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Case Studies on Transport Policy

journal homepage: www.elsevier.com/locate/cstp



A model to analyse the profitability of long-haul network development involving non-hub airports: The case of the Barcelona–Asian market

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ARTICLE INFO

Article history:
Available online xxx

Keywords:
Secondary airports
Hub-bypassing
Long-haul

ABSTRACT

Intercontinental direct flights are key for securing foreign investment and developing trade, however, traditional dog-bone airline networks exclude secondary airports from this type of traffic and contribute to uneven regional economic development. New aircraft technology and hub-bypassing strategies can allow non-hub secondary airports to connect to intercontinental destinations. By developing an Integrated Model for Forecasting New Routes we analyse two routes of the Barcelona–East Asian market and evaluate if new aircraft technology can be a game changer for European secondary airports. Results show that direct non-stop services from Barcelona to Tokyo could be viable with the Boeing 787-8, but not with the previous technology (i.e., Boeing 777). The Barcelona–Beijing route shows some demand limitations and would only allow for some seasonal services. The findings show important connectivity prospects for secondary European airports.

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1. Introduction

The evolution of aircraft technology (Snow, 2011; Leinbach and Bowen, 2004) is constantly changing the geography of air transportation (Bowen, 2010). Every new airliner has provided improved density economics (i.e., lower operating costs per seat-kilometre) compared to previous aircraft generations; some reducing unit costs through an increased size, others by increasing overall efficiency. In this regard, the increasing efficiency of wide-body twinjets, together with increasing air transport deregulation, hub congestion, and economic growth of non-hub regions, has fostered the introduction of hub-bypassing strategies by airlines (Maertens, 2010; Bel and Fageda, 2010). By means of this strategy, airlines, instead of concentrating the intercontinental traffic between their home hub and the hub of their alliance partner on the other continents (“dog-bone” networks), directly serve secondary airports in other continents from their main home hub. This practice has been used for a long time in two specific markets, namely the North-Atlantic and the Middle East markets (O’Connell, 2011a,b; Suau-Sanchez and Burghouwt, 2011; Maertens, 2010).

Our analysis is focused on the newest airliner available: the Boeing 787. It entered into scheduled commercial service on

November 1st, 2011, All Nippon Airways (ANA) being the launch customer on domestic services substituting its B767. The B787 was designed to replace the B757, the B767, the first B777 generation, the A300s and the A310s. More importantly, this aircraft was also devised to provide a similar flying range as the jumbo B747, but with a 200–250 seating configuration, half the capacity. This could serve as a route-enabler later giving way to larger aircraft as demand builds up (Mecham, 2003).

Compared to the Airbus A330, the B787 provides a 20% fuel consumption advantage both per trip and per seat. Moreover, Boeing (2013) claims that in addition to reduced maintenance costs, the B787 can achieve a 15% operating cost advantage over the A330 in missions up to 5500 km and up to 18% reduction in sectors above 11,000 km. With a greater range, a smaller cabin and a better efficiency overall, the B787 is an aircraft that was designed for point-to-point intercontinental traffic, and answers to the international traveller’s needs (i.e., more frequent and direct non-stop services). In fact, for its marketing purposes, Boeing has identified 450 potential and unserved city pairs that could be operated efficiently with the B787 (Turner, 2010). In this vein, Mason (2007) is of the opinion that airlines choosing the B787 might eventually adopt a hub-bypassing strategy aimed at capturing higher yielding passengers.

Against this background, this paper attempts to provide three contributions. Firstly, we aim to add to the debate on the availability of intercontinental services from secondary European airports by evaluating if new aircraft technology can be a game

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changer for European secondary airports. Previous literature (Maertens, 2010) analyses several internal and external determinants influencing the choice of secondary European airports by airlines, but does not take into account any control variable on the aircraft type. Secondly, we develop an Integrated Model for Forecasting New Routes (IMFNR) to determine the profitability of new air services. The model has been developed to fulfil the requirements of the air transport industry in terms of ease of applicability and transferability, but it is grounded in academic knowledge. Finally, the third goal is to add to the analysis and understanding of the particular case of Barcelona Airport, which could be considered the largest non-hub airport in Europe. In 2012, Barcelona Airport ranked as the 8th European airport in terms of traffic and the 1st in terms of traffic generation in Europe (Suau-Sanchez et al., 2015). Although this is a successful airport in terms of traffic numbers, according to OAG data, it has the lowest share of intercontinental seat capacity (6.6%) among other similar-size airports: Munich (15.6%), Rome-Fiumicino (18.5%), London-Gatwick (17.8%) and Paris-Orly (27.5%). This could be explained by past events. In 2004 Iberia dismantled its secondary hub in Barcelona and withdrew 5.6 million seats from the airport, 785,000 of them to intercontinental destinations, representing 69% of its intercontinental seat capacity (Suau-Sanchez and Burghouwt, 2011, 2012). Later on in 2012 Spanair, which was aiming to build a hub operation in Barcelona, went bankrupt. Malighetti et al. (2008) conclude that in terms of connectivity Barcelona is the 4th best European airport connected to European destinations, but falls to the 11th position for worldwide destinations.

Previous research on this case study analysed the impact of Iberia's network rationalisation on the availability of intercontinental services (Suau-Sanchez and Burghouwt, 2011, 2012), showed that the airport is disproportionately unserved when it comes to intercontinental flights (Bel and Fageda, 2008) and developed a model for demand forecasting using the Barcelona–Miami market as an example (Sismanidou et al., 2013). Building on the work by Sismanidou et al. (2013), we do not only forecast the demand side, but also the supply side. Also, we focus on the feasibility of new long-haul routes to two East-Asian hubs, a market that unlike the North Atlantic, is not characterised by hub-passing practices.

