Determinants of air traffic volume and structure at small and medium regional airports in Europe

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Abstract

This study investigates the determinants of air traffic volume and structure at regional European airports serving below 1 million passengers per annum. It discusses the airport choice factors for airlines and focuses on the characteristics of airport and its catchment area in order to explain variation in traffic volume for 146 regional gateways in 21 EU countries. Through the application of multiple linear regression and correlation analysis it is found that population size, airport charges and presence of capacity constraints are the most related to the number of passengers using the airport. Several different correlations are found with respect to the share of low-cost, full-service and charter carriers in the airport traffic, which in most cases extends findings of other researchers onto the field of small regional airports. The research concludes that while certain relationships can be found, their statistical significance is moderate, which leaves a scope for further study, perhaps involving smaller samples of airports. Findings of this study should be of interest to air transport researchers and to all the parties involved in route network development at regional airports, particularly to local authorities and airport operators.

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Abbreviations

Throughout this paper, IATA codes are used with reference to appropriate airlines and airports. These can be found in appendices 2 and 3 respectively.

Other abbreviations used include:

CC- charter carrier

FSC- full-service carrier

LCC- low cost carrier

MLR- multiple linear regression

1. Introduction

1.1 Route network development

The subject of route network development is a part of the wider topic of airport-airline relationships. It involves airline and airport strategies with respect to the air traffic connections they establish. While route network development has no universal definition, it generally discusses which routes an airline operates and why, what airports it selects and how it competes with other carriers' networks. Also, it concerns how airports are connected to each other and what type of traffic they serve.

1.2 The problem of airport choice factors

The airport-airline relationship in Europe has been transforming in recent years (Starkie, 2012). As the Copenhagen Economics (2012) report for IATA summarises, there is increasing competition between airports for airline services.

Some airport operators, for instance, tried to make themselves more attractive to particular carriers, by redeveloping the existing infrastructure or constructing new airports (e.g. Warsaw Modlin Airport) in a way that supports particular traffic types (Njoya and Niemeier, 2011). Also, regional authorities and private business entities have subsidised air services, hoping that the resulting inbound traffic would propel the local economy and tourism (Bel, 2009; Francis et al., 2003).

The general framework of the airport-airline relationship and airport route network development strategies have been discussed by Graham (2014, 2010). Others investigated causalities between airline traffic and more specific variables, such as catchment area expansion (Pantazis and Liefner, 2006), route volatility (Humphreys et al., 2006), airline negotiating power (Francise et al., 2004; Gillen and Lall, 2004), airfare level (Barbot, 2006; Malighetti et al., 2009), incentive schemes (Starkie, 2012), airport commercial revenue (Lei and Papatherodou, 2010) or financial performance (Papatherodou and Lei, 2006; Graham and Dennis, 2007).

The network strategies of carriers have been changing. It has been recently identified that European LCCs increasingly focus on major gateways, often at the expense of regional airports (Dobruszkes et al., 2017; Dziedzic and Warnock-Smith, 2016). Moreover, there are some fully-operational, newly-opened regional airports that are struggling to find sufficient demand from airlines (e.g. Radom Airport in Poland). This proves there is still not enough understanding of how airports can attract airlines. Given the fact that European carriers are increasingly footloose in their network decisions (Humphreys et al., 2006; Copenhagen Economics, 2012), the question arises as to how airport operators may secure an appropriate level of traffic in the years to come.

1.3 Motivation for a study

Such trends are particularly unfavourable to regional airports, which are often impatiently expected by their local communities to establish new routes and connect regions to destinations around the world. On the other hand, the limited interest from the air carriers and the changing market dynamics make this task very difficult to achieve. Also, the problem of securing the necessary level of traffic will be particularly troublesome for small and medium airports which are, due to their size, the most vulnerable to the airlines' changing minds.

At the same time, the literature appears to concentrate on larger airports whilst small regional gateway airports have their own problems and specificities, which make it worthwhile focusing research on them and what they can do to attract traffic.

Therefore, both literature and the market trends do leave scope for further study into determinants of airport traffic volume at smaller European gateways. Broadly speaking, this is the research gap this paper aims to fill.

1.4 Research questions

The following research questions were developed in order to understand route network development at small and medium regional airports:

- RQ1: What are the determinants of air traffic **volume** at small and medium regional airports in Europe?
- RQ2: What are the determinants of air traffic **structure** at small and medium regional airports in Europe?

1.5 Aims and objectives

To navigate the research, the following aims and objectives were formulated.

Aim 1: To analyse the determinants of air traffic volume at small and medium regional airports in Europe.

- Objective 1.1 To examine and categorise airport choice factors for airlines.
- Objective 1.2 To investigate the importance of airport choice factors for airlines in the context of air traffic volume.

Aim 2: To examine traffic patterns at small and medium regional airports in Europe.

- Objective 2.1 To present the structure of traffic at the considered airports.
- Objective 2.2 To investigate the relationship between airport choice factors and airport traffic structure.
- Objective 2.3 To discuss volatility of traffic at the considered airports.

1.6 Structure of the thesis and the research process

Table 1.1 provides details on how the thesis is organised and how and where the aims and objectives are realised.

Aim	Objective	Chapter	Addressing the objective by:
1. Determinants of air traffic volume	1.1 - airport choice factors	2. Literature review	- Reviewing the literature
		3. Discussion of airport choice factors	- Categorising the factors - Introducing industry examples
	1.2 - importance of factors	4. Methodology	- explaining the methods used
		5. Results	- presenting the results
		6. Discussion of results	- interpreting the results
2. Traffic patterns	2.1. - structure of traffic	4. Methodology	- explaining the methods used (descriptive statistics)
		5. Results	- presenting the results
		6. Discussion of results	- interpreting the results
	2.2. - relationship between airport choice factors and traffic structure	4. Methodology	- explaining the methods used (correlation analysis)
		5. Results	- presenting the results
		6. Discussion of results	- interpreting the results
	2.3. - air traffic volatility	5. Results	- presenting the results (descriptive statistics)
		6. Discussion of results	- presenting the results and examples

Table 1.1 Structure of the paper in the context of the aims and objectives

The rest of this study is organised as follows. The next two chapters aim to achieve the objective 1.1. Chapter 2 reviews the literature involving the airline and airport route network development. It provides a background for chapter 3, which categorises and discusses the airport choice factors more broadly, but also introduces the real-industry examples.

Chapter 4 presents and justifies the methodology applied in this study. It refers to the objectives 2.1 to 2.3. Then, the results obtained using this methodology are discussed in chapter 5. Airport traffic structure, its volatility and relationship with the airport choice factors are presented then. Finally, chapter 6 discusses the structure of airline networks at regional airports, presents causes of the current situation and compares the results among similar studies.

