year, airline business model, and geographic route group. This means that averages of the seat capacities, maximum possible seat capacities, and flight distances are obtained for all scheduled flights by constituent aircraft types in each aircraft cluster, as well as between several specific airport pairs in each route group and between airlines in each ABM cluster.

Entries for an average aircraft cluster flight include average scheduled seats and average maximum possible seat capacities, average utilisation, aircraft operator ABM, and average distance per flight on the 21 identified route groups. In this case, average utilisation refers to the ratio between average scheduled seats and average maximum possible seat capacity of the aircraft cluster. The analysis covers all seven passenger aircraft clusters. Average aircraft cluster flight entries with flight distance exceeding the possible limit stipulated by payload-range diagrams of aircraft are deleted. Entries with missing or zero seat capacities are also deleted.

4.1. Difference in seat capacities of LCC and FSNC aircraft, general

First, a two-sample t-test of average scheduled seats and average maximum possible seats comparing LCCs with FSNCs, using unequal variances, is conducted. This is irrespective of aircraft cluster operated in the average flight. The results suggest that LCCs use aircraft with substantially less scheduled seats than FSNCs. This is only statistically provable up to 90% confidence interval. In addition, LCCs use aircraft that have less average maximum possible seats than FSNCs. These are summarised in Tables 6 and 7.

Table 6. Summary result: t-test of average scheduled seats

Group	Obs.	Mean	Std. Err.	Std. Dev.	[90% Conf. Interval]	
FSNC	645	226.704	4.248	107.882	219. 707	233.701
LCC	247	212.606	6.190	97.285	202.386	222.827
combined	892	222.80	3.522	105.19	217.001	228.599
diff		14.097	7.861		1.153	27.041
diff = mean (FSNC) – mean (LCC)					t = 1.793	
Ho: diff = 0					degrees of freedom = 890	
Ha: diff < 0			Ha: diff= 0		Ha: diff > 0	
Pr (T < t) = 0.963			Pr (|T| > |t|) = 0.073		Pr (T > t) = 0.037	

Table 7. Summary result: t-test of average maximum possible seat capacity

Group	Obs.	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
FSNC	645	343.243	7.124	180.937	329.253	357.233
LCC	247	270.928	9.290	146.008	252.629	289.226
combined	892	323.218	5.857	174.919	311.724	334.713
diff		72.315	12.870		47.057	97.573
diff = mean (FSNC) – mean (LCC)					t = 5.619	
Ho: diff = 0					degrees of freedom = 890	
Ha: diff < 0			Ha: diff= 0		Ha: diff > 0	
Pr(T < t) = 1.000			Pr (|T| > |t|) = 0.000		Pr (T > t) = 0.000	

4.2 Difference in cabin utilisation and seat capacities of LCCs and FSNCs, by aircraft cluster

Two-sample t-tests of average maximum possible seats comparing LCCs with FSNCs, using equal variances, are conducted for each aircraft cluster. The results are summarised in Table 8 below.

Table 8. Summary result: t-test of maximum possible seats, LCCs and FSNCs

Aircraft Cluster	Mean maximum possible seats FSNC	Mean maximum possible seats LCC	Mean difference	*p* value mean (FSNC)-mean (LCC) =0	95% C.I.
TC	74	74	0	x	(0,0)
JC	91	106	-15.3	0.0000	(-22.3, -8.4)
NB	178	175	2.4	0.1416	(-0.2, 5.1)
MR	344	331	12.3	0.0777	(-1.4, 26.1)
LRC	457	410	47.5	x	x
LR	424	408	15.6	0.0074	(4.4, 26.9)
LRH	604	619	-15.2	0.0074	(-25.8, -4.5)
x: not available					

Although, LCCs are known to use significantly smaller (average maximum possible seat capacity) aircraft types than FSNCs, the results in Table 8 give more information into this relation by analysing the aircraft clusters individually. FSNCs use significantly bigger aircraft types than LCCs, in the LR cluster. This is probably because the latter try to minimise their landing costs, as part of their cost-minimization strategy. On the other hand, within a 95% CI, LCCs use significantly bigger aircraft types in JC clusters than FSNCs. LCCs could be said to also use bigger LRH aircraft than FSNC, but this cannot be statistically proven since only 16 observations are available to show this. Interestingly, given that the NB aircraft cluster embodies the main aircraft types of LCCs at least in Europe (EUROCONTROL, 2017), the results for this aircraft cluster are not significant. Although FSNCs have higher average maximum possible seats than LCCs, this difference is not statistically significant. As expected, LCCs have significantly more seats than FSNCs when using aircraft in clusters JC, NB, MR, and LR. These are also the main aircraft types in use by LCCs. The other clusters could be operated by LCCs, but only on rare occasions.

Evaluating the cabin utilisation behaviour of the two business models, LCCs have a significantly higher cabin utilisation than FSNCs for aircraft in the NB, MR, and LR clusters. A lower cabin utilisation by FSNCs hints towards the fact that they have a higher passenger comfort through a higher share of premium seats on aircraft in these clusters than LCCs.