The remainder of the paper is structured as follows: in Section 2 we review some of the supply and demand forecasting methods; Section 3 presents the dataset, the selected routes for the analysis and our method; Section 4 reports the results; and finally Section 5 develops the discussion and conclusions.

2. Forecasting new routes

In order to determine the economics and profitability of possible new services, the demand and supply dimensions need to be modelled and forecasted.

On the demand side there are several methodological approaches available to forecast traffic between two airports (Vlahogianni et al., 2004; Goedeking, 2010), such as gravity models and regression analysis (e.g., Grosche et al., 2007), fuzzy regression models (e.g., Profillidis, 2000), Quality of Service Index (QSI, e.g., Graham et al., 2013), Neural Networks (e.g., Dougherty, 1995; Zhang et al., 2001; Zhang and Qi, 2005) and the Logit models (e.g., Coldren et al., 2003; Liu et al., 2006).

Given that the aim of this paper is to ascertain the feasibility of new non-stop long-haul routes in unserved markets, linear or logistic models do not guarantee accuracy since a new direct non-stop entrant can trigger unexpected competitive responses and alter the logistic regression parameters. Introducing new non-stop services in a route therefore requires an accurate understanding of the market and the decision drivers of its passengers.

On the other hand, QSI models have been widely used by airlines to forecast their market share (Wei and Hansen, 2006; Coldren et al., 2003). They are based on the principle that passengers decide which alternative to take depending on a series of service quality parameters such as aircraft size, frequency, fares, or whether it is a non-stop or connecting service (Proussaloglou and Koppelman, 1999; Wei and Hansen, 2006). As a result, the core method chosen for forecasting demand is the QSI model. While it can be argued that passenger utility scores used in QSIs are arbitrary rather than statistically calibrated (Wei and Hansen, 2006), QSI methods have become an industry standard (Graham et al., 2013) and deliver real market results for airlines operating in a highly competitive marketplace. In this regard, this paper will attempt to contribute by developing an empirical QSI methodology built upon statistically calibrated variables and market specific supported argumentations.

Meanwhile on the supply side, production costs can be broken down between operating costs (e.g., fuel, crew, maintenance, etc.), standing costs (e.g., lease rates and insurance) and passenger related costs (e.g., terminal charges, ticket distribution, etc.). Although the basic cost performance indicators can be calculated using widely known methods (Morrell, 2013; Holloway, 2008), the main obstacle is that accurate production costs for an individual airline are usually difficult to model since detailed data is seldom available due to data confidentiality restrictions. Nevertheless, there is a wide body of literature dealing with individual supply elements, such as for example, fuel costs (e.g., Morrell and Swan, 2006), environmental costs (e.g., Miyoshi, 2014) or aircraft leasing rates (e.g., Oum et al., 2000).

Although most of air traffic forecasts rely on demand-side data, reliable supply forecasts have also become essential since deregulation given the increasing influence supply has on demand (Graham, 1999). This entails that demand stimulation effects need to be considered when calculating the profitability of a new air service (Fu et al., 2010).

3. Integrated model for forecasting new routes description

We have developed an Integrated Model for Forecasting New Routes (IMFNR) to determine the economics and profitability of new air services. Fig. 1 illustrates the workings of the model, which will be explained in detail below.

3.1. Data

Our main source of information is a MIDT (Market Information Data Tapes) dataset covering the period 2009–2012 on a monthly basis and containing actual demand data that has been extracted from the Global Distribution Systems (GDS). Each record represents an airline one-way booking and indicates the points of origin, destination, connecting airport and the average fare. Since not all bookings are done using GDS, the provider of the data adjusted the reservations using mathematical algorithms based on frequencies and seats per flight sector and historical trends. It is important to note that our dataset did not allow for traffic directionality.¹ As a consequence, the results are based on a full East Asia–Barcelona–East Asia operation (total return demand) and variables are one-way-based (fares, capacity, etc.).

Furthermore, the selected routes are assumed to start on January 1st, 2014² and the forecast extends until the end of 2018. The final profitability forecast is presented by route, operator and cabin class (economy and business).

¹ One-way data showed always Barcelona as origin and Asia as destination.

² To ease the comparison between alternatives using full financial years.

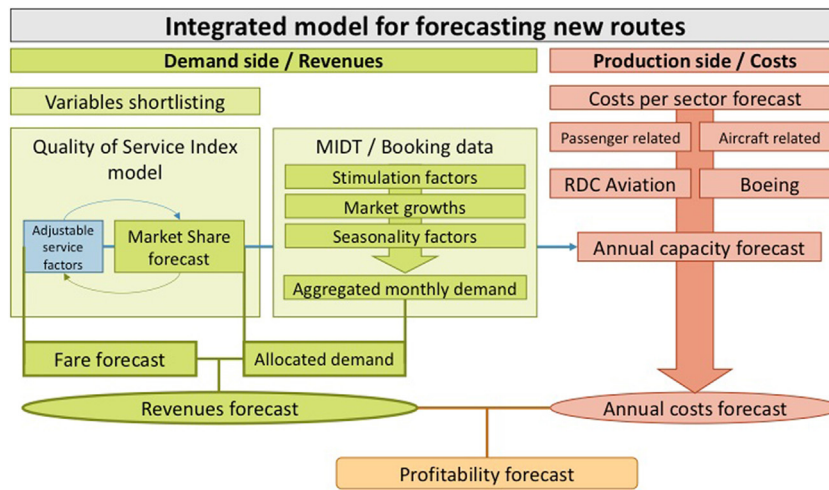


Fig. 1. Integrated model for forecasting routes (IMFR).