Chapter 7 summarises the research and presents the conclusions. Also, recommendations for future studies are made.

Complementarily, the graph on the next page outlines the research process map, which helps to understand the structure of the paper and the course of actions undertaken by the author of this study in order to meet the aims and objectives.

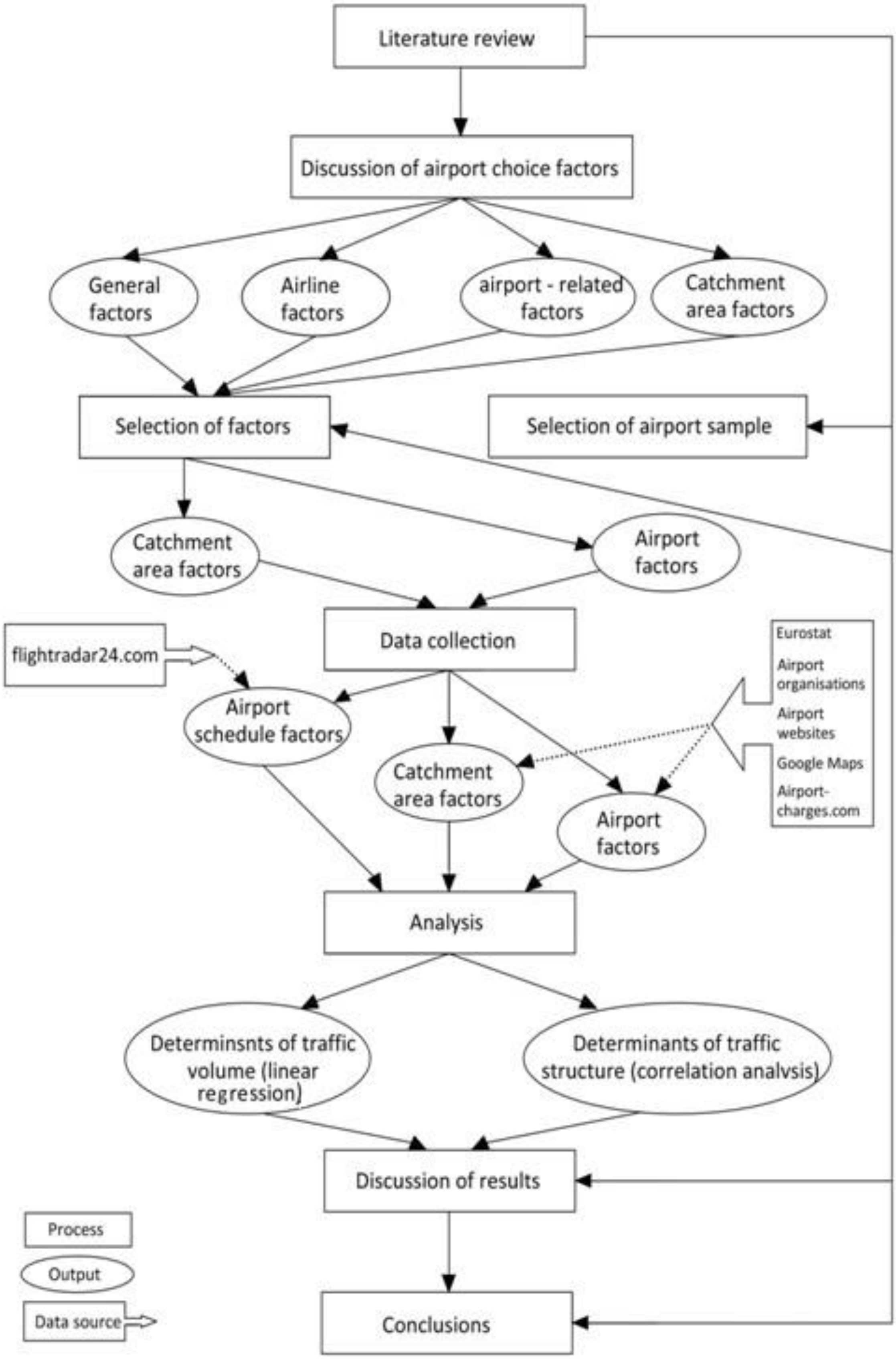

Figure 1.1 Research process map

2. Literature review

2.1 Technique of the literature review

The aim of the literature review was to establish the current state of the art with respect to how airlines select the airports they operate from. This question has been addressed in many different ways by both airline and airport management. For instance, it may be considered a part of airline strategy, either in the frames of the general business model, competition with other carriers, or specifically with respect to route network development. It can be also central to many aspects of airport business - attracting airlines can be the role of the marketing department, top management, or of the independent route development team. Moreover, other areas, be it airport benchmarking or airline internationalisation strategies, also indirectly involve the problem of route network development and airport choice factors. Therefore, since route network development involves many areas, the literature should be reviewed from multiple angles, using several keywords in order to capture as many perspectives as possible.

To identify the relevant literature, Scopus engine was used to include the widest range of potential sources. The following enquires were used:

'airport choice factors',
'airport attractiveness',
'airport airline relationship'
'airport route development'.

No time limitation was applied, although the majority of the papers found were published after 2000. This is due to the fact that significant changes in airlines' behaviour have taken place following the growth of LCCs in the first two decades of this century.

Particular attention was given to individual journals which appeared the most often cited in the relevant literature and thus seemed appropriate for this study. These include: Journal of Air Transport Management, Journal of Transport Geography and Journal of Transportation Research Part A. The issues of these journals from the past 5 years were browsed in order to identify the current trends with respect to airport route network development.

The literature review objectives were to identify, among others: what factors were analysed, what impact each factor has, what methodologies were applied, and what airlines or markets were studied.

These aspects are often interrelated, although the following review will aim to present them in a comprehensive way.

2.2 Literature review

2.2.1 Methodological approaches

Various methods and tools were used to understand how airlines choose airports. One of the most intuitive is to make judgments based on the general observation of the market. For instance, Barrett (2004) and Doganis (2006) described how the demands for the airport product diverge between different types of carriers. Such works do bring insights of the airline industry and are valuable for formulating the generalisations, although require frequent updates as the market undergoes constant evolution.