Table 9. Summary result: t-test of mean cabin utilisation, LCCs and FSNCs

Aircraft Cluster	Mean cabin utilisation FSNC	Mean cabin utilisation LCC	Mean difference	p value mean (FSNC) - mean (LCC)=0	95% C.I.
TC	0.929	0.938	-0.008	0.439	(-0.03, 0.01)
JC	0.848	0.883	-0.035	0.101	(-0.08, 0.01)
NB	0.817	0.910	-0.093	0.000	(-0.11, -0.07)
MR	0.661	0.774	-0.113	0.000	(-0.13, -0.09)
LRC	0.611	0.707	-0.096	x	x
LR	0.666	0.742	-0.076	0.000	(-0.11, -0.05)
LRH	0.612	0.680	-0.067	0.001	(-0.10, -0.03)
x: not available					

4.3. Regression model of average cabin utilisation per aircraft cluster

Innovations in aircraft design like Cabin Flex (Saab Press Center, 2015) and in aircraft interior design like Space Flex (Dron, 2015) and Smart Cabin Reconfiguration (Rahner, 2017) are developed and advertised to offer flexibility in or optimization of aircraft cabin utilisation. This implies that in addition to the revenue and profit generated by use of their aircraft, fleet planners also evaluate their strategies in terms of cabin utilisation. However, there has been little or no work done in estimating the predictors of aircraft cabin utilisation, compared to aircraft seating capacity. To support our previous findings, a simple regression model is constructed. The model estimates the effect of two variables of interest (distance and ABM) on our dependent variable cluster cabin utilization. From the definition of cabin utilization, a value above unity cannot exist. Furthermore, the regression analysis assumes a lower bound of 0.5 for the dependent variable. Furthermore, effects of control variables (route groups and years of observation) are included. Based on literature findings (Boeing Commercial Airplanes, 2017; Givoni & Rietveld, 2009), these control variables also have an impact on aircraft cabin utilisation. The variables are defined in Table 10, while the descriptive statistics of the variables are shown in Table 11. Three models are estimated via the OLS estimator, using robust standard errors. More variables are added in each new model to test their effect on the identified regression relationship of the previous model. Table 12 shows the results of the regression models. The main linear equation can be written as:

$$cabin\ utilization = \beta_0 + \beta_1 \ln dist + \beta_2\ LCC$$

where $cabin\ utilization$ refers to the cabin utilization of an aircraft cluster; $dist$ stands for the average distance flown by an aircraft cluster; and LCC is a dummy which stands for the operator ABM being LCC. A log-linear relationship is assumed between distance and cabin utilization similar to the approach of Givoni & Rietveld (2009). The betas are coefficients of the predictors to be estimated.

Table 10. Description of variables

Variable	Definition	Source
Aircraft cluster	An aircraft cluster is a hypothetical aircraft type with properties such as average scheduled seats, maximum possible seat capacity, and flight distance averaged (flight frequency weighted) over corresponding properties of constituent aircraft types. An aircraft cluster observation can be differentiated from another, composed of either the same or another set of constituent aircraft types, based on other properties like operating airline's business model, the origin and destination region pair, and the year of observation	See Table 1
cabin utilization	Ratio of average maximum possible seat capacity and average scheduled seats of aircraft cluster	Own computation
distance	Average flight distance of aircraft cluster, in kilometers	OAG Scheduled flights database
LCC	Dummy, takes a unitary value when operator of cluster aircraft is LCC	ICAO LCC database
Average scheduled seats	Average scheduled seats of aircraft cluster	OAG Scheduled flights database
Average maximum possible seats	Average maximum possible seat capacity of aircraft cluster	Various sources, see appendix
Year of observation	All years of observation in scheduled flight database used	OAG Scheduled flights database
Route Group Index	Index identifying route group	Own assumption

Table 11. Descriptive statistics of the variables

Variable	Observations	Mean	Std. Dev.	Min.	Max.
Cabin utilisation	878	0.7521	0.1267	0.5328	1
Distance	878	7.7636	1.0297	5.0015	9.6472
LCC	878	0.2813	0.4499	0	1
Average scheduled seats	878	224.5579	104.3599	11.0502	480
Average maximum possible seats	878	321.724	174.5599	12.8030	635.6649
Year	878	2009.251	5.5690	2000	2016
Route Group index	878	11.2551	5.7358	1	21

Table 12. Estimation results of the regression analysis

	Model 1	**Model 2**	**Model 3**
Distance	-0.071***	-0.066***	-0.117***
LCC in comparison to FSNC		0.083***	0.083***
Constant term	1.301***	1.241***	1.508***
Year present in model	No	No	Yes
Route Group Index present in model	No	No	Yes
N	878	878	878
R^2	0.330	0.415	0.568
rmse	0.104	0.097	0.085

* p<0.05, ** p<0.01, *** p<0.001

Model 1 depicts the influence of flight distance on cabin utilisation. The results show that distance has a negative impact on cabin utilisation. Thus, with increasing distance, cabin utilisation diminishes significantly. This hints towards the fact that with higher travel distance, passenger comfort, in terms of increased seat pitch, improves (Schmidt, 2018) and number of premium seats increases.

In Model 2, the effect of airline business models is added. The regression results show that cabin utilisation significantly increases when an aircraft cluster flight is operated by an LCC, as compared to an FSNC. This suggests that flights by LCCs offer significantly less legroom and passenger comfort. This outcome is in line with the theory on cabin utilisation of LCCs (Kremser, Guenzkofer, Sedlmeier, Sabbah, & Bengler, 2012).

Finally, we include two control variables (year and route group index) in Model 3 to test whether the coefficients of our variables of interest adhere to the same tendency. As expected, the control variables do not change the impact direction of the variables of interest. Furthermore, the significance of the variables of interest does not change when checking for the control variables. In addition, a better fit of the estimator (suggested by a higher R^2 and lower root-mean-square error value) was achieved by testing for the control variables.