3.2. Route choice and scenarios

In order to choose the routes for the analysis, the two highest demand East Asian markets from Barcelona in 2012 were chosen: Japan with 142,000 passengers, and China with 118,000 passengers (Barcelona Air Traffic Intelligence Unit, 2012). Afterwards the two biggest airports serving the capital cities of these countries, Tokyo-Narita (NRT) and Beijing Capital (PEK) were chosen. Tokyo-Narita is home of Japan Airlines (JAL) and All Nippon Airways (ANA). The Barcelona–Tokyo-Narita airport-pair had a demand of 113,194 passengers in 2012. On the other hand, Beijing Capital is home to three major Chinese carriers (i.e., Air China, China Southern and Hainan) and the Barcelona–Beijing Capital airport pair had a demand of 37,944 passengers in 2012.

Regulatory constraints were also considered for selecting the routes and building the scenarios. As Table 1 shows, there are no limitations in terms of frequencies, and Barcelona is present as an entry point in the air service bilateral agreements with Japan and China. On the other hand, the Chinese Government limits the number of carriers per long-haul route to just one. According to CAPA (2013a), the only exception made is Air China, the largest airline in the country and considered as the flag carrier, which can operate a handful of services from Shanghai in competition with China Eastern, which is not included in this analysis. This poses a major restriction for other players, namely China Southern and Hainan, which need to split the market with the flag carrier out of Beijing. Nevertheless, since Barcelona is not served by any Chinese carrier at the time of this analysis, the first entrant should not have any restrictions.

From an operational point of view, there are no payload restrictions for the B787-8 or B787-9 when flying from Beijing and Tokyo to Barcelona, and the current infrastructure would not be constrained by the addition of new flights.

Once the routes have been chosen the next step is to evaluate different non-stop flights for each route. These are summarised in Table 2.

Table 1
Air service agreements conditions from Spain to China and Japan.

Air service agreements	Maximum weekly frequencies	Current weekly frequencies	Multiple designation
Spain–China	21	2	Yes
Spain–Japan	7	0	Yes

Source: Spanish Civil Aviation Authority (DGAC, 2013), as of July 4th, 2013.

For the Barcelona–Tokyo route (scenarios 1 and 2), two airlines operating the B787-8 are considered. Regarding the cabin configuration, JAL operates the B787-8 with two different layouts, one for the domestic market and another for the long-haul markets, of which the latter is chosen. ANA presents two long-haul configurations, one with and the other without premium economy class. The former is chosen to match the product used by ANA in the Tokyo–Munich route, which is a city-pair with a similar profile to this case study.

For the Barcelona–Beijing route (scenarios A, B and C), we selected the carriers currently operating the B787s or which have ordered it. Air China has orders for the larger variant of the aircraft, the B787-9. Its cabin configuration had not been disclosed at the time of this analysis, but a two-class product was assumed as well as the layout suggested by Boeing (2013). Regarding China Southern, it only operates to Amsterdam out of Beijing and only uses the B787-8 in Europe from Guangzhou to London since Autumn 2013. Finally, Hainan flies to a handful of secondary cities in Europe but only uses its B787-8 to the US, a strategy mirrored by China Southern as well.

The forecast of the market shares was done for both economy and business class. The reason for this is firstly the fact that the data is available for both classes, and secondly the differences in demand levels and fare ranges in both cabins suggest a bespoke analysis is required. First and premium economy classes were not considered because only China Southern and ANA respectively, fitted them in the B787. They have been accounted for in the business and economy classes by increasing the average fares when calculating the optimised profits.

Having chosen the scenarios for the non-stop flights, we then selected the competing indirect itineraries, which are summarised in Table 3. The criteria for selecting these itineraries are the

Table 2
Scenarios for new direct non-stop flights from Barcelona to East Asia.

Scenario	Destination	Airline	Aircraft	Cabin configuration First/Business/ PremEco/Eco.
1	Tokyo-Narita	JAL	Boeing 787-8	–/42/–/144
2	Tokyo-Narita	ANA	Boeing 787-8	–/46/21/102
A	Beijing Capital	Air China	Boeing 787-9	–/50/–/214
B	Beijing Capital	China Southern	Boeing 787-8	4/24/–/200
C	Beijing Capital	Hainan	Boeing 787-8	–/36/–/177

Table 3
List of competing indirect itineraries considered.

IATA code	Airline name	Hub	To Tokyo Narita	To Beijing
AF	Air France	Paris Charles de Gaulle (CDG)	X	X
AY	Finnair	Helsinki (HEL)	X	X
AZ	Alitalia	Rome Fiumicino (FCO)	X	
BA	British Airways	London Heathrow (LHR)	X	X
CA	Air China	Frankfurt (FRA)		X
CA	Air China	Madrid (MAD)		X
CA	Air China	Munich (MUC)		X
CZ	China Southern	Amsterdam (AMS)		X
EK	Emirates	Dubai (DXB)	X	X
HU	Hainan	Brussels (BRU)		X
JL	Japan Airlines	Paris Charles de Gaulle (CDG)	X	
JL	Japan Airlines	London Heathrow (LHR)	X	
KL	KLM	Amsterdam (AMS)	X	X
LH	Lufthansa	Frankfurt (FRA)	X	X
LH	Lufthansa	Munich (MUC)	X	X
LX	Swiss	Zurich (ZRH)	X	X
NH	All Nippon Airways	Munich (MUC)	X	
OS	Austrian	Vienna (VIE)	X	X
QR	Qatar Airways	Doha (DOH)	X	X
SU	Aeroflot	Moscow-Sheremetyevo (SVO)	X	X
TK	Turkish Airlines	Istanbul (IST)	X	X

following: (a) the indirect itinerary should have at least a 1% passenger market share; (b) only itineraries that are operated at the time of the analysis (Summer season 2013) are considered; (c) indirect itineraries to Tokyo-Haneda have not been included in the analysis as they represent only 5% of the market to Japan's capital.³

3.3. Demand and revenue forecasting

Following the general flowchart defined in Fig. 1, a 4-step methodology is followed to obtain the revenue forecast.

