

Research article

Low-Cost Carriers route network development[☆]Marina Efthymiou^{a,*}, Panayotis Christidis^b^a Dublin City University Business School, Dublin 9, Dublin, Ireland^b European Commission, Joint Research Centre (JRC), Seville, Spain

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ABSTRACT

Low-Cost Carriers achieve economies of scale by deploying large, single-model fleets across an expanding set of regional bases. The addition of new bases and routes is bound by profitability and operational aspects, both posing limitations to the travel demand that can be served. We explored the evolution of Ryanair's network and discussed the factors that influence the airline's choices. We used highly detailed information on the evolution of the fleet and routes and calculated suitable indicators for the quantification of the trends. Based on these observations, we explored the implications for travel and tourism. The analysis was supported by interviews with industry experts. The main conclusion is that there is bi-directional causality between airline network evolution and travel demand.

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Introduction

Airline liberalisation/deregulation is a milestone for the growth in civil aviation activity. It allowed the entry and growth of new airline business models, allowing new opportunities for travel and tourism. Airlines can penetrate new markets and develop their networks further. Liberalisation has been accompanied by greater airline competition (Njoya & Christidis, 2017), resulting in lower fares, increased passenger traffic, greater connectivity and frequency, and operational improvements to Cost per Available Seat Kilometre (CASK) and increase auxiliary revenue (Shaw et al., 2021).

The most successful business model occurring from airline deregulation in Europe is the Low-Cost Carrier (LCC). Low-Cost Carriers offer a basic, very competitively priced scheduled service, usually out of regional airports on a point-to-point basis (Efthymiou & Papatheodorou, 2018). Ryanair is the most recognisable Low-Cost Carrier in Europe and is the outcome of a radical business transformation. It serves a variety of destinations ranging from city breaks in mainland Europe (e.g., Frankfurt) to summer holiday islands (e.g. Tenerife). Ryanair has been researched in terms of the business model (Barrett, 2004; de Wit & Zuidberg, 2012), pricing strategies (Malighetti et al., 2009), passenger perceptions (O'Connell & Williams, 2005), state aid (Lykotrafiti, 2008), labour (Efthymiou et al., 2021; Harvey & Turnbull, 2020) and connecting flights to the network (Klophaus et al., 2021; Morlotti et al., 2020). Papatheodorou (2021) developed an analytical framework that maps the systematic relationships between airlines, airports and destinations, and identified more than 10,000 combinations of factors that influence the dynamics of airline business models and network characteristics.

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Many scholars have investigated the effects of liberalisation (e.g., Button, 2017; Fu et al., 2010), the airline business models and how they have changed (e.g., Klophaus et al., 2012; Magdalena & Bouzaima, 2021). Roucolle et al. (2020) developed a method that characterizes an airline network structure through three indicators (NetCenter, NetWeave and NetSize). The academic research indicates that the network structure is the main characteristic that diversifies Low-Cost Carriers to Full-Service Network Carriers (FSNC). Klophaus et al. (2021) argue that more research on the role of flight frequency and aircraft capacity in Low-Cost Carrier network development is needed. Despite the network structure's significance for airline profitability, the literature is sparse (Roucolle et al., 2020).

This paper aims to investigate how Ryanair's network development, one of Europe's fastest-growing airlines, depends on and influences travel and tourism. On the theoretical level, we outline the literature related to the regulatory environment focusing on liberalisation and regulatory enablers and obstacles for route development and explain how airlines select their routes focusing on Low-Cost Carriers. At a practical level, we explore how the main principles identified in theory are applied in the biggest Low-Cost Carrier in Europe and discuss the repercussions for the travel and tourism sector.

This paper contributes to the literature by updating the extensive literature on Low-Cost Carriers and the effects of liberalisation. Liberalisation within large regional markets such as the EU tends to favour the development of Low-Cost Carriers and leads to a radical change in the logic of network development. We argue that while Full-Service Network Carriers follow a bottom-up model in network development, optimizing their network to serve destinations from a limited number of bases, Low-Cost Carriers adopt a top-down model that aims at optimizing the use of their fleet of aircraft through the addition of bases and destinations to their network. This top-down model primes high aircraft utilisation rates but – as a trade-off – leads to a higher instability for the destinations served. We also contribute to the literature on route development by investigating the operational and strategic reasons for route development and the correlation between aviation networks and shifts in travel demand. We demonstrate that to be efficient, the Low-Cost Carrier model of network development requires a specific combination of aircraft type, flight duration and connection frequency. As a result, this limits the type of destinations that can be served in terms of location, total demand and trip purpose. The results extend the knowledge base of aviation practitioners and, more specifically, airport and airline route development professionals by giving insight into the most extensive network and capacity airlines in Europe. The findings suggest that the network development strategy involves allocating aircraft to specific bases and scheduling according to the base's market conditions.

The rest of this paper is organised as follows. The [Enablers and obstacles for route expansion](#) section outlines the literature on network development; the [Method and data](#) section presents the data and method used; the [Ryanair's route network evolution](#) section discusses the findings; and the [Conclusions](#) section concludes the paper and provides areas for further research.

Enablers and obstacles for route expansion

With the increase of connecting Origin-Destination (O-D) airports, airline networks have become a complicated function that is not always well understood as airlines expand. Airline networks play an important role in destination connectivity, tourism development, and the provision of economic and social benefits (Papatheodorou, 2021). Thus, a better understanding of network development is important for aviation and tourism. This section discusses the main enablers and obstacles to route development.

Airline liberalisation and deregulation are a milestone for tourism development. The 1978 Airline Deregulation Act liberalised the US aviation market. Complex bilateral agreements have restricted the European airline networks, and the three liberalisation packages set the European Single Aviation Market (Efthymiou & Papatheodorou, 2018). The last package meant that airlines could operate any routes without requiring any permit of authorisation (except for Public Service Obligation routes). Liberalisation also led to the appearance of Low-Cost Carriers and contributed to increased tourism demand because additional routes became available and affordable (Efthymiou et al., 2016).

Low-Cost Carriers are a primary driver of route development and network deconcentration (Dobruszkes, 2013). Low-Cost Carriers, in some cases, have become more prominent aircraft operators than the long-serving Full-Service Network Carriers and charter airlines. Low-Cost Carriers have avoided competing against each other and have instead sought new routes to have a monopoly or take the market share of Full-Service Network Carriers. The most successful routes have been those serving leisure destinations that previously lacked reasonably priced air service (e.g., the Canary Islands). Dennis (2007a) suggests that it may be difficult for low-cost airlines to continue such dynamic market stimulation in the longer term. Routes market of Low-Cost Carriers to major hub airports has not grown significantly yet because competitive fares (albeit with restrictions) were always available on these city pairs (Dennis, 2007b). In contrast, Low-Cost Carriers have grown in mixed segmentation markets (e.g., Madrid serving leisure and business passengers).

Ryanair has an increasing average unit fleet size, which means markets will need to absorb this capacity. With Europe being a well-served mature market finding untapped niches is challenging. Expanding beyond Europe has several challenges related to the regulatory and political environment and operational constraints. Traffic rights and horizontal and neighbourhood agreements can affect the airlines' network expansion beyond the European Union. For example, neighbourhood agreements of the EU with Armenia and Tunisia in 2021 opened the market and gave access to airlines, including Ryanair.

The unavailability of secondary airports can act as an obstacle to Low-Cost Carriers' route development. Many major cities like Lisbon, Helsinki and Vienna do not have a secondary airport, and the high airport charges have acted as a disincentive for Low-Cost Carriers to serve them. Where this is possible, Low-Cost Carriers have served nearby airports in different countries with overlapping catchment areas (e.g., Bratislava and Vienna). This has not been the case for business-orientated routes where Low-Cost Carriers may lack slots, frequency and/or quality of service.

Along with the European Single Aviation Market reform, several legislations have been implemented to ensure a level playing field and passenger protection. While Low-Cost Carriers negotiate strongly for low airport charges, competition laws can be enforced. At the same time, subsidies to flag carriers that distort competition are illegal, with several examples in the European market (Gössling et al., 2017). It needs to be noted that Ryanair has grown so much that the size of the company, its financial performance and the scale of operations make it difficult for new and existing airlines to compete with such a giant in the Origin-Destination that it has a high market share. Since the Low-Cost Carriers model gives Ryanair a competitive advantage in terms of fares, its presence in a market can create more barriers to entry than Full-Service Airlines with comparable market shares.

The competition with High-Speed Rail is another consideration parameter, especially when airlines are pressured to abandon short-haul routes when a substitute transport mode has a lower carbon impact. Also, Low-Cost Carriers are deterred from creating domestic routes in countries with rail operators with a flat pricing structure and little yield management, like Germany and France (Dennis, 2007a). Environmental policies like Emissions trading scheme can also affect the network structure, with Low-Cost Carriers trying to reduce the cost of operations (Efthymiou & Papatheodorou, 2020).