A higher cabin utilisation implies more scheduled seats nearing the maximum possible seats per aircraft cluster. This also implies less passenger comfort, for example, when more rows of seats are added to the same aircraft. The results of the regression models therefore suggest that passenger comfort improves with increasing distance and on FSNC flights. Thus, there is a need for more innovative solutions for flexible adjustment of number of installed seats based on demand for short to medium haul flights, especially those operated by LCCs.

5. CONCLUSION

Aircraft cabin configuration is defined in terms of the average scheduled seats, average maximum possible seats, seats per cabin class, and average cabin utilisation of aircraft clusters. Examining the factors to which the configuration of an aircraft cabin is sensitive has been identified as useful in airline operating cost and yield estimation, aircraft conceptual design, and airline fleet planning. Studies have been conducted on the factors influencing aircraft seat capacities. However, none has been conducted analysing aircraft cabin utilisation using data on flights operated by LCCs and FSNCs, averaged within and between global geographical regions and using a clear majority of the global passenger aircraft fleet.

From the study, it is clear that the utilisation of an aircraft's cabin significantly depends on the scheduled flight distance as well as the operating airline's business model. Globally, LCCs had a low preference for premium class seats, especially on their short-haul routes. This study has also given insight into the trend in the average scheduled and maximum possible seats of aircraft, not only globally, but also within and between world regions. The results further suggest that there is no significant difference in aircraft types in the NB aircraft cluster used by LCCs and FSNCs. If this trend continues with the promised middle of market aircraft, a potential market for the aircraft would exist in both business models. By contrast, FSNCs show a greater preference for larger aircraft types in the twin-aisle LR aircraft cluster.

Further research is needed in determining the utilisation of available cargo capacity of aircraft operated on short-haul missions as compared to longer range missions. Also, a more rigorous regression analysis could be performed by using actual, instead of average, flight data and incorporating variables specific to the cities or countries of each specific airport pair. This will enable the investigation of more predictors in greater geographic detail so that more robust conclusions can be drawn.

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Appendix

Appendix 1: Low-Cost Carriers evaluated in study

Year	Low Cost Carriers IATA Codes
2000	ZA, Z2, YX, XQ, WS, WN, VQ, VA, VA, U2, TZ, TV, TV, SY, SJ, SH, SG, RE, QZ, PE, PC, P9, NK, NJ, NB, N7, LF, KF, JT, JR, JN, IT, IG, HV, HD, GO, G4, FR, FL, FF, F9, DY, DS, DI, DH, DG, DE, C6, BV, BL, BE, BC, B7, B6, AK, 8Q, 6A, 5J, 5D, 0B
2004	ZE, ZB, Z4, Z2, YX, Y2, XQ, X3, WW, WS, WO, WN, W6, VY, VQ, VF, VE, VA, VA, UO, U5, U2, TZ, TW, TV, TR, T6, SY, SX, ST, SJ, SH, SG, SG, RE, QZ, QG, PE, PC, PA, OX, O6, NZ, NK, NE, NB, MN, LS, LQ, LF, KK, KI, KF, JT, JR, JQ, JN, IX, IV, IT, IG, HV, HQ, HG, HD, HC, H2, GX, G9, G4, G3, FR, FL, FD, F9, F7, DY, DS, DJ, DI, DH, DG, DE, DD, C6, C0, BV, BL, BE, BC, B7, B6, AK, 9X, 9C, 8Q, 8I, 8A, 7G, 6A, 5P, 5J, 5D, 4U, 4P, 3L, 3K, 3J, 2L, 0B
2008	ZS, ZG, ZE, ZB, Z4, Z2, YX, YV, Y4, Y2, XY, XW, XQ, XG, X3, WW, WU, WS, WO, WN, WH, WG, W6, VY, VX, VF, VE, VB, VA, V5, UO, U5, U2, TZ, TW, TT, TR, TO, T6, SY, SX, SJ, SG, RE, QZ, QS, QG, QA, PE, PC, PA, O8, O6, NZ, NM, NK, NE, NB, MN, MJ, LZ, LS, LQ, LJ, LF, KK, KI, KF, JT, JR, JQ, JN, JE, J9, IX, IV, IT, IG, HV, HG, HD, HC, H2, G9, G8, G4, G3, FZ, FR, FL, FD, F9, F7, DY, DS, DJ, DG, DE, DD, D7, C6, C4, C0, BV, BL, BE, BC, B6, AK, AD, 9X, 9C, 8Z, 8Q, 8J, 8I, 8A, 7H, 7G, 7C, 6E, 6A, 5P, 5K, 5J, 4U, 4O, 3L, 3K, 2P, 2L, 0B
2012	ZE, ZB, Z2, YV, Y4, XY, XQ, X3, WW, WU, WS, WN, WH, WG, W6, VY, VX, VJ, VF, VE, VB, VA, V7, UO, U5, U2, TW, TT, TR, TO, T6, SY, SG, RI, RE, QZ, QS, QG, PQ, PC, PA, OD, NZ, NM, NK, MN, MM, MJ, LZ, LS, LQ, LJ, KK, KF, JW, JT, JQ, JE, J9, IX, IV, IG, HV, HG, HD, HC, H2, GK, G9, G8, G4, G3, FZ, FR, FN, FL, FD, FC, F9, E5, DY, DS, DJ, DG, DE, DD, DC, D7, C6, BV, BL, BE, BC, B6, AK, AD, 9C, 8Q, 8J, 7H, 7G, 7C, 6E, 5P, 5K, 5J, 4U, 4O, 3O, 3L, 3K, 2P, 2L, 0B
2014	ZE, ZB, Z2, YV, Y5, Y4, XY, XQ, X3, WW, WU, WS, WN, WG, W6, VY, VX, VJ, VF, VE, VB, VA, V7, UO, U2, TW, TT, TR, TO, SY, SL, SG, RI, RE, QZ, QS, QG, PQ, PC, PA, OD, NZ, NK, MN, MM, MJ, LS, LQ, LJ, KK, KF, JX, JW, JT, JQ, JE, J9, IX, IG, HV, HG, HD, H2, GK, G9, G8, G4, G3, FZ, FR, FN, FL, FD, FC, F9, E5, DY, DS, DJ, DG, DE, DD, DC, D7, C6, BV, BL, BE, BC, B6, AK, AD, 9C, 8Q, 7H, 7G, 7C, 6E, 5P, 5K, 5J, 4U, 4O, 3O, 3L, 3K, 2P, 2L, 0B
2016	E5, JX, 3O, MN, JE, FN, JQ, TT, VA, 9C, UO, IX, G8, 6E, SG, QG, QZ, JT, RI, HD, GK, MM, BC, LQ, 7G, JW, AK, D7, OD, Y5, NZ, PA, Z2, 5J, 2P, PQ, DG, DJ, 3K, TR, VF, ZE, 7C, LJ, TW, MJ, DD, FD, SL, BL, VJ, 3L, HG, QS, KF, TO, DE, 4U, X3, 5P, W6, WW, RE, FR, BV, IG, HV, DY, 5K, 0B, V7, VY, DC, DS, 2L, KK, 7H, 8Q, PC, XQ, WU, U2, BE, LS, ZB, AD, G3, H2, VE, FC, 4O, VB, Y4, J9, XY, G9, FZ, C6, WG, WS, FL, G4, F9, YV, B6, WN, NK, SY, VX, BF, RS, TZ, V6, 2D, 5F, 6F, 6J, 7B, 8W, AJA, AQ, CO, D8, DP, E2, RN, RY, TRJ, VNE, VU, VZ, XW, 2B, 9P, FT, GM, GY, OR