The first step is to define the variables influencing passenger demand, which is the dependant variable. The independent variables are quality of service parameters (travel time, circuitry ratio, stops in the itinerary, connection time, weekly frequency, arrival time, allowed baggage, aircraft mix, quality of seats, and hub rating), market parameters (capacity, presence in media, code-share, alliance, and dummy variable for Iberia's presence) and fares (one-way fare in US\$). These variables are tested for multicollinearity using regression analysis to eliminate those pairs of variables with a high correlation.⁴ After this test, the explanatory variables are narrowed down to 10. A further reduction of variables was recommended by airline network planning experts,⁵ so that the final shortlist included six explanatory variables: capacity, fare, stops, frequency, travel time and aircraft mix.

In the next step, the selected explanatory variables are fed in the quality service index (QSI) model, which evaluates the market share of an airline in a particular market. The QSI value for each airline service alternative *i* is a function of the explanatory variables:

$$QSI_i = (Capacity)^a \cdot (Stops)^b \cdot (Aircraft_mix)^c \cdot (Frequency)^d \cdot (Travel_time)^e \cdot (Fare)^f, \tag{1}$$

³ More complex analyses could include all travel options, however, we do not consider that our results are affected by our selection as we only exclude those with a marginal market share.

⁴ For the sake of brevity, the regression analysis is not reported, but can be provided upon request.

⁵ Two experts were consulted at this point, Jaume Adrover, Director of the firm GPA and member of the Barcelona Route Development Committee, and Jim Paton, Senior Lecturer at Cranfield University and former Network Planning Director at the Barcelona-based airline Spanair. The opinions provided by the experts were in line with Murray (1988), Weber and Williams (2001), Dague (2012) and Welch (2012).

where the exponents are the weightings for each variable, which are set in order to adjust the resultant market shares as close as possible to the actual reality of the market (see Table 4 for the weightings). The weighting process starts with industry-backed values, which were obtained from several industry reports classified as confidential. The industry values were reviewed by the industry sources mentioned in Footnote 5. The weightings were further adjusted by means of an iteration method (Meijerink and van der Vorst, 1977) that generated a sequence of improving approximate weighting values to match the model to the actual dataset.

The explanatory variables of the service quality are defined as follows:

- **Capacity:** Total number of seats flown per week on the route (non-stop and one-stop alternatives). The actual number of passengers was obtained from MIDT allowing to estimate capacity using an industry average load factor per cabin class, which is 70% for economy class and 50% for business class (European Travel Commission, 2010; Doganis, 2010).
- **Stops:** Number of stops in the itinerary. Data on actual number of stops for the current available itineraries was obtained from MIDT. Although the number of stops is a very simple value to assign, following the advice of an industry source (see Footnote 5), this variable will take the value of 3 for non-stop flights, and 1.5 for one-stop flights, in order to capture the actual perception of passengers.
- **Aircraft mix:** More comfortable aircraft in terms of cabin space, quietness and ride smoothness are more attractive to passengers and affect choice (Coldren et al., 2003). Given that in itineraries with connecting services two aircraft types are flown, the weighting of each aircraft type is proportional to the travel-time share of each leg. For the short-haul leg, narrow-body aircraft

Table 4
Weightings of the QSI market share model by cabin class.

Weight	Economy class	Business class
Capacity (a)	1	0.5
Stops (b)	1	2
Aircraft (c)	0.2	0.5
Frequency (d)	1.5	2
Time (e)	-1	-2
Fare (f)	-2	-1

take a value of –1, and wide-body aircraft take a value of 2. For the long-haul, leg class 1 aircraft get a value of 1, class 2 a value of 2, and class 3 a value of 3.⁶

- **Frequency:** Net number of weekly frequencies of each itinerary. The frequencies of the new service alternatives are set after adjusting them together with fares to optimise profits. This gives 7 and 3 weekly flights to Tokyo and Beijing respectively. These figures are aligned with Japanese carriers' strategy to focus on daily services to Europe and Chinese's stress on more access points with less frequency.⁷
- **Travel_time:** The variable is the result of dividing the travel time of the itinerary, which includes the flying time and the connecting time when an intermediate stop is involved, by the travel time of a theoretical non-stop flight. The theoretical travel time is calculated with TOPCAT, an aircraft performance calculation tool.
- **Fare:** One-way average fare in US dollars. Data for current available itineraries was obtained from MIDT. The data for each class has been aggregated from sub-classes, namely discount and full fares. The total average fare is obtained by weighting the average fare of each sub-class against the proportion of passengers that booked each fare sub-class.

Once the QSI value is obtained, the market share for each of the airline service alternatives is calculated as follows:

$$\text{Market_share} = \frac{QSI_i}{\sum_{i=1}^{i=n} QSI_i} \quad (2)$$

In the third step, the aggregated monthly demand is calculated in order to find out the demand for each of the competing services. Historical demand growth data is obtained from MIDT (Table 5). For the new services traffic stimulation should be considered (Sismanidou et al., 2013). Two types of stimulation effects are considered. The first, fare-driven stimulation, which is the competitive response to the introduction of a non-stop, more convenient service. As suggested by industry informants, the forecast expects a 10% reduction in economy class fares across all itineraries per every 100% increase in the market capacity. The reduction in business classes is expected at a 2%. Fare-driven stimulation is expressed as follows:

$$\text{Fare stimulation} = \left(\left(\frac{\text{Average market fare}_{\text{after reaction}}}{\text{Average market fare}_{\text{initial}}} - 1 \right) \cdot \text{Fare elasticity} \right) + 1 \quad (3)$$

The second type of stimulation is service-driven and follows Sismanidou et al. (2013). It is assumed that new direct services will generate a demand stimulation effect. The multiplication factor is derived from IATA's guidelines⁸ (Sismanidou et al., 2013). Stimulation factors and price elasticity are in Table 6.