Finally, apart from protectionist regulations and market saturation, travel distance and aircraft performance are important barriers to Low-Cost Carriers growth. Long sectors require frills (e.g., in-flight entertainment) that the Low-Cost Carriers business model does not consider (Francis et al., 2007). More importantly, the type of narrowbody aircraft used by Low-Cost Carriers cannot fly for more than 5 h. For example, Boeing 737s and Airbus 320s cannot operate efficiently on sectors of more than 5 h. These are the primary reasons Low-Cost Carriers have difficulty entering the long-haul market (Francis et al., 2007; Renehan & Efthymiou, 2020). The few exceptions where a long-haul-low-cost model may be feasible correspond to pairs of cities with especially high populations, primarily in Asia. However, their financial sustainability is still questionable, given their poor cost efficiency and low aircraft utilisation (Law, 2022).

The network structure is significant for the success of a Low-Cost Carrier (Gillen & Morrison, 2005) and airports are essential parts of the network. Traffic is highly concentrated on specific routes, with strong passenger demand. Full-Service Network Carriers have used these airports (origin or destination) to build their hubs. Full-Service Network Carriers hubbing resulted in 'fortress hubs' restricting competition, especially in the absence of alternative airports nearby (Dobruszkes, 2009). This has made the Low-Cost Carriers penetration challenging for some markets with limited slots and poor intermodality. Low-Cost Carriers initially developed their network relying on regional underutilised airports and former army bases with overlapping capture areas with hub airports and similar traffic flows or by expanding catchment areas and bringing in passengers from a much wider region. For example, in 2010, Ryanair would fly only to Girona airport and have a shuttle bus service transferring the passengers to Barcelona city. When the Low-Cost Carriers grew, it flew directly to Barcelona El Prat airport. Low-Cost Carriers will also collaborate with other entities like car hire companies to generate ancillary revenue (O'Connell et al., 2020).

The choice of airports relates to many factors, including Low-Cost Carriers network strategy. According to Graham (2013), Low-Cost Carriers choose airports according to their operating model and the extent of airline and airport competition. Low-Cost Carriers seek longer operating day and high aircraft utilisation; therefore, quick turnaround times, convenient slots, lack of congestion and good on-time performance are important choice factors for Low-Cost Carriers (O'Connell et al., 2020). Low aeronautical charges and other user costs are also important, whereas airports' experience with Low-Cost Carriers was not critical.

Warnock-Smith and Potter (2005) found that demand/catchment area was the most important factor, followed by convenient slot times, quick turnaround facilities and low aeronautical charges. They also found that optimistic forecasts for business and tourism, cost-conscious airport management, high competition, good surface access and spare airport capacity are factors of consideration for Low-Cost Carriers. Immigration patterns are also considered in the network design.

Regional airports (e.g. Donegal airport in Ireland) serving a local market and usually away from main population centres have high seasonality with the Low-Cost Carriers trying to accommodate tourism traffic or very low frequencies and passenger traffic. This creates the need to balance the network between Origin-Destination to maintain high aircraft utilisation and load factors. On the other hand, secondary airports (e.g. Luton airport) can cater to similar traffic flows to larger airports and have been extensively utilised by Low-Cost Carriers and primarily Ryanair. This has resulted in 'somewhere-to-nowhere' and 'nowhere-to-nowhere' routes. A Low-Cost Carrier already operating in the city pair will most probably enter another route in the same city pair, according to Gil-Moltó and Piga (2008). They analysed the UK-to-Europe market in 1997–2004. They found that Low-Cost Carriers operate in secondary airports to avoid routes dominated by flag carriers and entry barriers, mainly allocated slots based on grandfather rights. It needs to be highlighted that Low-Cost Carriers are now flying to/from main airports (e.g. Frankfurt am Main Airport) to serve business passengers (Dobruszkes et al., 2017). Gil-Moltó and Piga (2008) also argue that entry and exit are more likely in large markets and markets with many incumbents.

Regarding airport entry and exit, Malighetti et al. (2016) suggest that Low-Cost Carriers take decisions in the light of their overall network development. Papatheodorou (2021) argues that airlines may exit a route due to poor destination management. An airport or a route can be dropped when it does not fulfil the Low-Cost Carriers expectations. Apart from low traffic, there are other reasons for an airline to drop a route. Ryanair, for example, abandoned Belfast airport in 2011 when the runway expansion was severely delayed. While Low-Cost Carriers are ready to reduce capacity in low-performing Origin-Destination and abandon airports that do not serve their interests well, the presence of a base acts as a disincentive. Dennis (2007a) states that despite the general assumption of Ryanair that low fares can lead to high load factors for any route at any time, the airline is struggling in some circumstances to fill the aircraft. Malighetti et al. (2016) found that Ryanair is the Low-Cost Carrier responsible for the highest number of downsizing (reduction in capacity) globally, with 57 downsizings and 6 complete abandonments. This highlights that the airline quickly adapts its capacity to demand and shifts operations to low-demand routes. At the same time,

Low-Cost Carriers can aggressively and capacity and/or reduce fares when new carriers enter the market or when they want to displace a carrier in an Origin-Destination leading to a double stimulus to traffic. All interviewees confirmed this. Ryanair applied the increased frequency strategy in Cork-Shannon and the reduced fare strategy in the Athens-Thessaloniki route.

With a dominant position, Low-Cost Carriers have many alternatives and hence a higher negotiating power vis-à-vis airports, especially when the latter's annual traffic is low, and airlines have strong bargaining power (Papatheodorou et al., 2019). Gillen and Lal (2004) argue that outsourcing services (e.g. passenger handling) make network expansion much easier and that the aggressive expansion of Ryanair in the past has given the airline a first-mover advantage in negotiating with airports and allowed it to sign long-term contracts and avoid head-to-head competition and overlapping networks. They also suggest that fierce competition among airports enables Low-Cost Carriers to negotiate with more than one airport and be in a position of playing one off against another.

An element worth noting is the overlapping catchment areas of a Low-Cost Carrier. Where multiple airport regions exist, a Low-Cost Carrier serving an Origin-Destination from a secondary airport may add a new route for the same Origin-Destination from another nearby airport. As the network grows, these air services to common destinations can lead to cannibalisation within the airline (de Wit & Zuidberg, 2012). For example, Ryanair serves Dublin-Barcelona El Prat, Reus International and Girona-Costa Brava airports. With Europe being a very mature market, Low-Cost Carriers wanting to grow are searching for new markets to serve.

Reynolds-Feighan (2001) found that Low-Cost Carriers in 1969–1999 had a lower concentration level than Full-Service Network Carriers. The market concentration is predominantly measured by the Herfindahl–Hirshman index (HHI), a widely accepted indicator (Alderighi et al., 2012; Obermeyer et al., 2013). Some Full-Service Network Carriers had relatively low levels of concentration and very low or no connection rates among passengers at the airports served. Others had very high concentration levels and some connecting traffic. In Europe, Low-Cost Carriers point-to-point networks are significantly concentrated due to the use of base airports for many of their services (Graham, 2013). Despite Ryanair not offering connecting flights, some passengers self-connect with most of them using another Ryanair flight (O'Connell & Williams, 2005). Apart from market concentration being particularly important for public policy, especially considering the fare prices, it is an element of market structure and, thus, of importance for an airline's network strategy.

Low-Cost Carriers aim for high aircraft utilisation; therefore, the flight distances and number of sectors are important elements of consideration for network design. De Wit and Zuidberg (2012) state that the high daily utilisation of aircraft in a low-frequency route network requires an extensive network regarding the number of airports and routes served. Dobruszkes (2013) states that the median distance Low-Cost Carriers fly in Europe is constantly increased to grow the network while controlling costs (e.g. flight crew starting and finishing their day at their base). Klein et al. (2015) argue that Low-Cost Carriers establish foreign bases for overnight aircraft resting, line servicing, and permanently placing associated crews in neighbouring cities. Bases in key locations can also accommodate the constraints of flight distances and aircraft capabilities and, at the same time, facilitate growth, provided that the barriers explained earlier are also relaxed.

Whilst the older literature is in general agreement about the factors that influence Low-Cost Carriers network development and the main factors Ryanair considered in selecting airports in the past, according to Barrett (2004), are low airport charges; quick 25 min turnaround time; single-storey airport terminals; quick check-in; good catering and shopping at the airport; good facilities for ground transport and no executive/business class lounges, the airline's business model has changed, and we have seen Ryanair deviating from these factors.