Others chose a direct contact with airport or airline operators, or a panel of experts, in order to understand the actual industry practices. Classic questionnaires and surveys were the most commonly used in such cases. Warnock-Smith and Potter (2006) used them for the explorative study into airport choice factors of LCCs, while Halpern and Graham (2016) found them appropriate for investigating factors affecting route network development and performance of small airports. While providing information directly from the airline and airport units responsible for network development is a key advantage of such studies, they have been burdened with a rather low response rate.

Discrete choice modelling is yet another method used in the literature. An extensive piece of work in this style was done by Kupfer et al. (2016), who applied this method to systematise knowledge on the origin and destination airport choice for cargo airlines. As a method, it simulates the real market situation and is likely to provide the results that are similar to the decisions made by airline and airport managements in the actual industry. On the other hand, complexity, amount of time required and potential bias due to the participating airlines, are drawbacks of this method.

Airport choice and airline competition were also investigated using game theory. Barbot (2009) employed this method to analyse how airports cooperate with their carriers in order to compete against other airport-airline pairs. A question arises, however, whether airlines and airports are aware of the decisions they make and whether game theory can solve the complexity of route network development.

Finally, statistical and mathematical models have also been used to explain route network decisions. The work by Dobruszkes et al. (2011), which is the closest to this paper in terms of the approach and problem considered, represents this type of methodology. By looking at factual, numerical market data and application of a multiple linear regression model, Dobruszkes et al. (2011) established what determines the volume of air traffic in metropolitan areas in Europe (i.e. what makes an airport attractive to airlines). This method enables the use of extensive, real market data in order to detect trends and relationships between air traffic volume and, for instance, local economies. Nonetheless, it may be viewed over-simplistic given the actual market complexity.

Summing up, no standard method has been developed to analyse airport choice factors for airlines. Instead, a researcher can choose from several different and mutually complementary methods. Each method has its own limitations and advantages and therefore its usage should have justification in the specifics of the study carried out.

2.2.2 Perspectives assumed

As mentioned before, route network development can be viewed from multiple perspectives. This was the case also among the academics, who researched this subject assuming the perspective of an airline, airport, regulator or individual market. Most of studies so far focused on the two major market players in aviation, i.e. airlines and airports.

Considering the regulatory side, the first studies discussing how carriers develop their networks appeared after the deregulation of the market and the introduction of free market rules with respect to route network decisions. The contemporary, regulated environment received criticism and academics tried to propose the new optimal industry setting, e.g. regarding the most advantageous location of hubs in Europe. For example, it was noticed that a new system of hub-and-spokes had developed in Europe due to deregulation and that national carriers still maintained their positions in the market (Burghouwt and Hakfoort, 2001). This changed a few years later, when Europe saw a rapid growth of LCCs. Owing to deregulation, this sector of the market developed significantly and introduced new dynamics into the air transport sector. New carriers, through development of European point-to-point networks, undermined the status quo and reduced the role of many FSCs (Starkie, 2008).

Second, route network development was compared among airline types. A general framework for airline business models was established, according to which the low-cost carriers (LCCs) operate to and from secondary airports, while primary gateways are used by full-service carriers (FSCs) (e.g. Barrett, 2004; Doganis, 2006). The rapidly changing nature of the market made this framework questionable. LCCs sought growth by expanding into primary markets, traditionally controlled by FSCs (e.g. Klophaus et al., 2012; Dziedzic and Warnock-Smith, 2016). Instead of business models, specific airlines could be also analysed. Muller et al. (2012) analysed the network of an LCC JetBlue and found that the carrier avoided concentrated airports and targeted dense routes when entering new markets. Also, network competition between different airlines was analysed (e.g. Franke, 2004). It was shown that LCCs stimulate the market and attract a new demand, thus acquiring large market shares (Pitfield, 2007). Entry of LCCs into the market was also found to lead to the reduction of fares offered by other carriers, even on the routes unaffected by direct competition (Windle and Dresner, 1999).

Network development could be also looked at from the perspective of individual markets. Most of the research focussed on US and European markets (e.g. Burghouwt and Hakfoort, 2001), although some studies reviewed other continents (e.g.Cheng et al., 2008)), or the markets at the city of region level (e.g. Lu and Mao, 2014),. The geographical scope is thus variable, and even though many similarities were found between different markets, each of them has its own specifics. For example, Europe historically sees more international traffic compared to other continents and its largest traditional carriers play a significant role, especially on domestic routes (Reynolds-Feighan, 2010, Alderighi et al., 2012). Moreover, the networks in Europe are constructed around a few node airports and the carriers avoid the American, pan-continental network type (Reynolds-Feighan, 2010). The Asian market is in turn characterised by larger aircraft types and less developed airport infrastructure, which limits the choice of new destinations the airline can serve (Chang et al., 2008).

Yet another perspective is the airport's one. More attention has been given to how the major airports are attractive to airlines. This is probably caused by their larger role in the market, academic attractiveness and data availability. Even in the few cases where regional gateways were a subject to the research, the authors tended to exclude the smallest airports (Zuidberg and de Witt, 2016b). Of course, a few notable exceptions exist (e.g. Lian and Ronnevik, 2011; Adler et al., 2013; Dobruszkes et al., 2017), although it can be generalised that small regional airports have not been in the mainstream of academic research.

2.2.3 Airport choice factors and their meaning

The closest approach to the one presented in this paper is the one oriented at airport choice factors. In this type of study, the academics tried to understand in what way specific factors influence the airline route network decisions, for instance in terms of which airports to serve, where to grow capacity and what routes to open. Taking into consideration different characteristics of destinations, the researchers hope to identify trends and similarities in airlines' behaviour. It is perhaps this method that allows the identification of the most significant factors.

A thorough analysis of these factors, however, is beyond the scope of a literature review. Therefore, only the summative list of airport choice factors considered in different studies is presented in the table below[1]. More detailed discussion and analysis will be provided in a separate chapter of this paper.

[1] It needs to be noted that the table includes only those studies that involved a wider study of factors of airlines. Shorter, specific studies are not included at this stage, as they do not provide such a general outlook of the airport choice factors, although they will be cited in the next chapter.