In the fourth step, the final revenue forecast is calculated having the fare assertion as a starting point. Base average fares for new service alternatives are fixed at the profit maximisation point, rather than market share maximisation. Then a history-based inflation factor is added and a fare discount factor considered for low season months.⁹ Revenue is then calculated considering the

⁶ Class 1 aircraft include the A330-200, A330-300, A340-300, B767-300, and B777-200ER. Class 2 aircraft include the A340-600, B747-400, B777-300ER and MD-11. Class 3 aircraft include the A380-800, B787-8 and B787-9.

⁷ Analysis performed with airline capacity data between 2007 and 2013.

⁸ A spill model is considered here. If the traffic for a certain month divided by the number of seats deployed for the non-stop flights is larger than a specified saturation seat factor, the demand is cut at that percentage of filled seats. The demand not taken returns to the market and is absorbed by other itineraries.

⁹ The monthly discount factor is 0.7 for February and March, 0.8 for January, April and May, and 0.9 for June, October, November and December. The high season months of July, August and September have no discount.

Table 5
Historical demand annual growth rates for the period 2009–2012.

	Barcelona–Tokyo	Barcelona–Beijing
Economy class	5.68%	9.13%
Business class	6.47%	6.77%

Source: MIDT.

Table 6
Stimulation factors and price elasticity.

	Stimulation factors				Fare elasticity
	Barcelona–Tokyo		Barcelona–Beijing		
	Fare-driven	Service-driven	Fare-driven	Service-driven	
Economy class	1.133	1.043	1.389	1.677	–2.5%
Business class	1.044	2.675	1.292	2.912	–0.6%

Source: Author's based on RDC Aviation's Route Pro database.

Table 7
Cargo revenues as a percentage of passenger revenues.

Airline	Percentage considered
Japan Airlines (JAL)	4.55%
All Nippon Airways (ANA)	6.24%
Air China	4.85%
China Southern	3.66%
Hainan	2.57%

Source: ANA (2012), JAL (2013), Air China (2013), China Southern (2013) and Hainan (2013).

demand obtained in the third step. Cargo revenues are considered as a percentage of the total passenger traffic of each airline and have been calculated from the financial statements of the carriers.¹⁰ This percentage of cargo revenues however has been halved for conservative purposes (Table 7).

3.4. Production side and costs forecasting

Costs are built using two industry tools, ICAS (Integrated Cost Analysis Software) software from Boeing and Route Pro from RDC Aviation. The combination of both sources yields a detailed estimation of the cost per sector.

Boeing's ICAS tool provides the cash aircraft related operation costs (CAROC) broken down into the following categories: fuel, flight crew, cabin crew, navigation charges, landing charges, aeroplane station, ground power, airframe maintenance and engine maintenance. The assumptions made by ICAS software are the following: flying distances consider a 103% of the great circle distance for each route, engine types are the actual ones fitted into the aircraft of the operator and cabin configurations are the real ones used by the airline operator.

RDC Aviation's Route Pro tool is the source for passenger related costs (terminal charges, airport infrastructure, commissions, CRS distribution, catering and other passenger charges) and aircraft standing costs (lease rates and insurance). The following

¹⁰ Note that although cargo revenues are considered as a percentage of the total passenger traffic, cargo revenues are usually related to long-haul flights. We do not think that this invalidates our results; on the contrary, this avoids the possibility of having inflated cargo revenues for the studied routes.

Table 8
 Market share evolution for the Barcelona–Tokyo route by cabin class.

Airline	Barcelona–Tokyo					
	Economy class			Business class		
	Actual 2012	Scenario 1 JAL 787	Scenario 2 ANA 787	Actual 2012	Scenario 1 JAL 787	Scenario 2 ANA 787
<i>Direct non-stop</i>						
JAL	–	48%	–	–	65%	–
ANA	–	–	37%	–	–	66%
<i>Indirect one-stop</i>						
KLM	17%	9%	11%	12%	5%	4%
Air France	15%	8%	10%	24%	9%	8%
Alitalia	14%	8%	9%	5%	2%	2%
Lufthansa	12%	6%	8%	26%	9%	9%
Swiss	9%	4%	6%	3%	1%	–
Emirates	8%	4%	5%	4%	1%	1%
Aeroflot	8%	4%	5%	1%	–	–
Turkish Airlines	5%	3%	3%	2%	1%	1%
ANA	3%	2%	–	5%	2%	–
Finnair	3%	1%	2%	3%	1%	1%
British Airways	2%	1%	1%	8%	3%	3%
Qatar Airways	2%	1%	2%	1%	–	–
JAL	1%	–	1%	5%	–	2%
Austrian	1%	–	1%	2%	1%	1%

Table 9
 Market share evolution for the Barcelona–Beijing route by cabin class.

Airline	Barcelona–Beijing							
	Economy class				Business class			
	Current 2012	Scenario A Air China 787	Scenario B China Southern 787	Scenario C Hainan 787	Current 2012	Scenario A Air China 787	Scenario B China Southern 787	Scenario C Hainan 787
<i>Direct non-stop</i>								
Air China	–	37%	–	–	–	68%	–	–
China Southern	–	–	31%	–	–	–	58%	–
Hainan	–	–	–	32%	–	–	–	63%
<i>Indirect one-stop</i>								
Swiss	28%	19%	20%	20%	11%	4%	5%	4%
Aeroflot	24%	17%	17%	17%	13%	5%	6%	5%
Air France	13%	9%	9%	9%	13%	5%	6%	5%
Air China	7%	–	5%	5%	6%	–	3%	2%
Austrian	5%	4%	4%	4%	2%	1%	1%	1%
Lufthansa	5%	3%	3%	3%	13%	4%	5%	5%
British Airways	4%	2%	2%	2%	11%	4%	5%	4%
China Southern	0%	0%	–	0%	3%	1%	–	1%
Emirates	4%	3%	3%	3%	6%	2%	3%	2%
KLM	3%	2%	2%	2%	6%	2%	3%	2%
Turkish	3%	2%	2%	2%	4%	1%	2%	1%
Finnair	1%	1%	1%	1%	2%	1%	1%	1%
Hainan	1%	1%	1%	–	4%	1%	2%	–
Qatar	1%	1%	1%	1%	6%	2%	3%	2%

assumptions were considered: (a) costs per passenger, except for terminal and airport charges, are obtained from airline’s financial statements; (b) terminal and airport related charges are based on airport operators’ figures; (c) lease rates and insurances are projected as per airlines’ financial statement; (d) all passenger related costs have been calculated according the forecasted demand; (e) all forecasted costs consider a 2% annual inflation factor.