Method and data

George and Bennett (2005) and Yin (2003) describe case studies as empirical inquiries. Research by case studies is common in aviation management studies (e.g. Corbet et al., 2021; Efthymiou et al., 2021; O'Connell et al., 2020). Tasci et al. (2020) argue that case studies as a method are used to study complex topics in a systematic way for both building and testing theories. We use Ryanair in an exploratory way as a case study due to its scale of impact to draw important findings for theory and practitioners. We followed a two-stage analysis for our study. Firstly, and because of our emphasis on adding to the theory for network development, we did qualitative research that included open-ended, semi-structured, exploratory qualitative interviews with three key aviation experts:

- Kate Sherry, ex-Director of Route Development at Ryanair and current Aviation Director at Edinburgh Airport – interview transcript of 9462 words;
- Stephen Kavanagh, Non-Executive Director at CDB Aviation and Aer Lingus and Former Aer Lingus CEO – interview transcript of 9217 words;
- Enda Corneille, Ireland manager of airline Emirates – interview transcript of 8583 words.

The style of exploratory semi-structured interviews promotes flexibility, comfort, and rapport (Creswell & Miller, 2000). Ethical considerations and procedures were followed, and all interviewees signed a consent form. The interviews helped us gain a novel understanding of and discover the current industry practices for network development. The topic areas the interviewees emphasised as main aspects of network development, i.e. fleet, bases, frequencies and distances, and the connection of aviation to tourism informed the second stage of our research.

In the second stage, we used detailed figures from the 2000–2021 period to produce evidence on network developments. We used data from Sabre on the flights for all origin-destination pairs within Europe to estimate the network indicators (frequency,

distance, fleet). We combined those indicators with data from EUROSTAT that provide information on trip duration and purpose. We then evaluated the airline market concentration and its importance for tourism.

To evaluate the importance of airports in airline market concentration, we apply the Herfindahl Hirschman Index (HHI), one of the most frequently used indicators in the analysis of aviation markets (Obermeyer et al., 2013; Roucolle et al., 2020):

$$HHI = \sum_{i=1}^n s_i^2 \quad (1)$$

where i corresponds to each airline competing in the airport, and s_i the share of passengers of airline i in this airport. Higher values correspond to higher market concentration. A value of 1 would mean that a single operator occupies the whole market.

The potential impact of airline market concentration can be further analysed to correlate the dependence on a particular airline and the importance of tourism in the region served by each airport. Tourism pressure – or tourism density – is an indicator that can measure the importance of tourism in a specific region. At a European level, the indicator can be calculated at a NUTS2 level¹ using data on the total number of nights spent and the total area of each region (i.e. million of nights spent per km²).

$$\text{Tourism pressure} = \frac{\text{Annual nights spent in touristic establishments}}{\text{Total area}} \quad (2)$$

Ryanair's route network evolution

Findings from the interviews indicate that the network development of Ryanair is very much related to its business model. Sherry said the main parameters for route development are costs, demand potential and operational elements. She also said that Ryanair will always negotiate the best agreements with airports and target the cheapest ones that offer the best incentives. Ryanair will consider why people travel, diaspora, ethnic travel potential, type of passengers, passenger leakage through hub airports and if a similar route worked in the past. Sherry also stressed that Ryanair considers operational characteristics too, like sector length, slot availability, physical ability to land at the airport, handling agents and other costs. Then, based on how many passengers travel indirectly or with competitors and the total cost of the route, they will consider whether it is worth flying.

According to Kavanagh, Ryanair taught airlines, particularly in the era of O'Leary, that airlines can be reasonably indifferent to the revenue they are generating. Still, to be profitable, they need to keep their costs low. Sherry partly confirmed that and stated that '*Ryanair believes more in lowering cost in terms of feeding into profitability than generating fares*' and '*ancillary revenue would be considered in the breakeven point analysis*'. They also said that some markets (e.g. Cologne, Hamburg) are more difficult due to government protection of flag carriers and market loyalty, but this has changed over the past years. Sherry argues that with its low fares, Ryanair does not cannibalise the carriers but grows the markets.

We empirically analyse the evolution of Ryanair's network based on operational indicators, identifying the main trends and potential limits to growth. We then explore the implications of those factors on the characteristics of demand for travel and tourism.

Ryanair Fleet evolution

The evolution of Ryanair's active fleet is closely linked with the overall growth of the airline. The limited flight network in early 2000 was served by just 26 planes. The fleet consisted of over 400 aircraft by 2019 due to the continuous network extension, the growth in demand, and an ambitious aircraft purchasing strategy. Corneille argues that there are two approaches in fleet planning: bottom-up and top-down. Ryanair followed the latter and the high aircraft orders evidenced this. In fact, a major milestone in the development of Ryanair's business model was the decision to place an order of 100 (plus an option for 50 more) recently introduced B737s during the first major crisis for aviation globally, the aftermath of Sep. 11, 2001 (<https://www.theguardian.com/business/2002/jan/24/theairlineindustry1>). This large order represented more than 25 % of Boeing's annual total deliveries at that moment and allowed the B737 line to sustain a production rate of 14 planes a month (<http://www.b737.org.uk/production.htm>). Given the scale of the operation and the overall uncertainty regarding the market situation, the deal presumably involved a considerable discount on the average aircraft price paid by Ryanair and the flexibility of the contract conditions. As a result, Ryanair achieved lower acquisition costs than most other competitors and enjoyed lower fixed costs for its operations. This advantage – in turn – permitted lower fares and became one of the pillars of the low-cost model championed by Ryanair. However, the massive number of new planes created a commitment for the airline and raised the risk for its operation. The business model faced a significant challenge in operating the enlarged fleet profitably even at lower fare levels. That meant that new markets were needed, where sufficient demand was present, and those planes could be deployed. Sherry stated that Ryanair every season would generate far more route opportunities for aircraft than was necessary to be the '*choosers and the pickers*'. Therefore, they weren't made to enter a particular market just to place an aircraft.

Ryanair decided to make a similar bet for the post-pandemic recovery. The company is negotiating the purchase of 200 B737s for delivery until 2025 (<https://corporate.ryanair.com/news/ryanair-negotiations-for-a-boeing-max10-order-end-without-agreement/>). The crisis caused by Covid-19 is the largest in aviation's and tourism's history, and the uncertainty for airlines is

¹ https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Tourism_statistics_at_regional_level#Tourism_pressures.

higher than in 2001 (Abate et al., 2020). But on the other hand, the relative size of the order compared to the actual fleet size is lower, which limits the risk for Ryanair. Nevertheless, it still reveals the trade-off between risk and benefits and reinforces the importance of aircraft purchasing as part of an airline's business model.

Fig. 1 shows that the growth in Ryanair's fleet was monotonous for most of the period 2000–2019, except during the European financial crisis during 2011–2015 (the crisis in 2008–2009 did not modify the airline's aircraft acquisition strategy in a noticeable way). The 2011–2015 crisis primarily affected Southern Europe (Greece, Italy, Portugal, Spain) and Ireland. Still, the exposure of Ryanair in most of those countries was significant and caused a period of stagnation in the airline's growth in terms of fleet and activity. It was also a reason to accelerate the diversification of the markets where Ryanair sought presence to mitigate the risk of over-exposure in specific areas. An inflexion point can be observed in November 2018, with 169 planes gradually moving to Malta Air & Ryanair Sun starting in November 2018, though the vast majority moved after March 2020. The shift to using additional airline brands (including Buzz and Laudamotion) – apart from the original Ryanair – is a new aspect of Ryanair's development strategy and aims to provide flexibility regarding licenses and the use of beneficial local regulations. The analysis presented here addresses the core Ryanair brand, although the same drivers discussed can be applied to the new brands. Kavanagh highlighted in his interview that Ryanair had a pan-European brand and capital allocation should have been between elements of the network and not operating companies as they degraded the leverage they have as a pan-European brand and created complexity. The new operating companies, especially in the case of Buzz and Malta Air, allow the use of pre-existing bilateral aviation agreements with countries outside the European Single Sky Area and the possibility of extending the geographic scope of Ryanair's network. Kavanagh argues that they could have used the process of Wizz Air, where they kept the same autonomous structure and brand.

The impact of the Covid-19 pandemic was quickly evident after March 2020, with 42 planes retired (“parked”) by May 2021 and the rest of the fleet operating at much lower load factors and flying fewer sectors. A partial recovery of travel demand during



Fig. 1. Evolution of Ryanair's active fleet (number of aircraft).

Source: own calculations based on aircraft delivery and retirement data extracted from <https://www.planespotters.net/airline/Ryanair>, validated with totals from Ryanair annual reports and ICAO registration database.

the summer periods of 2020 and 2021 allowed a higher utilisation of the remaining aircraft. However, it was still insufficient for the operations to maintain profitability.

Practically all planes in the Ryanair fleet are B737 with Y189 or Y197 configurations. The single aircraft type principle is a main element of Low-Cost Carriers and is increasingly becoming a standard in other aviation business models, such as regional carriers. Apart from the possible discounts discussed above, using the same model across an airline provides additional advantages that can eventually be translated into cost savings (flight schedule, aircraft maintenance, certification, training and recruitment of pilots, crews and technicians). Nevertheless, using a single model also poses certain limitations regarding the markets where the planes can be deployed profitably. These include the size of demand and flight frequency (that would allow a high enough share of the 189 or 197 seats would be filled in at prices that could leave a benefit for the airline) or the sector length (which influences the number of daily aircraft rotations and minimum fare to be paid by customers). Kavanagh stated that 'if you have too many aircraft in your fleet, you look for long sectors'.