Appendix 2: Historical Development of Aircraft Cluster Average Seat Capacity, all airlines

A/C	2000	2004	2008	2012	2014	2016	Average Annual Growth Rate 2000-2016 [% p.a.]	Average Annual Growth Rate 2008-2016 [% p.a.]
LRC	273	277	261	255	326	291	0.7	1.5
LRH	389	383	372	366	347	374	-0.2	0.0
JC	66	61	65	68	70	72	0.6	1.4
TC	67	68	68	69	68	69	0.2	0.1
MR	207	217	219	227	237	250	1.2	1.5
LR	288	282	284	287	294	302	0.3	0.7
NB	135	139	146	153	158	162	1.1	1.3

Appendix 3: Historical Development of Aircraft Cluster Average Seat Capacity, FSNC

A/C	2000	2004	2008	2012	2014	2016	Average Annual Growth Rate 2000-2016 [%]	Average Annual Growth Rate 2008-2016 [%]
LRC	273	277	261	255	326	291	0.7	1.5
LRH	389	382	372	366	347	374	-0.2	0.1
JC	66	61	64	66	68	71	0.5	1.3
TC	67	68	68	69	68	69	0.2	0.1
MR	207	217	219	227	235	247	1.1	1.4
LR	288	282	284	287	294	301	0.3	0.7
NB	136	138	143	149	152	156	0.9	1.1

Appendix 4: Historical Development of Aircraft Cluster Average Seat Capacity, LCC

A/C	2000	2004	2008	2012	2014	2016	Average Annual Growth Rate 2000-2016 [%]	Average Annual Growth Rate 2008-2016 [%]
LRC	290							
LRH	480	407	376	360	346	336	-2.1	-1.4
JC	115	69	84	98	99	100	0.0	2.7
TC		67	67	70	69	69	0.2	0.3
MR	205	226	246	253	294	309	2.7	2.9
LR	318	267	308	297	302	321	0.2	0.9
NB	135	143	151	160	168	171	1.5	1.6

Appendix 5: Historical Development of Aircraft Cabin utilisation for all Airlines on Intra- and Inter-Regional Flights

Route Group	A/C	2000	2004	2008	2012	2014	2016
Intra North America	JC	73%	70%	74%	77%	78%	79%
	NB	83%	83%	85%	87%	88%	89%
	LR	65%	67%	71%	64%	73%	72%
Intra Europe	JC	81%	85%	89%	92%	93%	93%
	NB	79%	84%	89%	90%	92%	94%
	LR	60%	66%	65%	71%	72%	73%
Intra-Asia	JC	96%	81%	82%	86%	87%	91%
	NB	83%	84%	86%	86%	88%	89%
	LR	74%	72%	68%	71%	71%	72%
North America-Europe	JC			82%	24%	29%	24%
	NB	88%	66%	54%	68%	85%	83%
	LR	61%	60%	64%	63%	65%	67%
Europe-Asia	JC	89%	92%	94%	91%	89%	86%
	NB	80%	81%	81%	84%	84%	87%
	LR	62%	66%	66%	64%	64%	67%
Asia-North America	JC						
	NB	91%	91%	84%	86%	78%	82%
	LR	60%	64%	65%	63%	62%	66%