4. Results

4.1. Market share, demand and revenue forecast

Tables 8 and 9 show the results of the QSI market share analysis. For the Barcelona–Tokyo route, on the one hand, a direct non-stop flight with ANA could secure 37% of the economy market and a 66%

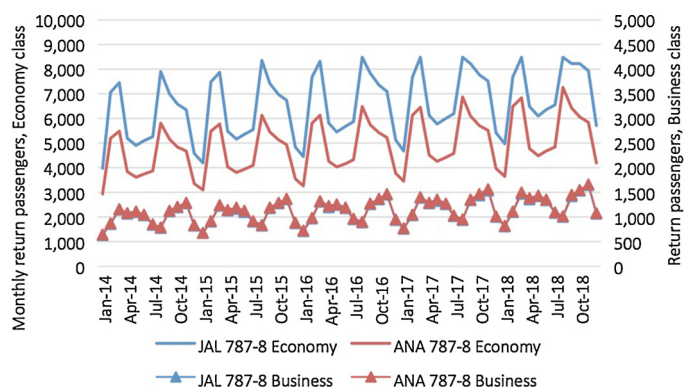


Fig. 2. Barcelona to Tokyo monthly demand by cabin class.

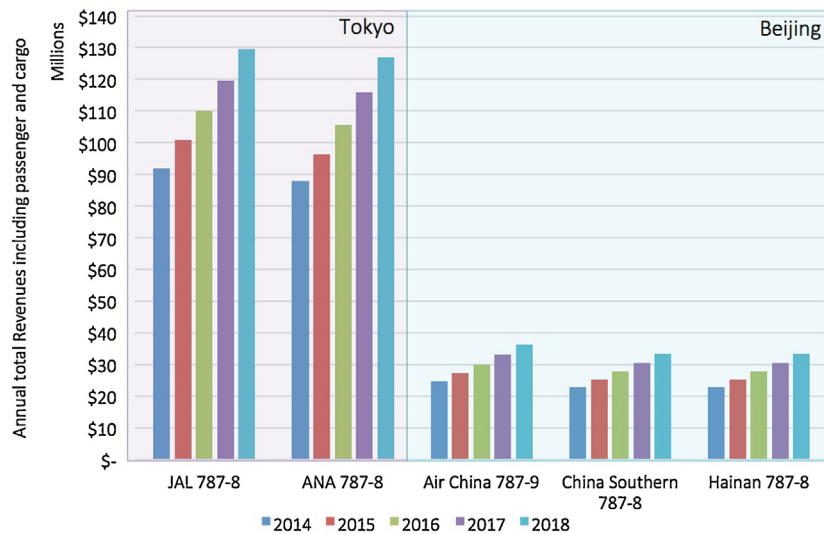


Fig. 3. Total revenues per year from Barcelona to Tokyo and Beijing.

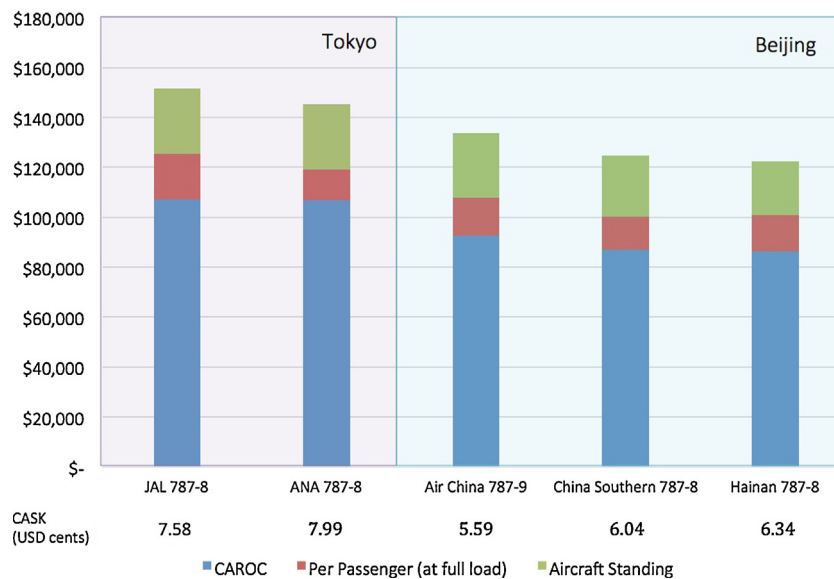


Fig. 4. Costs per one-way trip from Barcelona to Tokyo and Beijing. Note: CAROC stands for cash aircraft related operating costs.

of the business market, on the other hand, a direct non-stop flight with JAL could take 48% of the economy market and 65% of the business market. For the economy market, the knock on effect on competitors flying with 1 stop would be quite evenly distributed. However, for the business market, Lufthansa and Air France would lose their market dominance. For the Barcelona-Beijing route, new entrants would be able to secure a third of the economy market, this is a lower share than in the Japanese case because the Chinese market has lower fares and offers less room for competition. Regarding the business market, as in the Japanese case, the carrier offering the non-stop option is clearly dominating the market.