Ryanair bases evolution

The growth in activity and the exploitation of the rapidly expanding fleet would not have been possible had Ryanair limited its operations to the two bases it used before 2000, Dublin and London Stanstead. The geographic location of those two airports has the advantage of hinterlands that generate and attract an important number of travellers and face limitations regarding the number of destinations and the travel demand that can be served. Complementing the growth of the fleet discussed above, another important element of the development of Ryanair's network was the expansion of the operational bases used. As stated in the [Enablers and obstacles for route expansion](#) section, spare airport capacity is important for Low-Cost Carriers. Each base added to the network permitted the development of a new sub-network with its own combination of flight origins and destinations and assigned aircraft and crews. By 2021, Ryanair operated from 84 bases and served 225 airports in 37 countries, offering over 2100 routes (Table 1). Initially, the airline avoided basing operations in hubs used by national flag carriers to avoid direct competition and achieve lower costs at secondary airports.

Moreover, Ryanair avoided congested airports for reasons explained in the literature review. Kavanagh argues that initially, the cost at airports was very static, whereas nowadays, airport costs and charges structure is more complicated with additional costs like green taxes. Sherry mentioned that Ryanair is usually the biggest or the only customer in secondary airports. Things are structured to the airline's liking compared to larger airports, that can be more complex. Corneille stated that flights to main airports happened as part of the 'always getting better' project, leading to higher yields. However, there are many that they can still not penetrate due to congestion, high airport charges, strong presence of Full-Service Network Carriers or lack of slots (e.g. Heathrow airport).

In any case, the already established hubs would have probably been saturated by local players and would not have left Ryanair room for growth. We also need to remember that slots are allocated based on grandfather rights and that purchasing slots is a challenge for Low-Cost Carriers. Even so, the number of airports without competitors is limited, and the airline gradually increased its presence in major airports, especially after 2010. It continued to avoid direct competition in flag carriers' main hubs. Still, it did enter markets when the major local operator faced major financial difficulties and became uncompetitive (airports in bold in

Table 1
New Ryanair bases 2000–2020.

Year	New bases
2000	1: Glasgow Prestwick
2001	1: Brussels Charleroi
2002	1: Frankfurt Hahn
2003	2: Milan Bergamo, Stockholm Skavsta
2004	2: Rome Ciampino, Barcelona Girona
2005	5: Liverpool John Lennon Airport, Shannon, Pisa, Nottingham East Midlands, Cork
2006	3: Bremen, Madrid , Marseille
2007	3: Bournemouth, Birmingham, Belfast
2008	4: Alghero, Bologna, Cagliari, Edinburgh
2009	8: Bari, Brindisi, Faro, Leeds Bradford, Oslo Rygge, Pescara, Porto, Trapani
2010	8: Barcelona El Prat, Gran Canaria, Kaunas, Lanzarote, Malta , Seville, Tenerife, Valencia
2011	6: Baden, Billund, Budapest , Paphos, Palma De Mallorca, Wroclaw
2012	7: Chania, Eindhoven, Fez, Krakow, Maastricht, Marrakech, Zadar
2013	4: Athens , Brussels , Lisbon, Rome
2014	5: Bratislava, Cologne , Gdansk, Glasgow , Warsaw
2015	6: Belfast, Berlin, Corfu, Gothenburg, Ibiza, Milan Malpensa
2016	10: Bucharest , Corfu, Frankfurt Main , Hamburg, Ibiza, Nuremburg, Prague , Sofia , Timisoara, Vilnius
2017	2: Memmingen, Poznan
2018	4: Burgas, London Southend, Marseille (return), Bordeaux
2020	8: Billund (return), Riga, Stockholm, Corfu, Rhodes, Chania, Zadar, Zagreb

Source: Extracted from <https://corporate.ryanair.com/about-us/history-of-ryanair/> (in bold, airports where local national flag carrier is also based).

Table 1), except Frankfurt am Main and Madrid (in the case of the latter using the gap left when Iberia/IAG moved to the new T4 terminal).

Nevertheless, the list of active bases evolves continuously. Ryanair often decides to close a specific base when market conditions change, especially after the Covid-19 pandemic, or when government/regional financial incentives are insufficient for the airline. For the 2022–23 winter period, Ryanair decided to close its bases in Athens, Brussels Zaventem and Frankfurt am Main, all three airports with strong competition from local Low-Cost Carriers or Full-Service Network Carriers.

The growth strategy in terms of new bases of operation resulted in a much higher geographic diversification for the airline (Fig. 2). Sherry stated that cost was the main point of consideration even when opening bases and commercial principles were applied. Even though London Stansted and Dublin remain the largest bases in terms of connections and passengers, at least 40 airports in Europe and North Africa are bases with Ryanair traffic that – on its own – is comparable to a small or medium-sized airline. With their relatively high degree of decentralised management of operations, the bases optimize the use of the resources allocated to them and have been a key driver of activity for the airline. According to Sherry, a base can be important to ensure the first wave of flight from an airport (when there is that directional need), and airports perceive bases as a security factor that generates local employment and, therefore, are willing to offer a better deal. Each base uses locally managed flight crews and ground personnel in proportion to its allocation of aircraft and routes. There is no minimum requirement as regards the number of planes operating from a base, which can be as low as a single aircraft, nor the number of destinations served (which depends on the frequency of connections with each destination and the number of aircraft allocated to the base).

Establishing new bases and selecting flight connections to operate was not deterministic. It involved extensive ‘trial and error’, as is probably the case for aviation network development globally. Several bases were removed from the network (and, in some cases, were later re-established). The cost of establishing a base can be significant: for example, according to Ryanair’s own estimates, the investment in a 2-plane base in Nuremberg costs \$200 million. Many flight connections were eventually cancelled, with bases or destinations replacing them and the available planes frequently redeployed. While there was growth in aggregate terms in both the number of bases and the number of origins-destinations served, there is a significant churn rate concerning

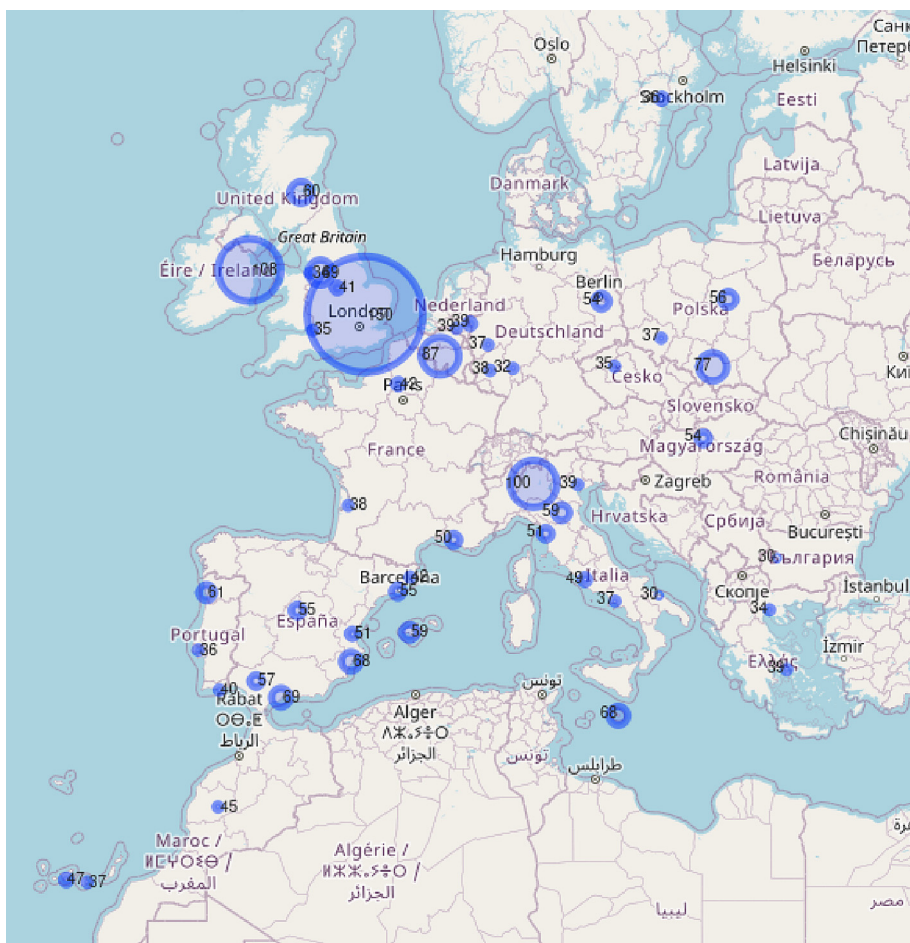


Fig. 2. Airports with more than 30 connections offered by Ryanair, 2019. Source: own calculations based on SABRE Market Insights data.

individual routes. In his interview about how airlines develop their routes, Corneille referred to incidents of ‘pet routes’, meaning routes developed because senior management dictated them without objective criteria. Ryanair never introduced ‘pet routes’. Corneille stated that it usually takes airlines 3 years to drop routes with low traffic, Aer Lingus dropped that recently to 18 months, and Ryanair is 3 months. Kavanagh suggested that airlines should drop low-traffic routes within 3 months and redeploy the assets quickly. It seems that 3 months is the ideal time to decide on a route’s future. The continuous re-evaluation of route viability is an additional element of the airline’s priority of maximizing the aircraft utilisation profitability and – as a result – of the airline as a whole.