Appendix 6: Historical Development of Aircraft Cabin utilisation for all FSNCs and LCCs on Intra-Regional Flights

			2000	2004	2008	2012	2014	2016
FSNC	Intra North America	JC	73%	70%	73%	76%	78%	78%
		NB	82%	80%	81%	82%	84%	86%
		LR	65%	67%	71%	64%	73%	72%
	Intra Europe	JC	81%	84%	89%	92%	92%	93%
		NB	79%	81%	84%	84%	88%	89%
		LR	60%	66%	65%	71%	71%	73%
	Intra-Asia	JC	96%	81%	78%	86%	87%	91%
		NB	83%	84%	84%	83%	84%	85%
		LR	74%	72%	68%	71%	71%	72%
LCC	Intra North America	JC	92%	66%	79%	86%	88%	88%
		NB	89%	90%	91%	92%	93%	93%
		LR						
	Intra Europe	JC	89%	86%	93%	88%	96%	99%
		NB	86%	93%	98%	98%	99%	99%
		LR	67%	70%			94%	71%
	Intra-Asia	JC		88%	96%			88%
		NB	89%	90%	93%	95%	99%	99%
		LR		70%	76%	73%	65%	91%

Appendix 7: Historical Development of Aircraft Cabin utilisation for all FSNCs and LCCs on Inter-Regional Flights

			2000	2004	2008	2012	2014	2016
FSNC	North America-Europe	LR	61%	60%	64%	63%	65%	67%
	Europe-Asia	LR	62%	66%	66%	64%	64%	67%
	Asia-North America	LR	60%	64%	65%	63%	62%	66%
LCC	North America-Europe	LR			71%	69%	73%	73%
	Europe-Asia	LR		70%		65%	58%	80%
	Asia-North America	LR						89%

Appendix 8: Historical Development of Aircraft Seat Capacities for all Airlines on Intra-Regional Flights

		2000	2004	2008	2012	2014	2016
Intra North America	LRC	272	272	42			
	LRH	371	344	383	68	80	374
	JC	58	54	58	60	61	64
	TC	65	66	65	72	72	72
	MR	186	196	193	188	191	199
	LR	286	276	298	260	297	299
	NB	132	133	135	141	146	151
Intra Europe	LRC	281	275	0		409	
	LRH	380	391	378	365	389	406
	JC	73	74	76	83	88	91
	TC	67	69	69	69	65	69
	MR	208	215	217	220	233	238
	LR	252	274	277	284	290	295
	NB	139	146	153	159	165	169
Intra Middle East	LRC				270	446	450
	LRH	390	383	381	375	385	388
	JC	101	103	87	86	85	83
	TC	72	71	68	67	65	66
	MR	211	232	222	241	260	266
	LR	266	260	261	273	289	307
	NB	130	136	143	153	149	151
Intra Africa	LRC	272	256	285	95		
	LRH	375	369	372	390	416	368
	JC	67	90	82	69	74	72
	TC	69	70	69	62	69	69
	MR	211	225	220	237	236	243
	LR	259	266	270	279	278	285
	NB	128	133	139	141	144	148
Intra Latin America	LRC	282	281	294	204		
	LRH	412	387	339	394	375	405
	JC	88	87	78	80	87	86
	TC	65	65	65	70	69	69
	MR	197	205	201	204	213	226
	LR	263	258	259	260	285	296
	NB	129	135	142	152	156	158
Intra Asia	LRC	274	276	260	274	272	265
	LRH	388	379	368	371	360	383
	JC	92	74	71	75	69	79
	TC	70	70	70	70	70	70
	MR	238	240	245	255	267	276
	LR	330	317	295	304	307	308
	NB	145	145	150	156	161	165

Appendix 9: Historical Development of Aircraft Seat Capacities for all Airlines on Inter-Regional Flights

Route Group	A/C	2000	2004	2008	2012	2014	2016
North America-Europe	LRC	264	278	243	273	280	274
	LRH	403	394	351	371	350	348
	JC			66	32	38	32
	TC						
	MR	213	220	221	229	230	233
	LR	265	263	275	269	275	284
	NB	147	108	93	127	131	155
Europe-Asia	LRC	269	277	257	273	305	274
	LRH	391	382	372	373	339	385
	JC	75	70	75	60	61	62
	TC			72	69	71	70
	MR	214	209	213	244	256	261
	LR	265	282	287	281	279	292
	NB	144	144	139	145	149	158
Asia-North America	LRC	278	270	288	270	264	264
	LRH	382	372	382	338	296	354
	JC			0			
	TC				72		
	MR	198	214	242	231	243	249
	LR	266	282	287	276	275	290
	NB	164	164	151	120	108	157
North America-Latin America	LRC	252	281		0	0	0
	LRH	367	355	384	342	357	371
	JC	44	43	54	63	63	71
	TC	64	64	64	72		
	MR	190	207	204	197	199	204
	LR	266	240	254	248	260	275
	NB	140	139	143	146	150	156
North America-Middle East	LRC	371					
	LRH	430	438	433	373	363	401
	JC				109		
	TC						
	MR	213	212	213	238	236	222
	LR	283	284	308	302	309	323
	NB	144					165
North America-Africa	LRC						
	LRH	366	362	447	358	359	369
	JC						
	TC						
	MR	225	236	223	224	231	237
	LR	319	304	291	271	280	293
	NB						120
Europe- Africa	LRC	274	269	282	150	6	16
	LRH	381	389	345	407	391	363
	JC	84	109	104	99	104	97
	TC	70	72	72	69	70	70
	MR	219	236	237	255	248	262
	LR	262	265	278	278	282	284
	NB	144	149	153	159	161	162
Latin America-Europe	LRC	283	278	268	287	303	274
	LRH	422	409	400	410	398	406
	JC				100		
	TC						
	MR	227	235	247	246	275	288
	LR	258	272	281	285	306	309
	NB	150	132	122	149	156	159
Africa-Middle East	LRC				240	444	450
	LRH	377	371	376	369	375	363