Author	Adler and Berechman, 2001	Dobruszkes et al., 2013	Barrett, 2004	Boguslaski et al., 2004	Lawton and Solomko, 2005	Warnock Smith and Potter, 2005	Chang et al., 2008	Muller et al., 2011	Lu and Mao (2014)	Dziedzic and Warnock Smith (2016)
Context	26 AP, mostly big in W.Europe, 19 AL,	European metropolitan areas	FSC vs LCC	Southwest in US	Asian LCC market	European LCCs	LCCs in China	JetBlue in US	LCCs in Taiwan	European LCCs
Passenger demand	X			X	X	X	X	X	X	X
AP location		X				X	X		X	X
Slot availability / airside congestion	X					X		X	X	X
AP operating hours							X		X	
Environmental and night operation restrictions	X									
ATC reliability/ navigational aids	X				X		X		X	
AP fees/ discounts	X		X		X	X	X		X	X

Author	Adler and Berechman, 2001	Dobruszkes et al., 2013	Barrett, 2004	Boguslaski et al., 2004	Lawton and Solomko, 2005	Warnock Smith and Potter, 2005	Chang et al., 2008	Muller et al., 2011	Lu and Mao (2014)	Dziedzic and Warnock Smith (2016)
Context	26 AP, mostly big in W.Europe, 19 AL,	European metropolitan areas	FSC vs LCC	Southwest in US	Asian LCC market	European LCCs	LCCs in China	JetBlue in US	LCCs in Taiwan	European LCCs
AP capacity						X	X			
Dedicated infrastructure									X	X
Aircraft maintenance									X	
AP surface transport							X		X	
Passenger processing time	X		X							
Turnaround time	X		X			X			X	X
AP design and layout	X		X				X			
AL experience at the AP						X				X
Non-aeronautical revenues						X				X
Airport ownership						X				

Author	Adler and Berechman, 2001	Dobruszkes et al., 2013	Barrett, 2004	Boguslaski et al., 2004	Lawton and Solomko, 2005	Warnock Smith and Potter, 2005	Chang et al., 2008	Muller et al., 2011	Lu and Mao (2014)	Dziedzic and Warnock Smith (2016)
Context	26 AP, mostly big in W.Europe, 19 AL,	European metropolitan areas	FSC vs LCC	Southwest in US	Asian LCC market	European LCCs	LCCs in China	JetBlue in US	LCCs in Taiwan	European LCCs
Quality of the labour force	X									
Labour costs	X									
Cost of procuring local services	X					X				
Delay data	X									
National administrative function		X								
International administrative function		X								
Economic decision-power		X								
Knowledge and scientific research		X								
Tourism attractiveness		X				X				X
GDP/income		X		X				X		
Unemployment								X		
Population		X		X				X	X	

Author	Adler and Berechman, 2001	Dobruszkes et al., 2013	Barrett, 2004	Boguslaski et al., 2004	Lawton and Solomko, 2005	Warnock Smith and Potter, 2005	Chang et al., 2008	Muller et al., 2011	Lu and Mao (2014)	Dziedzic and Warnock Smith (2016)
Context	26 AP, mostly big in W.Europe, 19 AL,	European metropolitan areas	FSC vs LCC	Southwest in US	Asian LCC market	European LCCs	LCCs in China	JetBlue in US	LCCs in Taiwan	European LCCs
AL competition				X	X	X		X		X
AP competition		X				X				X
Route length				X				X		
AP type				X				X		
Network economies/ AP compatibility with the AL network	X			X				X		

Table 2.1 Airport choice factors according to the literature reviewed (selected). Based on Lu and Mao, (2014). AP= Airport, AL=Airline

What is the most striking is the number of potential factors that affect the airlines' choice of airports. As researchers recognise, there is a myriad of aspects that affect the decision whether a route will be opened (Kupfer et al., 2016). Second, it can be seen that different factors play a role depending on what airline or market type is considered. Different airline business models imply different strategies, and particular markets may involve unique opportunities or create specific barriers. In other words, airline route network development is indeed a complex field.

Regarding importance of factors, demand was almost always recognised crucial in establishing a new route. Adler and Berechman (2001), Boguslaski et al. (2004), Lawton and Solomko (2005), Muller et al. (2011), Lu and Mao (2014) and Dziedzic and Warnock Smith (2016) uniformly found the demand to be important, if not necessary, for airline services. Intuitively, no demand equals no supply in the free market. Unless the route is served under the Public Service Obligation (PSO) scheme, an airline has no interest in operating a route nobody wishes to use. In this sense, the whole essence of route network development could be narrowed down to forecasting traffic and entering the most promising routes (e.g. Vasigh et al., 2013). It, however, focuses solely on the results of forecasts and ignores their drivers. Given the long list presented in the table, it appears that demand is driven by all the remaining factors and therefore cannot be simplified.

Moreover, none of the studies specified whether it is the volume or the quality of demand that matters. Presumably it is the latter, because presence of high-yield passengers can justify the operations even in case of lower load factors (Doganis, 2006). In other words, an airline may benefit from entering a thin route and still be profitable despite not full utilisation of aircraft capacity. This is especially important for small regional airports which by nature cannot generate high volume of demand. Furthermore, in some cases the volume of demand is difficult to estimate and negligible in the short run. For instance, it was found that LCCs, having entered the market, generate a new demand which would not appear if the low-cost service was not available (Brandt, 2003; Doganis, 2006; Pantazis and Liefner, 2006). Last but not least, lack of high demand on certain routes is not a disqualifying factor for FSCs. Through long-term presence on thin routes, the airline may generate transfer traffic vital for other routes and also build its position in the market in the long run (Pels, 2008). Therefore, demand is indeed a significant airport choice factor, although its understanding is clouded.

Another key factor is airport costs and availability of incentive schemes. Lower charges were especially expected by LCCs, as they reduce the overall operational cost (e.g. Bel, 2009; Graham, 2013). Today, however, this expectation became common for other carriers as well. It is also owing to European regulations, according to which an airport cannot apply a preferential charging policy to selected carriers and discriminate against others (Jones et al., 2013). Furthermore, in the light of the LCCs' move towards more expensive, primary airports (Dziedzic and Warnock- Smith, 2016), the actual importance of airport charges appears to be lower in practice.

The next frequently mentioned factors were the turnaround time and availability of slots. Again, this traditionally referred to the LCCs, which preferred short aircraft stays on the apron and thus operated from less congested airports (Lawton, 2002; Calder, 2003; Barett, 2004). Also, it has been questioned whether the availability of capacity is enough for smaller airports to avoid leakage of traffic to main gateways (Lian and Ronnevik, 2011; Dziedzic and Warnock-Smith, 2016). On the other hand, however, lack of convenient slots can be an obstacle serious enough to block the airline entry to the airport (Czerny, 2008). A good example of this is charter and cargo carriers, which rely to a large extent on night operations (Kupfer et al., 2016).

Other authors indicated airport location as another important factor. It can influence airline entry in two ways. First, distance to the nearest competitive airport may be considered (Chang, 2008; Dobruszkes, 2013). In this context, location is an indicator of competition the airport faces from its neighbours, but also of the airline's flexibility to switch to another gateway without exiting the market. On the other hand, airport location may be understood as proximity to the urban area it serves. Airports located closer to city centres were traditionally selected by FSCs serving business traffic, while remote ones were used by LCCs and CCs to cater for leisure and tourism traffic (e.g. De Neufville, 1995).