Flight distances and frequencies

As discussed in the [Enablers and obstacles for route expansion](#) section, Low-Cost Carriers seek high aircraft utilisation and a wide catchment area, among other factors. Kavanagh identified the geographical locations of airline bases central to population masses as a significant factor that can offer many advantages regarding flight distance (time) and production cost. Kavanagh brought the example of the EasyJet route Liverpool-Belfast with a frequency of 12 routes/day. He said there were no taxes at the time, it was the shortest possible sector, it used 1.5 airplanes and the floor price was £19 because that ‘*was enough to generate the load factor you needed*’.

As a result of Ryanair’s market expanding in new geographic areas that do not offer shorter distance opportunities, the average length of flights across the airline has been continuously increasing (Fig. 3). From just over 600 km in 2000, when the only bases were Dublin and Stansted, to over 1200 km for most months after 2015. Most growth in flight connections came from the 1500–2000 km band, where the optimum operational exploitation of aircraft is probably located. Most Low-Cost Carriers in China operate in the 600–1800 km range (Wu et al., 2020). The median route distance in 2017 was 1415 km for Spring (China), 1438 km for Ryanair, 1201 km for EasyJet, 1366 km for Southwest (USA) and 1773 km for JetBlue (USA), while the median distance weighted by seats ranged from 964 km to 1703 km (Dobruszkes & Wang, 2019). Flight duration can be around 90 min at that range, and an individual plane can serve more than 6 sectors daily. According to Sherry, passengers’ willingness to pay depends on the fare, largely regardless of the flight distance. Potential travellers often perceive fares for shorter or longer flight durations as expensive in absolute terms, even if the cost is proportional to the travel distance. The wider geographic distribution enabled by the growth in bases and destinations allowed the airline to cover a larger number of routes that offer the flight distance and fare combination for which there is higher demand.

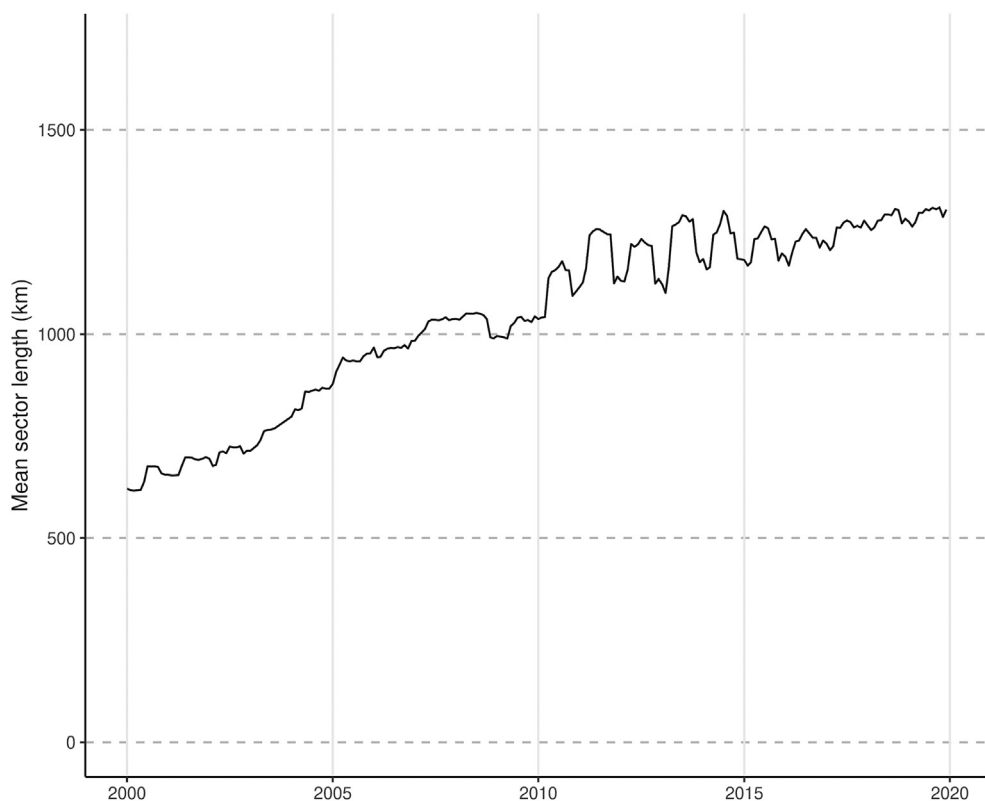


Fig. 3. Evolution of mean flight distance (monthly).

Source: own calculations based on SABRE Market Insights data.

There are obviously several outliers in the distribution of flight distances that – at least for a specific period – are viable for various reasons. The shortest routes served by Ryanair were Belfast City, UK–Prestwick, UK (129 km, operated between 2007 and 2010, 1×–2× daily) and Málaga, Spain–Tetuán, Morocco (132 km, started in 2019, 1× weekly), both being alternatives to a ferry plus road trip. Kavanagh stated that there is a ‘sweet spot’ of 4 or 6 aircraft rotations a day, but as the economies of scale began to be exploited and revenue management techniques employed, an hour sector makes sense. So, the shortest possible flight (i.e., taking 1 h for an Origin–Destination) allows for higher aircraft utilisation and more passenger traffic to generate more ancillary revenue. Moreover, when we factor in the various cost incentives and co-advertisement revenue from tourism authorities, Low-Cost Carriers like Ryanair prefer to serve short sectors and expand their network utilising short sectors. Yet, there are longer sectors that can be profitable. The longest route was Skvavsta Stockholm, Sweden–Tenerife Sur, Spain (4291 km, 231 total flights each way during the 2013–2019 winter periods), which served a market of high purchasing power travellers to a warm destination during the low season.

Seasonal variation is a major challenge for most airlines' aircraft utilisation and network development. Sherry said that season extension can be challenging and depends on the destination. In the case of Ryanair, the mix of routes operated caused significant instability in terms of the weighted average of sector length at a monthly level, especially between 2010 and 2015. The high share of holiday destinations increased the average flight distance in the summer and returned to lower levels during the winter. Introducing bases and routes that do not depend on summer tourism gradually allowed a more stable performance at an airline level.

The level of aircraft utilisation and the route flight frequency are two additional challenges from the operational point of view (Fig. 4). A main competitive advantage for Ryanair in its early years – more than 7 daily flights per aircraft on average – cannot be easily maintained: the average fell to about 6 in the high season and 4 in the low season. This probably signifies a limit for at least this element of the Low-Cost Carrier model and is a natural consequence of the trade-off with increasing average flight distance at an airline level. With existing markets quickly saturating, Ryanair needs to explore new connections at a wider geographic scale, and the options for a high level of aircraft utilisation are reduced.