	JC	117	121	78	83	74	62
	TC						
	MR	225	235	231	271	266	271
	LR	272	266	274	281	302	325
	NB	136	144	144	150	151	155
	LRC	288	279	270			
	LRH	278	392	359	383	294	296
	JC						
Latin America-Africa	TC						
	MR		223	188	186	229	228
	LR	235	245	251	272	244	241
	NB				174	166	165
	LRC	288					
	LRH	356	392	373	353	360	334
	JC						
Africa-Asia	TC						
	MR	196	205	211	224	235	256
	LR	286	292	288	282	294	304
	NB		136		154	163	146
	LRC						
	LRH						
	JC				85	103	50
Latin America-Asia	TC						
	MR			205	174		
	LR			277	268	270	273
	NB					180	
	LRC	279	263	294	288	423	450
	LRH	416	386	364	367	348	332
	JC	83	93	89	87	81	91
Europe-Middle East	TC			72	71	72	72
	MR	218	211	222	250	250	252
	LR	256	258	271	287	300	308
	NB	145	143	148	154	157	161
	LRC	290	270	273	270	448	450
	LRH	400	391	380	376	366	387
	JC	11	92	81	116	95	98
Asia-Middle East	TC	72					
	MR	224	228	223	238	263	288
	LR	298	268	282	299	312	327
	NB	133	141	157	161	165	172

Appendix 10: Historical Development of Aircraft Seat Capacities for FSNC Intra-Regional Flights

Route Group	A/C	2000	2004	2008	2012	2014	2016
Intra North America	LRC	272.4	271.8	42.2			
	LRH	362.9	344.4	382.9	67.6	80.4	373.6
	JC	57.2	53.5	56.6	58.5	59.7	61.8
	TC	65.0	65.6	65.2	72.0	72.0	71.5
	MR	185.8	195.0	192.4	188.4	190.9	199.4
	LR	285.8	275.6	297.6	260.5	297.0	298.7
	NB	131.7	131.5	135.6	143.5	147.0	150.4
Intra Europe	LRC	281.2	274.8	0.0		409.1	
	LRH	379.8	390.9	377.9	365.2	389.0	406.2
	JC	73.4	72.9	76.3	82.4	88.2	91.2
	TC	66.9	68.9	69.3	68.3	64.2	69.1
	MR	209.9	211.6	210.1	219.2	227.8	231.3
	LR	251.7	273.9	277.2	283.6	288.9	295.8
	NB	138.4	142.0	145.2	150.2	156.1	161.0
Intra Middle East	LRC				270.0	445.6	450.0
	LRH	390.0	383.0	380.9	373.9	385.5	387.7
	JC	101.3	103.0	87.0	85.6	85.0	83.0
	TC	72.0	71.0	68.0	67.3	64.7	66.4
	MR	210.7	231.9	222.2	241.2	259.6	266.0
	LR	265.6	259.6	261.4	273.1	288.9	307.2
	NB	129.6	135.8	141.8	148.3	142.9	144.7
Intra Africa	LRC	272.2	256.2	285.0	95.0		
	LRH	375.3	368.7	371.9	390.0	416.0	368.4
	JC	66.6	90.8	81.5	68.8	73.6	72.9
	TC	68.8	69.8	69.2	62.5	68.9	69.0
	MR	211.1	224.9	219.3	237.6	235.3	243.2
	LR	259.1	265.8	270.4	279.1	277.7	285.3
	NB	127.6	132.1	136.7	137.8	139.3	142.7
Intra Latin America	LRC	282.3	281.2	294.0	203.8		
	LRH	412.3	386.9	339.1	394.4	374.8	405.3
	JC	88.0	86.7	81.5	77.9	83.8	83.0
	TC	64.8	64.9	65.2	69.3	70.3	68.7
	MR	196.5	204.3	199.9	204.1	211.1	224.2
	LR	261.7	258.2	259.4	259.8	285.5	297.5
	NB	129.6	134.7	140.8	149.3	152.0	154.2
Intra Asia	LRC	273.6	275.8	260.1	274.0	272.2	264.5
	LRH	387.5	377.9	368.4	371.0	359.6	383.1
	JC	92.0	73.6	61.4	75.3	69.2	79.0
	TC	70.0	69.9	69.7	70.3	69.2	69.5
	MR	237.2	240.8	245.5	253.6	263.6	272.5
	LR	330.4	316.7	295.0	304.3	306.7	306.2
	NB	144.7	145.1	147.4	150.7	154.5	159.0

Appendix 11: Historical Development of Aircraft Seat Capacities for FSNC Inter-Regional Flights