Considering the distance to the city centre, airports can try to reduce their impact by improving their ground transport accessibility (Warnock-Smith and Potter, 2006; Chang et al., 2010). Widening the modes of transport offered and increasing the frequency or improving the standard of service may make it easier for potential passengers to reach the airport, which translates into higher potential demand and access to airline services.

The last of often cited factors is airline competition. In this respect much depends on the airline's attitude to facing competition. As Mueller at al. (2012) noted, some markets may be simply too small to be catered by more than one airline. Therefore, typically carriers avoid direct rivalry and presence of one airline on the route usually deters other operators from serving it. Nonetheless, it cannot be ignored that competition in Europe is increasing (Copenhagen Economics, 2012) and it is a matter of time before carriers compete directly on more routes.

Finally, there are many other choice factors which appear sporadically in the literature. They can still be critical for the airline's decision about launching a particular new route. It is, however, difficult to generalise on the impact these factors have, as their role usually depends on the specific airport, airline or route and they will be reviewed in Chapter 3.

From the above discussion, yet again a complex picture of airport choice factor arises. Not only are the airport choice factors numerous, but they also have distinct meanings for each airline or market. Moreover, their importance and actual influence have changed over the years and may still undergo further changes. This leaves scope for a wider study which would compare different carrier types and verify the role of particular airport choice factors.

2.3. Regional airports' perspective

Apart from the examples mentioned in 2.2.2, less attention has been given to the smaller, regional airports in the literature. Specifically with respect to the airport choice factors and determinants of air traffic volume, the author is not aware of any previous study involving small airports.

More often, such airports were a subject to studies involving smaller airport samples, limited to a particular region or country (e.g. Castillo-Manzano, 2008; Campisi et al., 2010; Augystyniak et al., 2015). This is probably due the fact that researchers have access to data for specific, separate segments of the market, rather than for all the airports. Also, some authors mentioned state aid and public subsidies as important conditions for new routes being launched from regional airports (e.g. Barbot, 2006; Bel, 2009), some of them concluding that public aids may be economically reasonable (Malavoti and Marty, 2017).

2.4. Summary- identification of knowledge gaps

The preceding literature review showed a wide but rather disorderly picture of airport/ airline route network development. Airport choice factors for airlines have been analysed from various perspectives in the past. There are a few major limitations of the literature which this paper aims to address.

Firstly, the research undertaken so far appears fragmented. Different perspectives were applied in different studies, which resulted in a high number of papers discussing different elements of the same subject, i.e. airport/airline route network development, sometimes leading to inconsistent conclusions. What is more, the richness of the literature may also lead to vague conclusions. As different studies involve different factors, ultimately it may be difficult for an airport operator to how they are related to each other and how they affect each other Therefore, the knowledge needs to be systematised and discussed jointly in one study in order to provide a wide picture of airport choice factors and to understand their relative importance.

Secondly, large airports have received the greatest attention in the literature. This is probably due to the popularity of the larger gateways and lack of available data for smaller ones. Nonetheless, small regional airports constitute a significant group of airports in Europe and an analysis of their situation will assist in understanding of the overall market.

Thirdly, LCCs were studied more often than other airline types. It is not surprising given the changes they have brought to the market, although other carriers cannot be forgotten. Therefore, more attention should be directed at CCs and FSCs.

3.Discussion of airport choice factors

Numerous factors have been shown to affect an airline's choice of airport (Kupfer et al., 2016). This chapter thoroughly discusses these factors. For the purpose of clarity, the factors are classified into the general, airline related, airport-related and catchment-area related ones. Based on the literature review, classification was found by the author the most appropriate for this study. First, it includes airlines and airports, i.e. the two main parties involved in networking processes. Second, it spreads onto the political and jurisdictional external environment these parties operate in. Finally, it includes the airport's hinterland, along with its population and economy. One needs to remember, however, that other divisions are possible, as certain factors are mutually related (e.g. political stability affects economy of the region). Thus, the categorisation presented in this study should be considered exemplary one

3.1 General factors

Air transport is influenced by the political and jurisdictional framework it exists in. This framework establishes the macro environment for aviation, lays the foundations for the market and sets the limits for its growth. It indirectly affects factors in other groups and in that sense determines the network strategies of airlines and airports.

3.1.1 Air transport regime

There are several economic/jurisdictional factors, which establish the legal boundaries of the air transport market. Burghouwt (2007) labels them jointly as the air transport regime. On the one hand, the air transport regime involves regulation of prices, market share, frequency and capacities, and on the other, the extent to which a state controls its airspace and access to the market. In practice, it regulates what routes can be opened and the conditions which potential carriers must meet. For instance, the recent loosening of sanctions related to aircraft refueling is expected to create opportunities for Iranian carriers to launch new routes (Clark, 2016). Contrarily, in the past Russia threatened to withdraw EU carriers' rights to fly over Siberia, which could lead to rerouting of many long-haul flights, making them unprofitable and eventually causing their suspension (Hille, 2014).

Considering the European market, the EU operates a Single Aviation Market (SAM), implemented through three liberalisation packages. Since the third package came into force in 1997, the Community carriers are free to fly between any two points within the Community (including domestic routes in foreign countries), offer whatever frequency with whatever aircraft they wish and set fares at the level they find appropriate commercially (Staniland, 2008). These conditions were further extended to Iceland, Norway and Switzerland to form the European Common Aviation Area Agreement (European Parliament, 2017). Of course, access to markets can be restricted when the route is operated under the Public Service Obligation scheme (European Parliament, 2017), nevertheless the principles of a free market and competition are dominant in the European regime (Burghouwt 2007)

The practical effect of the SAM in Europe was the growth of low-cost carriers' (LCC) and point- to- point flights between the member states (Starkie, 2008). The new industry setting was especially beneficial for regional airports, which traditionally had been connected to the rest of the world through hubs. The number of intra- ECAA routes increased by 145 percent within fifteen years of the introduction of the third package (Holloway, 2008). The relaxation of market rules not only provided airlines with a wider choice of airports, but it also made the carriers more footloose (Halpern and Graham, 2008). Thus, while airports can attract more airlines, maintaining the incumbents is another problem. This is consistent with the ACI report, which indicates that small airports face an increasing threat of traffic loss, as the point-to-point connections they serve can be easily relocated by airlines (Copenhagen Economics, 2012).