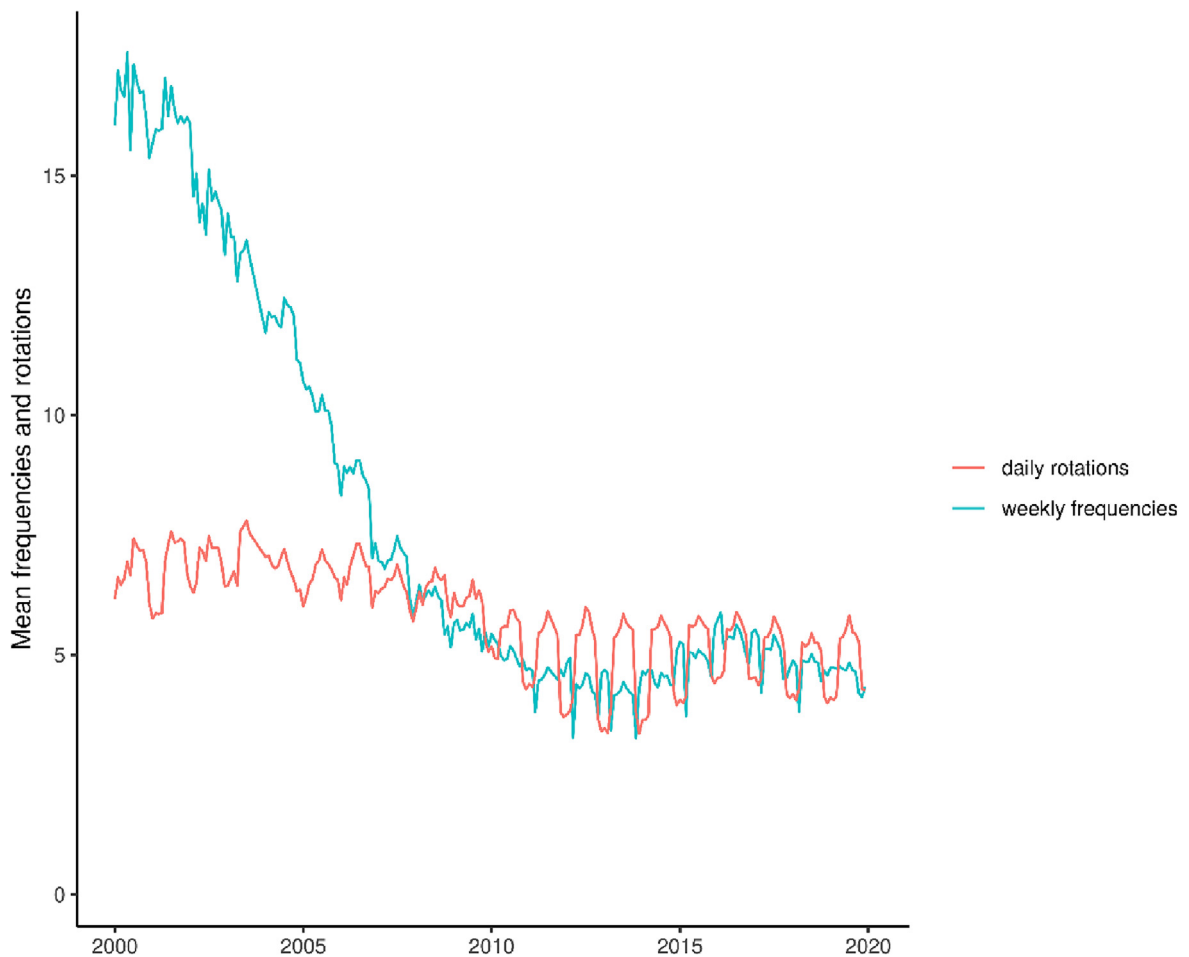


Fig. 4. Evolution of daily flights per aircraft and weekly route frequency (monthly mean).

Source: own calculations based on SABRE Market Insights data.

Regarding flight frequency, the growing coverage of the Ryanair network means that the new market the airline enters cannot ensure sufficiently high levels of demand. This is a natural consequence of the law of diminishing returns that all businesses are faced with when operations are scaled up. Ryanair typically starts new routes with a 2× weekly frequency, intending to eventually increase to daily, 2× daily, or higher if sufficient demand builds up. Expanding the network to new bases and airports with lower demand meant that a large number of 2× or 3× weekly connections were added. As a result, the mean for the airline fell from over 15 a week (i.e., at least 2× daily) to about 5/week in 2019 (Fig. 4).

Fig. 5 shows an example of frequency distribution for June 2019. Most routes are served by 2 or 3 flights a week, while there is a considerable number of 1/week connections. There is a long tail in the distribution, with some high frequency routes of several flights a day, but those are concentrated mainly in Stansted. Occasionally Ryanair appears to ‘flood’ a specific market for a short-term period, perhaps to disembark into a new market or as part of a –questionable but legal– move against a competitor. This happened in the Stansted-Dublin and Athens-Thessaloniki cases, but both cases were short-lived tactics that the existing demand could not justify. Corneille argues that they have a ‘predatory’ approach and in some cases, ‘they go into a market to own that market’. In the case of Dublin-Cork, when Ryanair deployed a B737 on the route, some other operators entered the market and at its peak (and for a short time), the daily frequency reached 13 flights. However, Ryanair persevered and once the others withdrew and their monopoly was secured, Ryanair reduced capacity and ultimately withdrew from the route altogether. Predation, where an airline lowers the fares in response to the market entrance of a new rival, has also been noted (Gilroy et al., 2018). High seasonal variation is also evident in the aircraft rotation and weak flight frequencies. As with average flight distance, the situation appears to be under control after 2015, mainly due to the new bases added, providing a more stable demand throughout the year. Sherry stated that in some cases, the low frequency could ‘kill off a route’, and high frequency may not be profitable in other cases.

Market concentration and airline dependence

All interviewees recognised the interconnection of aviation and tourism, and Kavanagh highlighted that aviation creates economic value for tourism destinations. Sherry argued that in the destinations where tourism is a big part of the local economy and the airport is part of the local infrastructure (e.g. publicly owned), the airport is fully aligned to the region’s tourism needs and a collaboration with the airline is easier. The airport, in those cases, is less concerned about the yield it will make off passengers and considers the tourism spending potential overall.

Using Ryanair as an example of the main trends in Low-Cost Carriers network development, we can identify certain aspects that may influence the interplay between air transport on the one hand, and developments in travel and tourism, on the other.

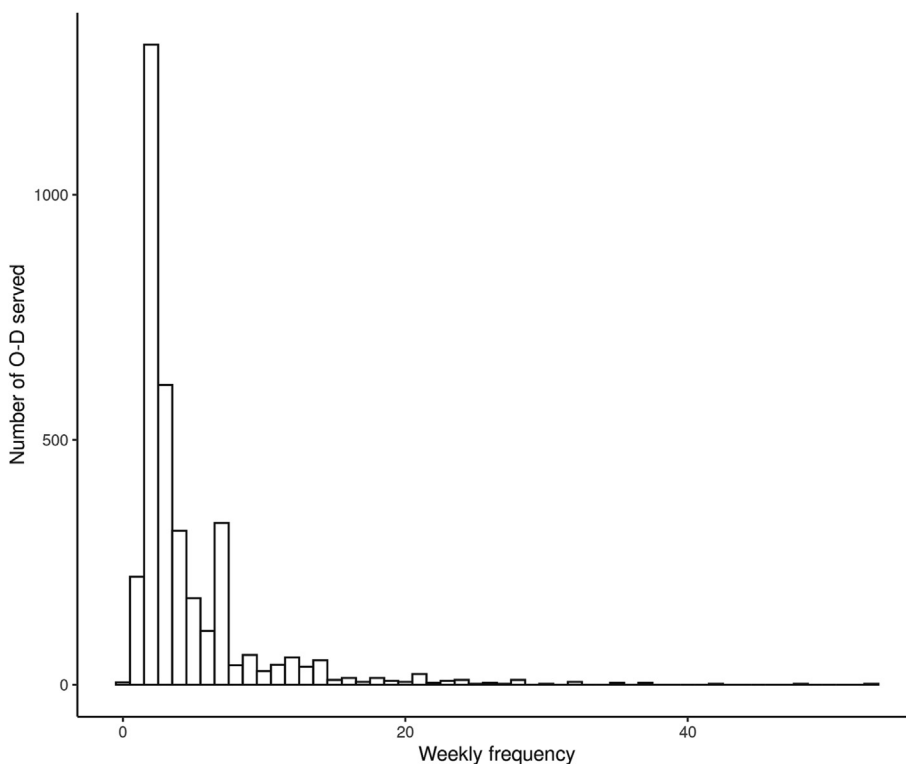


Fig. 5. Distribution of weekly frequency per Origin-Destination pair (June 2019).

Source: own calculations based on SABRE Market Insights data.

The growth of Ryanair was initially – until 2004 – based on adding bases at secondary airports that were not widely used at the time (e.g. Charleroi and Bergamo). Most of those bases successfully developed their markets, and Ryanair maintained its position as the dominant airline until nowadays. According to Sherry, high seasonality is an element faced by Low-Cost Carriers serving tourism destinations. Kavanagh argues that Low-Cost Carriers' incentivisation can drive and stimulate traffic, especially for regional airports that wish to expand their seasonality. He argues that structures need to be sustainable. The massive presence of Ryanair has proven a double-edged sword for the airports themselves and their hinterland. Ryanair flights attracted more visitors and allowed increased connectivity while preventing other airlines from achieving a significant market share. However, the main risk for the airport was that Ryanair decided to stop operations from a specific base. This happened, for example, when the airline closed the base in Girona and shifted part of its operation to El Prat, Barcelona, with important repercussions on Girona's traffic and tourism activity in the region surrounding it.