With regard to demand, it is significantly influenced by seasonality and results between airlines do not differ from the Barcelona-Beijing case, as the amount of seats supplied are very similar between the different airlines. However, in the Barcelona-Tokyo route, ANA offers substantially less economy seats than JAL, which pushes prices up for ANA and therefore yields less demand (Fig. 2). This is the same reason why ANA secures a lower market share than JAL in economy class. Although this might be seen as a

limitation, it can have some benefits for the long-term projections, since JAL's economy class gets saturated as early as August 2016. Seat factors reach maturity in the 60–80% range, which is within the European-Japanese market load factor average of 70% (European Travel Commission, 2010). The opposite is happening with the services offered by Air China, China Southern and Hainan, which obtain lower load factors in economy class because cabins are configured to accommodate more passengers. Also, the limited premium cabin of China Southern quickly saturates in March 2016.¹¹

To conclude the demand forecast, total annual revenues are calculated (Fig. 3).¹² At a first glance, there is a great difference between the results for Tokyo and Beijing. The difference cannot only be attributed to the difference in weekly frequency, but also to the difference in average yield between these markets. This is in

¹¹ Full results on monthly demand by cabin class and monthly seat factor evolution can be provided on request.

¹² Full results with monthly revenue figures can be provided on request.

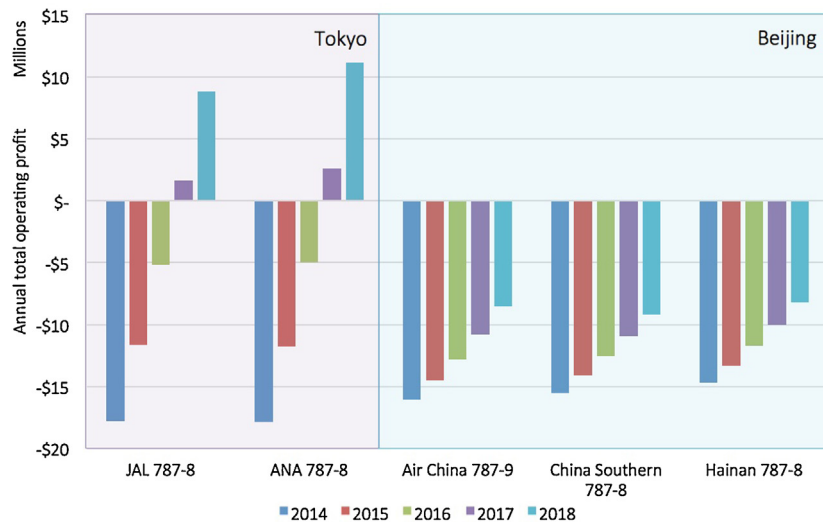


Fig. 5. Total profitability per year from Barcelona to Tokyo and Beijing.

line with an analysis using our dataset, which shows that in 2012 the Barcelona–Tokyo market yield was 27.7% above the Barcelona–Beijing market. For Tokyo, JAL obtains slightly higher revenues than ANA, even if the latter equips their aircraft with premium economy class seats. However the key in a medium yield market such as Barcelona is the total number of seats offered, which is higher for JAL. For Beijing the difference in revenues between airlines is negligible, therefore the difference in profits will boil down to costs.

4.2. Costs forecast

ANA and JAL find themselves as the highest-cost airlines in East and South East Asia (CAPA, 2013b). Indeed, the results obtained point in the same direction. The costs in terms of costs per available seat kilometre (CASK), of 0.145 US\$ for ANA and 0.130 US\$ for JAL are around 50% higher than Air China's and China Southern's (Fig. 4). The difference in costs per trip among operators lies in engine type, aircraft capacity (weight), salary scales, sales commissions and distribution fees, catering and, to a lesser extent, lease rates and insurances. Note that denser-seat aircraft are more expensive on a per trip basis, but costs per seat are cheaper. Total monthly operating costs are affected by the seasonality of demand, which impacts on variable passenger costs, but also on airlines' structure. For example, Hainan's lowest cost structure is an advantage when it comes to aircraft standing and cash costs, but its catering and distribution costs are 27% higher than its Chinese counterparts due to smaller structure and less bargaining power. This trade-off generates differences in costs with China Southern depending on the month.

4.3. Profits forecast

Once the forecast costs are subtracted from the forecast revenues, the forecast profit is obtained (Fig. 5). Our findings show that the Barcelona–Tokyo route can deliver operating profits from the fourth year of operation onwards. Nevertheless, the Barcelona–Beijing route is not able to break even within our period of analysis. The rapid profitability growth of the Tokyo flights is mainly due to the mix of large demand volumes and medium to high yields. In contrast the Beijing route exhibits losses which do not decrease sufficiently because of the lower number of operations and lower load factors.

Another important element to highlight is the seasonality of profits. As mentioned above, demand is highly seasonal, while costs do not change much along the year. Tokyo flights are profitable from June to November and Beijing's deliver modest profits in September and October. If a seasonal operation were to be carried out from 1st April to 31st October, Tokyo flights would break-even in the third year.¹³

We carried out an additional sensitivity analysis to further support the decision-making process. Revenue per passenger per kilometre (Yield) was increased and decreased accordingly to reflect a competitive response scenario. Navigation charges have been subjected to variability should the European Emission Trading Scheme affect long-haul flights with a substantial increase in taxes. The profitability in the Tokyo flights in the fifth year of operation is only compromised if fuel expenses increase by 25%. Other variables have a tangible but affordable impact in the accounts. Regarding the flights to Beijing, they do not break even on a full-year basis despite including optimistic scenarios.