3.1.2 Political stability

Political stability and terrorism further impact aviation growth. Attacks targeting aviation or using aircraft as a tool directly inhibit the industry growth, as they increase fear of flying among people (Vasigh et al., 2013). For instance, the 9/11 attacks triggered the industry downturn, hitting especially US airlines (Gillen and Lall, 2013). However, non-aviation terrorism also harms the industry. Political instability in a country may deter potential visitors and in turn make the airlines retreat from the respective market. Following the 2016 terrorist attacks in Turkey, several charter airlines stopped serving the country and an FSC Delta abandoned its plans to launch the Istanbul to New York service (Clampet, 2016).

3.2 Airline- related factors

This group of factors refers to the airlines themselves. Its fundamental assumption is that a particular airport presents a different value for different airline business models (Lordan, 2014). Unfortunately, due to changing market dynamics, the literature is gradually lacking a clear-cut distinction of airline business models. There is no agreement on what elements they consist of (Daft & Albers, 2013) and even when some standard distinction is employed, significant differences still occur among airlines classified under the same label (Mason & Morrison, 2008). Thus, rather than reviewing a model, it is enough to consider only those elements that dictate the airline network strategy. This section does so and based on the most detailed list of such elements known to the author (i.e. by Daft& Albers, 2013), identifies the following factors:

3.2.1 Network design

Airports have to fit the network of airlines. Airlines expect them to be compatible to their own networks and increase their network economies (Adler and Berechman, 2001; Boguslaski et al., 2004; Muller et al., 2011). The two most common network types in the literature are point to point (PP) and hub and spoke (HS) (e.g. Cheng-Lung, 2010).

In an ideal PP network, all the airports are connected directly with each other (Burghouwt, 2007). In practice, however, such networks tend to be arranged around several base airports, from which the carriers access the main destinations (Hanlon,2007) and some direct flights are not operated due to operational, economic and political issues (Alderigihi et al., 2007; Cento, 2008). In the HS systems, all airports are connected indirectly through one or a few airports (hubs), rather than through direct flights. This allows airlines to connect many cities with fewer flights than in a PP network, although this comes at a cost of complexity related to transfer of luggage and passengers between connecting flights.

PP systems are traditionally used by LCCs and CCs, while HS networks are the domain of full-service carriers (FSCs) (Pels, 2008). Therefore, the former two are theoretically interested in serving any airport regardless of its transfer capabilities and geographical location. By extension, FSCs seek an optimal hub airport which supports transfer operations. Therefore, the choice of a hub is further constrained by the airport capacity, minimum and maximum connection time, quality of connections, delay data, reliability of air traffic control and local labour force costs (Adler and Berechman, 2001; Alderighi et al., 2007). Given the above, it can be said that LCC would be less constrained in launching a route from a regional airport. Contrarily, FSC would need to assess the potential transfer traffic. Time of operation would have to be adjusted appropriately to the wave structures, so that passengers travelling from a regional airport would be given enough time to make connections to another journey legs in the hub.

Airline's network design also dictates the average length of operated routes (Daft and Albers, 2013). For instance, airline entry to the route is positively correlated with the route length for long haul carriers (Boguslaski et al., 2004; Muller et al., 2011). Therefore, an airport will only be considered by an airline if the potential route is of the appropriate length for the airline business model. Unusually, SAS decided to establish its own LCC subsidiary to serve short-haul routes (Sumers, 2017). Nonetheless, at some stage the only method to extend the network for a carrier is to enter more and more remote regions, thus increasing the average route length. That is why the average route length of European LCCs has increased by 100 km in nearly a decade (Dobruszkes, 2013). The increase of route length may also be explained by the fact that on the other hand shorter routes are more often dropped by the airlines (de Wit and Zuidberg, 2016).

Naturally, there are exemptions to the above rules. First, several FSCs maintain PP connections despite operating HS systems elsewhere (Hanlon, 2006; Alderighi et al., 2007). For instance, LOT will launch flights from Budapest to US regardless of operating a hub in Warsaw (Liu, 2017). Second, some LCCs do perform transfer operations (Fichert and Klophaus, 2012; Lordan, 2014) and plan to launch feeder services (e.g. Ryanair- Hofmann, 2017). Also, LCC traffic tends to concentrate around a set of bases and create base-and-spoke systems (Dobruszkes, 2006). This suggests that an airport will be selected by the LCC if it can be efficiently connected with one of its existing bases.

3.2.2 Geographical focus

Another criterion limiting the choice of airports for an airline is its geographical focus. Firstly, an airline may focus on a niche region and operate flights only in a selected area, similarly to Aloha Airlines concentrating on intra-Hawaii routes (Taneja, 2004). Alternatively, it can master in accessing specific destinations. This is the case for Brussels Airlines and Iberia having a large number of destinations in Africa and South America respectively, or for charter companies which focus on tourism-attractive destinations.

Secondly, the geographical focus is dictated by where the airline is located. For instance, the FSC strategy is closely related to the location of the hub (Wu, 2010). Usually, such carriers reinforce their position in the region by operating to the nearby airports and providing connectivity through the hub. To some extent this is influenced by the airline's nationality and ownership, particularly for flag carriers controlled by national governments (Doganis, 2006; Albers et al., 2010). Especially in the past, networks of state-controlled carriers were based on their home markets (Berechman and de Witt, 1996) which is the reason why the geographical focus is sometimes measured by the percentage share of domestic flights operated by the airline (Daft and Albers, 2013). However, it is not necessarily limited to the country and airlines may target broader regions (Burghouwt and de Witt, 2005), for example, LOT entering the Hungarian-US market (Dobruszkes, 2013).

3.2.3 Fleet

Another element determining the airline's network strategy is the type of aircraft it operates. In the strictest sense, the airline can only serve routes within the range of the aircraft it uses and when the selected airport is technically prepared to handle this aircraft. While the range restriction can be artificially eased by adding intermediate stopovers to access remote airports (e.g. SAS operating a route between Copenhagen and Buenos Aires, Hanlon, 2007), the airport technical requirements are inflexible (Ashford et al., 2013)

Especially in the past, network development was driven by aircraft capabilities (Swan, 2002). Today, aircraft's unique performance makes serving a particular route more or less viable. For instance, carriers operating regional jets are more likely to enter shorter routes with high population on both ends (Savage and Scott, 2004). More recently, following the introduction of Boeing 787, airlines not only used them to replace less efficient aircraft, but were also more likely to establish new routes that had not been served before (CAPA, 2014) As of 2017, 17% of all the routes operated by B787s were new (anna.aero 2017). Another thing is that airport needs to be technically prepared to handle appropriate type of aircraft. This directly impacts several regional airports, as they may find their infrastructural parameters (e.g. runway length, ILS category) insufficient to serve an airline. Notwithstanding, aircraft technical characteristics play only a partial role in airline scheduling. Other aircraft- related problems the airlines consider include: how to schedule flights to meet the desired frequencies and serve targeted markets; what size of aircraft to assign to each flight; how to satisfy maintenance requirements for aircraft, and which crew to assign to each flight (Barnhart and Cohn, 2004). Therefore, it may be summarised that an airline will only be interested in serving an airport if it is technically possible and economically reasonable to do so, given the type of aircraft the airline operates.