The dependence of an airport or a region on a specific airline can therefore be a main concern. A base of a Low-Cost Carrier or Full-Service Network Carriers tends to induce additional travel demand, but may also lead to a high market concentration for the airline that operates the base. Fig. 6 shows the degree of market concentration and the share of the largest airline across European airports in 2019. Out of 360 airports, 19 depend almost exclusively on one airline (HHI higher than 0.9), and Ryanair is the dominant airline in 9 of them. There are 58 airports where the market can be considered highly concentrated (HHI between 0.5 and

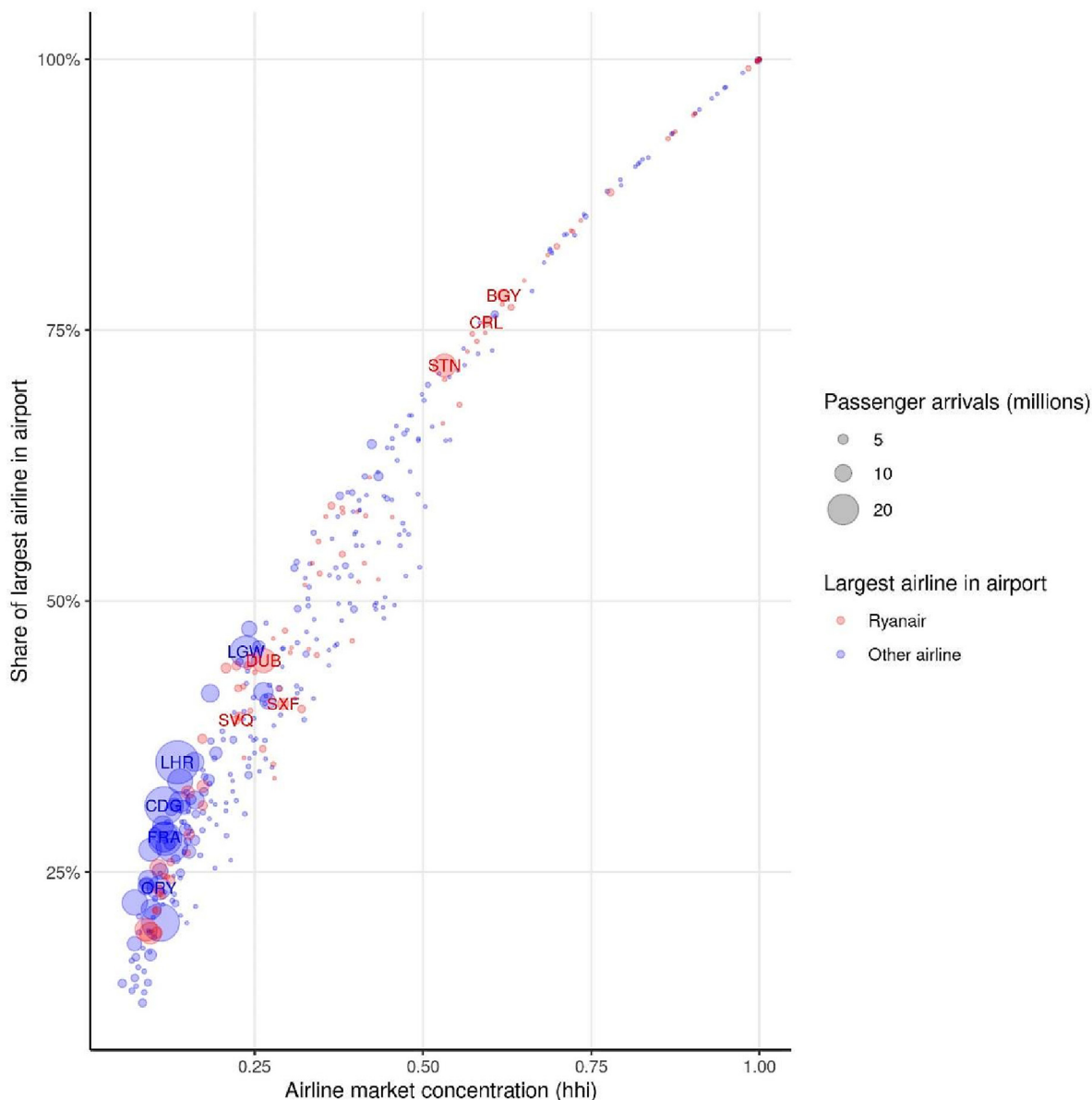


Fig. 6. Airline market concentration per airport, Europe, 2019.

0.9), in 22 of which Ryanair is the airline transporting the most passengers. Three of the main Ryanair hubs – Stansted (STN), Charleroi (CRL) and Bergamo (BGY) – belong to this category and reflect the legacy of the airline's network development strategy in the early 2000s. The majority of the remaining Ryanair bases operate in a more competitive landscape. Ryanair has the largest share of passengers in Dublin (DUB), Berlin Schönefeld (SFX) and Seville (SVQ), but shares the market with a relatively high number of other airlines.

The distribution of the values of the HHI indicators across the airports with Ryanair's presence reveals another trade-off in the network development strategy. The new bases added to its network need to be connected with flights to major airports with competitive markets to expand its market presence. This is necessary to ensure that a critical mass of demand is available and obliges Ryanair to compete for slots and other provisions without the oligopsony advantage it may enjoy in smaller airports.

Source: own calculations based on SABRE Market Insights data.

The average for the EU in 2019 was about 671 nights spent in touristic establishments/km² across the EU territory. Tourism pressure tends to be higher in regions where space is at a premium, such as capital regions, major urban regions, and some

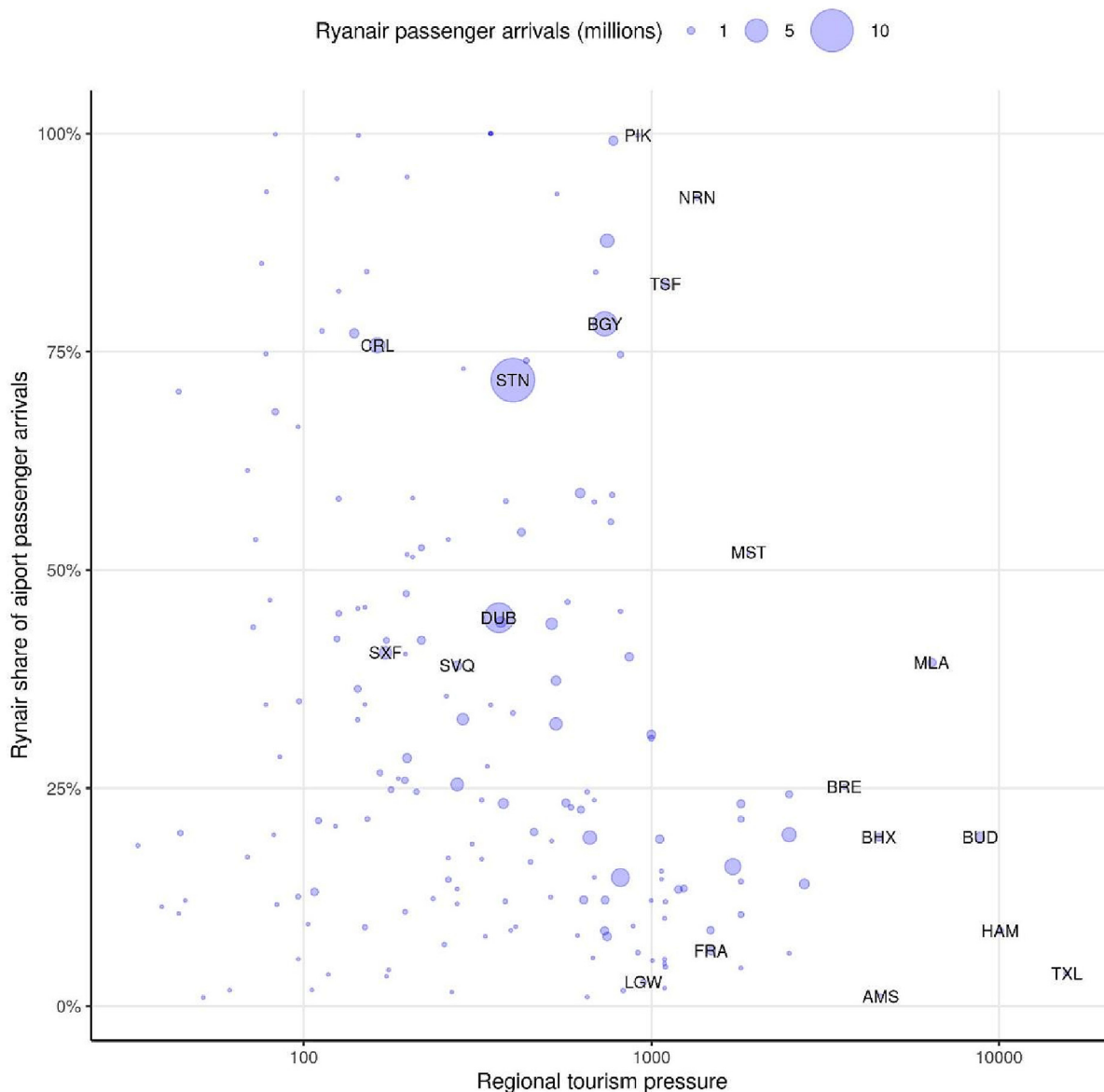


Fig. 7. Ryanair share and tourism pressure, Europe, 2019 (x axis in logarithmic scale, nights/km²). IATA airport codes: AMS (Amsterdam), BGY (Milan Bergamo), BHX (Birmingham- West Midlands), BRE (Bremen), BUD (Budapest), CRL (Charleroi), FRA (Frankfurt am Main), HAM (Hamburg), LGW (London Gatwick), MLA (Malta), MST (Maastricht), NRN (Weeze), PIK (Glasgow Pitwick), STN (London Stansted), SVQ (Seville), TSF (Treviso), TXL (Berlin Tegel). Source: own calculations based on SABRE Market Insights data.

coastal (particularly small islands) regions. In contrast, tourism pressure is relatively low in many eastern and northern regions and the interior regions of France and Spain.