Route Group	A/C	2000	2004	2008	2012	2014	2016
North America-Europe	LRC	264	278	243	273	280	274
	LRH	403	394	351	371	351	348
	JC			66	32	38	32
	TC						
	MR	213	220	221	229	230	232
	LR	265	263	275	269	275	284
	NB	147	108	93	127	129	116
Europe-Asia	LRC	269	277	257	273	305	274
	LRH	391	382	372	373	339	385
	JC	75	70	75	60	61	62
	TC			72	69	71	70
	MR	212	207	212	243	256	261
	LR	265	282	287	281	280	292
	NB	144	144	140	145	149	157
Asia-North America	LRC	278	270	288	270	264	264
	LRH	382	372	382	338	296	354
	JC			0			
	TC				72		
	MR	198	214	242	231	243	249
	LR	266	282	287	276	275	289
	NB	164	164	151	120	108	157
North America-Latin America	LRC	252	281		0	0	0
	LRH	352	355	384	342	357	371
	JC	44	43	52	55	57	66
	TC	64	64	64	72		
	MR	190	207	204	197	199	203
	LR	266	240	254	248	260	276
	NB	142	139	142	144	148	153
North America-Middle East	LRC	371					
	LRH	424	438	433	373	363	401
	JC				109		
	TC						
	MR	213	212	213	238	236	222
	LR	283	284	308	302	309	323
	NB	144					165
North America-Africa	LRC						
	LRH	366	362	447	358	359	369
	JC						
	TC						
	MR	225	236	223	224	231	237
	LR	319	304	291	271	280	293
	NB						120
Europe- Africa	LRC	274	269	282	150	6	16
	LRH	381	389	345	407	391	363
	JC	84	109	104	99	104	97
	TC	70	72	72	69	70	70
	MR	219	236	235	256	246	262
	LR	262	265	278	278	282	284
	NB	144	148	149	155	155	156
Latin America-Europe	LRC	283	278	268	287	303	274
	LRH	422	409	400	410	398	406
	JC				100		
	TC						
	MR	220	232	245	251	278	296
	LR	257	272	281	285	306	310
	NB	150	132	122	149	156	159
Africa-Middle East	LRC				240	444	450
	LRH	377	371	376	369	375	363

	JC	117	121	78	80	74	62
	TC						
	MR	225	235	231	271	266	271
	LR	272	266	274	281	302	325
	NB	136	144	143	146	148	152
	LRC	288	279	270			
	LRH	278	392	359	383	294	296
Latin America-Africa	JC						
	TC						
	MR		223	188	186	229	228
	LR	235	245	251	272	244	241
	NB				189	166	165
	LRC	288					
	LRH	356	392	373	353	360	334
Africa-Asia	JC						
	TC						
	MR	196	205	211	224	235	251
	LR	286	292	288	282	294	304
	NB		136		154	162	148
	LRC						
	LRH						
Latin America-Asia	JC				85	103	50
	TC						
	MR			205	174		
	LR			277	268	270	273
	NB						
	LRC	279	263	294	288	423	450
	LRH	414	386	364	367	348	332
Europe-Middle East	JC	83	93	89	85	81	91
	TC			72	71	72	72
	MR	218	211	221	251	250	252
	LR	256	258	271	287	300	308
	NB	145	143	148	151	152	156
	LRC	290	270	273	270	448	450
	LRH	400	391	380	373	364	387
Asia-Middle East	JC	11	92	81	116	95	98
	TC	72					
	MR	224	228	223	237	251	276
	LR	298	268	282	299	312	327
	NB	133	141	151	156	158	165

Appendix 12: Historical Development of Aircraft Seat Capacities for LCC Intra-Regional Flights

Route Group	A/C	2000	2004	2008	2012	2014	2016
Intra North America	LRC						
	LRH	480					
	JC	120	61	86	97	103	103
	TC						
	MR	192	217	224	221	222	225
	LR						
	NB	132	136	135	138	145	151
Intra Europe	LRC	290					
	LRH						
	JC	98	90	71	88	90	89
	TC		72	66	71	69	68
	MR	190	241	250	222	251	262
	LR	295	267			359	270
	NB	146	157	167	174	176	178
Intra Middle East	LRC						
	LRH				420	400	
	JC				98		
	TC						
	MR				210	315	346
	LR						
	NB		150	150	173	166	167
Intra Africa	LRC						
	LRH						
	JC		81	118	50	73	56
	TC						
	MR	214	242	259	214	261	259
	LR						
	NB	150	156	166	169	177	176
Intra Latin America	LRC						
	LRH						
	JC			66	105	105	106
	TC				72	68	70
	MR	267	232	225	214	259	263
	LR	332	267			272	267
	NB	114	136	145	157	164	165
Intra Asia	LRC						
	LRH		436		420		420
	JC		115	125			97
	TC			66	66	72	72
	MR	268	221	243	305	330	352
	LR		267	307	278	275	402
	NB	151	149	164	172	180	181

Appendix 13: Historical Development of Aircraft Seat Capacities for LCC Inter-Regional Flights

Route Group	A/C	2000	2004	2008	2012	2014	2016
North America-Europe	LRC						
	LRH	480	392	379	338	332	332
	JC						
	TC						
	MR	269	264	251	220	256	273
	LR			313	304	314	323
	NB					136	170
Europe-Asia	LRC						
	LRH			371	338		
	JC						
	TC						
	MR	269	243	266	253	236	255
	LR		267		285	257	320
	NB			121	180	185	184
Asia-North America	LRC						
	LRH			359			
	JC						
	TC						
	MR						
	LR						390
	NB						
North America-Latin America	LRC						
	LRH	480					
	JC			95	100	100	100
	TC						
	MR	222	226	200	210		220
	LR					272	267
	NB	112	139	148	151	156	161
North America-Middle East	LRC						
	LRH	480					
	JC						
	TC						
	MR						
	LR						
	NB						
North America-Africa	LRC						
	LRH						
	JC						
	TC						
	MR						
	LR						
	NB						
Europe- Africa	LRC						
	LRH					420	
	JC			91	100	112	
	TC						
	MR	215	243	262	234	262	263
	LR	311	267			358	287
	NB	151	181	172	176	180	181
Latin America-Europe	LRC						
	LRH						
	JC						
	TC						
	MR	257	248	258	214	260	261
	LR	325	267				275
	NB						
Africa-Middle East	LRC						
	LRH						