3.2.4 Access to different types of airports

The airline business model also regulates what types of airports an airline seeks. Primary airports are preferred by FSCs, which use them as hubs or important O&D markets. Secondary gateways are recognised more attractive for LCCs and to some extent to charter carriers (CCs) due to lower congestion and more attractive airport charges compared to the primary gateways (Williams, 2011). However, some of the LCCs downsized their capacities at secondary airports.. A decade ago, Boguslaski et al. (2004) found that Southwest Airlines explore a market through secondary airports, while a later study of JetBlue entry patterns by Muller at al. (2011) brought mixed conclusions in this respect. Also in Europe the LCCs have reduced their reliance on secondary airports (Dziedzic and Warnock-Smith, 2016) and expanded towards the major airports. Finally, regional airports are characterised by lower activity of FSCs, which use them as spokes within their networks (Jarach, 2005). Instead, they are central to the strategy of LCCs (Williams, 2011). Also the CCs operate to holiday destinations underserved by FSCs (Pels, 2008), which usually means a regional airport.

3.3 Airport- related factors

Another group of choice factors includes airport characteristics. It describes the technical and managerial profile of an airport, understood as a company along with its infrastructure. Based on these factors, airlines assess how attractive a business partner the airport is and what level of service it provides. This is the level where comparisons between airports can be made and where an airport can try to differentiate itself from competitors.

3.3.1 Airport charges

Airport charges constitute 3-5% of airline total cost (Fichert and Klophaus, 2011; Jones et al., 2013, Graham, 2014). The shorter the routes an airline operates the more frequently it visits airports and thus the more it spends on airport charges. Therefore, aeronautical fees can influence the carrier's network decisions. Historically, especially LCCs and charter carriers negotiated lower rates with airports (Francis et al., 2003; Barrett, 2004; Warnock-Smith and Potter, 2005). This brought a chance to regional airports, which used low charges to attract newcomers (Francis et al., 2003). Over time, the expectation of low fees has been present also among the FSCs (Adler and Berechman, 2001) and has become common for all the airlines. For instance, Lufthansa's CEO has publicly expressed such expectation following Ryanair's entry to Frankfurt (Hofmann, 2016). Recently, however, the airport fees appear to be less critical than in the past, given the LCC growth at primary airports, which are traditionally more expensive to operate from.

According to the literature, an airport operator may reduce the charges in a way that favours use of a particular type of aircraft, or enhances growth of passenger numbers. For instance, lower fees may be introduced for bigger aircraft if the airport seeks to grow long-haul traffic (Graham, 2008) However, airports are not always free to set charges on their own - in many countries the airport charges and discounts are subject to regulation by an appropriate body or airport group (e.g. Bel, 2009). Also, the operator can hardly limit the discounts to selected airlines only, as other incumbents would oppose (Francis et al, 2004; Fichert and Klophaus, 2011). Last but not least, it is against the EU law to impose lower charges selectively, without making them equally available to other carriers (Barbot, 2006; 2009).

Therefore, while it can be generally stated that airport charges do influence airline network decisions, one should be aware of their rather moderate importance nowadays, as well as of the legal constraints associated with the application of aeronautical discounts.

3.3.2 Incentive schemes

An incentive scheme is a tool used by the airport operator to achieve traffic or route growth (Allroggen et al., 2013). Usually it includes aeronautical discounts, but it may equally encompass other non-financial benefits offered to the airline, such as marketing support, revenue guarantees, data or contact provision (STRAIR, 2005). Rebates are usually given to airlines achieving a certain threshold of passenger numbers, reaching a defined growth rate, launching a route specified by the airport, or a new route in general (Fichert and Klophaus, 2011). In Europe, larger airports operate incentive schemes that support long term growth, while smaller more often implement systems favouring a particular airline (Malina et al, 2012). This suggests that schemes operated by regional airports may in fact lead to domination of a single carrier or type.

Through application of incentives, the airport accepts part of the risk associated with the operation of new routes. This in turn makes it less risky financially for an airline to enter or grow at the airport. For instance, termination of incentives was to stop Ryanair growth in Dublin (Mulligan, 2016). On the other hand, airlines will not launch a route solely due to the presence of incentive schemes available (Warnock Smith and Potter, 2005). Also, incentives no longer secure a competitive advantage if they are applied by other airports. This is already the case, as 63% of the top 200 European airports employ some type of incentives (Malina et al. 2012).

Therefore, the importance of incentives is blurred. Some expect their role to increase in the future (Jones et al, 2013), although they have become more or less a standard in many regions of Europe. The literature has not yet established how successful the airports have been in applying the incentives and whether or not they helped to develop the desired traffic (Malina et al., 2012).

3.3.3 Labour costs

The scope and type of airline activity is also influenced by the level of labour costs at particular airport. Whenever the airline's presence at the airport becomes more stationary, e.g. it hires a station manager or establishes a base, these costs may play a role. This may be excercised by regional airports, as labour costs in their areas is usually smaller than in big, metropolitan areas. The relationship between labour cost and the base likelihood of LCCs was analysed by Zuidberg and de Wit (2016), who found it particularly important for easyJet. Another issue is labour reliability. In countries with stronger unionisation, it is more difficult for an airline to apply strict policy towards its staff and the airline management faces a higher risk of labour strikes. To give a practical example, the dispute between labour unions and Ryanair eventually made the carrier close its Billund base in 2015 (The Crouch, 2015).

3.3.4 Efficient turnaround

Airlines, especially LCCs, try to minimise the amount of time the aircraft spends on the ground (Barrett, 2004). Quickness of the aircraft turnaround was found the second most important criterion for LCCs when selecting an airport (Warnock-Smith and Potter, 2005) which was confirmed elsewhere (Dziedzic and Warnock-Smith, 2016).