In the case of Ryanair, there is a balanced distribution regarding the importance of tourism for the airports served (Fig. 7). The number of passengers to or from airports in high tourism-pressure regions is a small share of the total (e.g. in Berlin or Amsterdam). In contrast, the airports with a higher market share tend to rely less on tourism (e.g. Stansted, Charleroi and Bergamo). In fact, most airports where Ryanair is present serve less tourist destinations. This results from the airline's network development strategy, which demonstrates a preference for less frequented airports and a move towards capturing or creating demand for travel outside the traditional market segments. This is also reflected when Ryanair's presence is mapped against tourism pressure (Fig. 8). Regarding tourism pressure, Ryanair has a limited presence in the regions in the top 25 quartile (for example, in the Canary Islands, the Balearic Islands, Crete or the Algarve) and is very active in regions of low tourism pressure in Poland, France and Ireland.

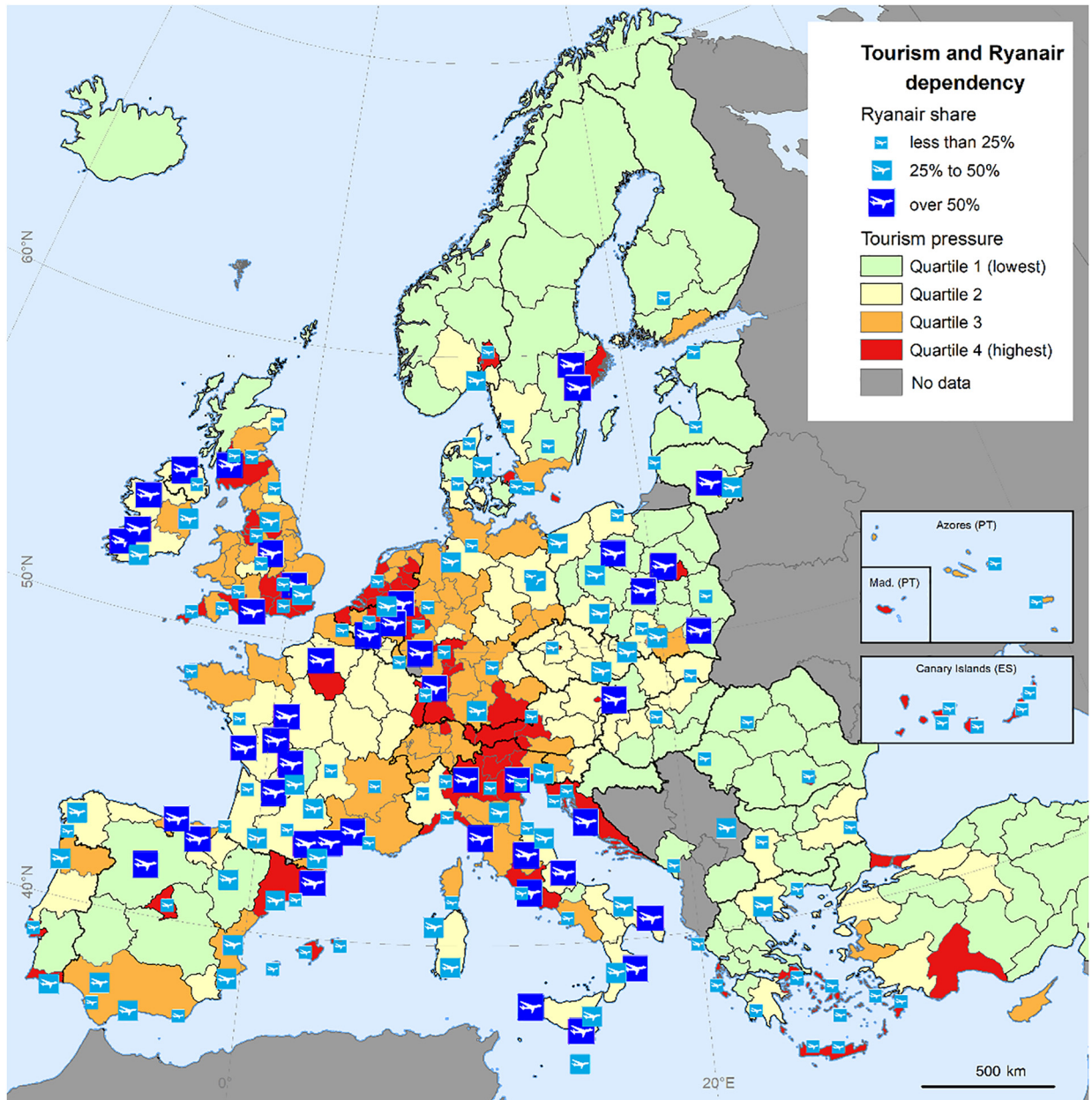


Fig. 8. Tourism and Ryanair dependency, Europe, 2019. Source: own calculations based on SABRE Market Insights data.

Conclusions

Using Ryanair as a case study, we found that large Low-Cost Carriers follow a top-down approach in their network development strategy. This approach implies a general objective of maximizing profit through the continuous expansion of the fleet and the geographic coverage of flights, instead of a bottom-up approach based on the satisfaction of the travel demand in a given geographic area.

The Low-Cost Carrier business model relies on a 'sweet spot' of 90 min in flight duration. This combines traveller preferences (time but also the willingness to pay) and operational requirements (sectors/day, cost/pax-km). Low-Cost Carriers in Europe (e.g. Ryanair) benefited from air transport liberalisation at a European level but now face limitations in two directions. The European market is at a very mature stage with high levels of competition, which in practice means that most profitable routes are already exploited. The diminishing returns from adding capacity within Europe do not permit the expansion's speed to be maintained. In parallel, being close to reaching full geographic potential, there is a need to expand outside the EU + EEA. Still, the lack of international aviation agreements is a hurdle for most potential markets in Eastern Europe, the Middle East and Africa.

Operational challenges include the need to address seasonality and daily/schedule-based variation. New travel demand segments such as visiting friends and family, city breaks, or other non-traditional travel purposes can decrease seasonal variability and increase growth. Smaller airports with high slot availability and expanding bases eastwards provide additional levers for optimizing scheduling.

As established by various researchers (e.g., Law et al., 2022; Tang & Jang, 2009), there is bi-directional causality between airline network evolution and travel demand. The Low-Cost Carrier growth depends on entering new geographic markets and exploiting/promoting emerging market segments such as visiting friends and family or short breaks in non-traditional destinations. The case of Ryanair provides empirical evidence of how the growth patterns of airline networks depend on the spatial and temporal distribution of demand. It is also evident that the choices of airlines in terms of network development affect the demand to and from the airports served, often creating new opportunities for travel and tourism that would not have been possible without the operation of a Low-Cost Carrier.

While this business model appears to be followed by most short-haul Low-Cost Carriers in Europe and the rest of the world, the geographic distribution of demand, the technological evolution on the aircraft side, the general economic conditions and the travel preferences of users can potentially lead to further refinements or new paradigms. For example, long-haul Low-Cost Carriers use larger aircraft and require connections between high-population centres, resulting in networks that evolve in a substantially different manner.

The paper contributes to the body of knowledge in the travel and tourism literature by providing evidence of the practices of route development at a domestic and international level. Low-Cost Carriers contribute to tourism arrivals and support numerous tourism destinations' discovery, revival and development. Insights about Low-Cost Carriers network and, more specifically, fleet deployment, base evolution, flight distances, and frequencies, enhance the understanding of airline and airport practitioners and destination management professionals and provide new insights into theory. Some areas of further research include the competition between air and rail transport and the effect this has on the network structure and tourism flows and measuring the bi-directional causality between airline networks and tourism demand. Another potential area is the comparison of Low-Cost Carriers point-to-point and Full-Service Network Carriers hub-and-spoke network development. Finally, the competition of High-Speed Rail with air for Origin-Destination markets is another area that will add to the discourse.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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