	JC				98		
	TC						
	MR			265	210	321	310
	LR						
	NB		150	155	163	164	165
Latin America-Africa	LRC						
	LRH						
	JC						
	TC						
	MR						
	LR						
	NB				150		
Africa-Asia	LRC						
	LRH						
	JC						
	TC						
	MR						377
	LR						
	NB					176	122
Latin America-Asia	LRC						
	LRH						
	JC						
	TC						
	MR						
	LR						
	NB					180	
Europe-Middle East	LRC						
	LRH	480					
	JC			90	98	111	
	TC						
	MR	216	234	266	215	309	267
	LR						356
	NB			163	177	176	177
Asia-Middle East	LRC						
	LRH				420	397	420
	JC				98		
	TC						
	MR	217	233	267	323	392	387
	LR						
	NB		150	172	173	175	180

Appendix 14: Maximum Possible Seat Capacity per Aircraft Type

Aircraft Cluster	SPECIFICACFT (OAG)	SPECIFICACFTNAME (OAG)	Maximum Possible Seats per Aircraft
LRC	M11	Boeing (Douglas) MD-11 Passenger	410
LRC	74M	Boeing 747 (Mixed Configuration)	264
LRC	74E	Boeing 747-400 (Mixed Configuration)	264
LRH	380	Airbus A380-800 Passenger	853
LRH	747	Boeing 747 (Passenger)	624
LRH	743	Boeing 747-300 /747-100 /200 Sud (Pax)	624
LRH	744	Boeing 747-400 (Passenger)	624
LRH	773	Boeing 777-300 Passenger	550
JC	318	Airbus A318	132
JC	AR1	Avro RJ100	112
JC	AR8	Avro RJ85	100
JC	72F	Boeing 727 (Freighter)	0
JC	73F	Boeing 737 (Freighter)	0
JC	732	Boeing 737-200 Passenger	130
JC	736	Boeing 737-600 Passenger	130
JC	CRJ	Canadair Regional Jet	90
JC	CR2	Canadair Regional Jet 200	50
JC	CR7	Canadair Regional Jet 700	78
JC	CR9	Canadair Regional Jet 900	90
JC	E70	Embraer 170	78
JC	E75	Embraer 175	88
JC	E90	Embraer 190	114
JC	ERJ	Embraer RJ 135 /140 /145	50
JC	ER4	Embraer RJ145	50
JC	100	Fokker 100	109
JC	TU3	Tupolev TU134	76
TC	AT7	ATR 72	70
MR	AB6	Airbus A300-600 Passenger	345
MR	310	Airbus A310 Passenger	265
MR	313	Airbus A310-300 Passenger	265
MR	330	Airbus A330	440
MR	333	Airbus A330-300	440
MR	757	Boeing 757 (Passenger)	280
MR	75W	Boeing 757-200 (winglets) Passenger	228
MR	752	Boeing 757-200 Passenger	228
MR	753	Boeing 757-300 Passenger	280
MR	767	Boeing 767 Passenger	350
MR	762	Boeing 767-200 Passenger	255
MR	763	Boeing 767-300 Passenger	350
MR	T20	Tupolev TU-204 /tu-214	210
LR	332	Airbus A330-200	380
LR	340	Airbus A340	440
LR	342	Airbus A340-200	300
LR	343	Airbus A340-300	440
LR	345	Airbus A340-500	375
LR	346	Airbus A340-600	475
LR	764	Boeing 767-400 Passenger	375
LR	777	Boeing 777 Passenger	451

LR	772	Boeing 777-200 Passenger	440
LR	77L	Boeing 777-200LR	375
LR	77W	Boeing 777-300ER Passenger	451
LR	IL9	Ilyushin II-96 Passenger	300
NB	32S	Airbus A318/ 319 /320 /321	220
NB	319	Airbus A319	156
NB	320	Airbus A320	180
NB	321	Airbus A321	220
NB	M80	Boeing (Douglas) MD-80	172
NB	M81	Boeing (Douglas) MD-81	172
NB	M82	Boeing (Douglas) MD-82	172
NB	M83	Boeing (Douglas) MD-83	172
NB	M88	Boeing (Douglas) MD-88	172
NB	M90	Boeing (Douglas) MD-90	172
NB	717	Boeing 717-200	117
NB	737	Boeing 737 Passenger	189
NB	733	Boeing 737-300 Passenger	149
NB	734	Boeing 737-400 Passenger	168
NB	735	Boeing 737-500 Passenger	132
NB	73W	Boeing 737-700 (winglets) Passenger	149
NB	73G	Boeing 737-700 Passenger	149
NB	73H	Boeing 737-800 (winglets) Passenger	189
NB	738	Boeing 737-800 Passenger	189
NB	739	Boeing 737-900 Passenger	189
NB	D9S	McD-Douglas DC9 30 /40 /50	139
NB	TU5	Tupolev TU154	180

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