5. Discussion and conclusions

The findings of this paper show that a direct non-stop operation in the Barcelona–Tokyo market could be possible with the Boeing 787 family. But in order to find out whether new aircraft technology can be a game changer in relation to older aircraft, we repeated the analysis for the following two scenarios. The first scenario considers JAL operating a Boeing 777-200ER with a 245 seat cabin (56 business, 40 premium economy and 149 economy); this aircraft is usually used in the low-demand routes to Europe, namely Tokyo–Haneda to Paris and Tokyo–Narita to Moscow, and has been used for some charter flights to Barcelona during the last five years. The second scenario considers ANA operating a Boeing 777-300ER with a 247 seat cabin (8 first, 77 business, 24 premium economy and 138 economy); this aircraft was flown by ANA to Munich before switching to the B787. Results are reported in Fig. 6. The higher capacity of the B777 and lower efficiency, compared to the B787, makes it impossible for it to break-even in the period considered. Overall, we can conclude that the Boeing 787 is able to reduce trip costs by 15% on average, which allows for operations in

¹³ Monthly profitability results are not reported for the sake of brevity, but can be provided on request.

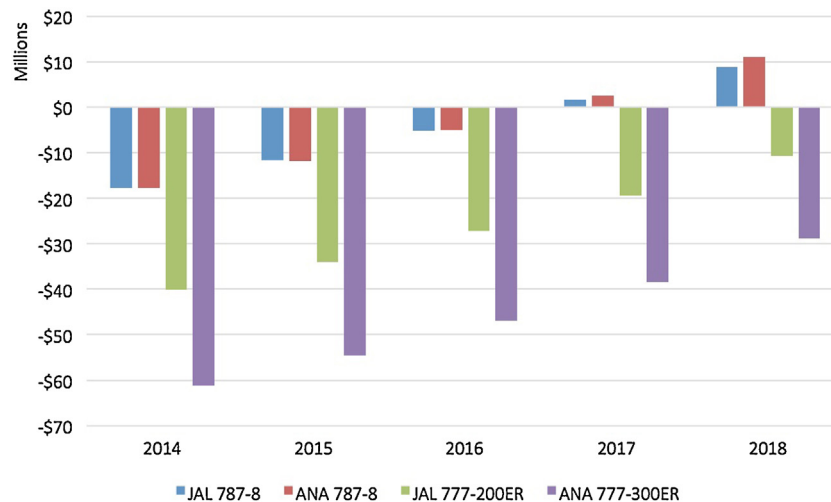


Fig. 6. Profitability comparison between the Boeing 777 and the Boeing 787.

thinner markets, although for the Tokyo example this aircraft can reduce operating costs by up to 32%.

Hence, the economics of new aircraft technology can indeed turn an unfeasible route into a feasible one. This can have significant positive impacts for individual mid-size airports that might suffer from lower than desired passenger demand. From a market point of view, it shows that new aircraft technology will have the capacity to reshape global airline network structures, as previous technology did in the past.¹⁴ Traditional dog-bone networks (Button, 2002) will increasingly be challenged by hub-bypassing strategies (Doganis, 2013; Maertens, 2010). These results are also in line with O'Connor and Fuellhard (2013) and Bel and Fageda (2010), all of them highlighting the increasing role of secondary cities and airports in airline networks, and Mason (2007) who anticipated that the new Boeing 787 would serve airlines as a hub-bypassing tool.

Industry developments taking place after conducting our analysis confirm our findings. In early 2014, Air China announced that it would start the multi-stop service Beijing–Vienna–Barcelona from 5 May 2014 (flight CA841/842). This is a four-times weekly service using an A330-300 with an intermediate stop, which secures enough demand to make the service profitable. According to our results, a non-stop operation could only be profitable during certain months of the year. In this regard, one cannot ignore the reality of the market, in which, according to O'Connell (2011a,b), more aggressive carriers like Qatar Airways or Emirates are capitalising on increasing demand. The latter started operating in Barcelona with the Airbus A380 on 1 February 2014, boosting the travel potential to the Asia-Pacific. Therefore, flag carriers from either end of the market should start securing market shares by deploying their more efficient aircraft before airlines from third continents become the main players. This is particularly important from the regional economics perspective, since location decisions of multinational and intensive knowledge firms are strongly influenced by the availability of non-stop direct services (Bel and Fageda, 2008).

The findings of this paper are also useful for policy makers and airport managers. The vast majority of airports were originally developed for political objectives and have traditionally focused on operational capabilities needed for safe and efficient movement of aircraft, people and cargo. Literature suggests that we are now in a

marketing-oriented era (Halpern and Graham, 2013). Airports are not just infrastructure providers anymore; successful airports are also network managers (Fageda et al., 2015; Goedecking, 2010). This means that the capacity of non-hub airports to attract and develop traffic by taking advantage of the new aircraft technology will be crucial for their growth and connectivity prospects. In other words, airline–airport collaboration will be increasingly important to take full advantage of the opportunities that the new technology offers, thus enabling the industry move towards a level playing field between hub and non-hub airports. A stronger competition between hubs, which suffer from increasing congestion, and non-hub airports may call for a more market-oriented approach when managing airports. Making the right call on investment decisions, flexible airport planning, airport charges, slot allocation, airport marketing and airport product definition could be the difference between success and failure.

Acknowledgments

This analysis would have not been possible without the wise advice of Jim Paton (Cranfield University). We are also thankful to Ricky Mack (Boeing Commercial Aircraft), and Jaume Adrover and Xavier Requejo (Barcelona Chamber of Commerce and GPA) for the data support and critical comments. Thanks also to Sònia Corrochano (Director of Barcelona Airport) and her team for the informal feedback, as well as Mario Arbery (IAG Cargo). Finally, we would like to thank the two anonymous reviewers and the editors of this special issue for their valuable comments.

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¹⁴ See Bowen (2010) for a comprehensive review of the impact of aircraft technology on long-haul travel.

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