While the 30 minutes turnaround was initially required by LCCs (Doganis, 2006), it is now considered standard for most short and medium haul flights, regardless of the airline type. Subject to airspace availability, procedures, type and number of passengers, apron limitations, ground handling performance (Wu, 2010), all airlines keep the turnaround time as short as possible. The airport should then try to influence as many of these factors as possible in order to ensure quick turnarounds and become attractive to carriers. For instance, Norwegian teaches its airports how to reduce turnaround (Eva, 2013) and external audits in this area are offered by Boeing (2017).

3.3.5 Operating hours and slot times

Airports may be imposed a night curfew, which limits or even completely ban aircraft operations during specified time-frames. This seriously decreases airport attractiveness, especially to the carriers reliant on night operations, such as charter and cargo airlines (Gardiner et al., 2005). Shorter operating hours are also negatively related with the LCC base likelihood (Zuidberg and de Wit, 2016). For example, a planned curfew for Warsaw Chopin is expected to make Wizzair and charter carriers relocate some of their operations to the nearby regional airports (Tulodz, 2017), which can serve night operations.

Airport availability to the airlines can be also constrained by slot regulation. Air carriers are interested in serving the airport primarily in the most attractive time of the day, so that the flights they operate are more convenient to their passengers and also fit the airline's own network. For instance, easyJet considers slots between 6 and 8 in the morning as crucial for achieving a desirable aircraft rotation throughout the rest of the day and lack of slots may block the airline from serving an airport (Warnock-Smith and Potter, 2005, Muller et al., 2012). Slots are important also for FSCs operating hub and spoke networks, since they additionally need to coordinate flights so that they arrive into the hub at a similar time. Even though regional airports may appear less constrained in the context of slot constraints, an airline wishing to connect it with a coordinated airport firstly needs to possess landing and departure slots at the latter.

While such constraints are generally faced by large airports, IATA slot coordination applies even to some smaller ones, especially those serving seasonal traffic. For example, relatively small airports of Annecy or several Greek Islands (Sitia, Kithira, Lemnos) are slot coordinated (IATA, 2017). This affects charter carriers, which cannot fully exploit the potential of tourism traffic in the season.

3.3.6 Ground accessibility

The airport may increase its attractiveness by improving its ground accessibility (Pantazis and Liefner, 2006; Malina et al., 2012). Barrett (2004) generally stated that good transport facilities are important especially for remote airports used by LCCs. Later, they were classified moderately important (Warnock-Smith and Potter, 2005) or even unimportant (Dziedzic and Warnock- Smith, 2016) in airport selection. Less attention has been given to other airlines in this context, but it seems that especially rail transport is important for FSCs, as sometimes the rail services are operated under code-share agreements with airlines. That is why availability of a TGV station made some airlines remain in the old terminal at Paris CDG airport rather than move to the new facility together with other carriers from the same alliance (Wu & Lee, 2014). Summing up, an easily-accessible airport may be convenient to potential passengers and therefore increase the airport's attractiveness to airlines, especially those cooperating with ground transport providers. Regional airports may wish to take advantage of ground accessibility ba attracting traffic to a secondary destination and distribute passengers further in the region using a well-developed transport infrastructure.

3.3.7 Distance to the city

Simply, the closer the airport is to the city, the more accessible it is for the local population. This argument has been used by FSCs operating from major airports, as opposed to LCCs focusing on remote gateways. Today, airlines appear to recognise that an airport's proximity to the city directly affects its potential to attract business passengers (Dziedzic and Warnock-Smith, 2016) and that some airports may be located too far from the city to effectively serve it (Dobruszkes et al., 2017b). Especially when two airports aspire to serve the same city, the remote one has lower chances for growth. Nonetheless, when only one airport serves the city, as is the case for most regional airports, distance is no longer a source of competitive advantage.

Alternatively, distance to the nearest major airport, rather than to the main city the airport serves can be measured (e.g. Liu et al, 2006). For instance, a study on Italian airports by Campisi et al. (2010) showed that airports located closer to big hubs (rather than to their own cities) experience highest growth. Contrarily, less accessible regional airports see much lower traffic.

3.3.8 Airport competition

Distance to the nearest major market, or to the nearest airport in general, can be also considered a proxy of airport competition. The closer two airports are located to each other, the more similar their catchment areas are and the easier it is for an airline to relocate. In theory, a carrier can exercise airport competition in three ways. Firstly, by cooperating with its airport and competing against neighbouring airport-airline pairs. For instance, a regional airport may work in pair with an LCC in order to compete with a local major airport and its carriers. Secondly, by threatening to move to an alternative location and increasing pressure on the operator to achieve specific goals (e.g. lower airport charges). Thirdly, an airline may effectively use two airports without cannibalising its own traffic.

The literature, involving primarily LCCs, is inconclusive in this respect. Klein (2015) found that competition from neighbouring airports makes base establishment less likely. Zuidberg and de Witt (2016), however, found no correlation between these two phenomena. Moreover, it is not always clear which airports compete against each other, especially when they are not located in the same city (Dziedzic and Warnock- Smith, 2016). Also, catchment area range varies over time. Therefore, there is no standard measure of airport competition. For instance, IATA (2012) estimates that 63% of Europeans live within two hours' drive of at least two airports. Others use the total number of airports located within a certain radius (Zuidberg and de Witt, 2016), within the same administrative unit (Dobruszkes, 2017), or the distance to the nearest major airport (Liu et al., 2006).

Therefore, while it can be assumed that airport competition impacts the airline network strategies, diversity of approaches in this field makes it difficult to draw more specific conclusions.

3.3.9 Dedicated infrastructure

In reaction to the growth of LCCs, several studies compared infrastructural requirements of LCCs and FSCs (e.g. Pitt and Brown, 2001; De Neufville, 2006; De Neufville, 2008). Some of the airports took a note of different expectations, especially from the side of LCCs, and developed dedicated infrastructure that suits their purposes (Halpern and Graham, 2013). It has been confirmed by the cases of several airports that such infrastructure drives down the airline costs (Hanaoka and Saraswati, 2011) and favours growth of the number of routes (Njoya and Niemeier, 2011).

Smaller regional airports, however, are less likely to construct infrastructure for a specific airline type. Given their uncertain future, they try to provide a standardised, extendable product to handle multiple carriers. The product can be tailored later on the individual airline, when its presence at the airport becomes more significant.

3.3.10 Airline competition

The airline's network decisions are also influenced by the actions of its competitors. On the one hand, presence of another airline at the airport may block new entrants, as the market can be too small for more than one carrier (Muller et al, 2012). Airlines therefore have little interest in entering each other's markets and direct competition most usually takes place on thick routes between FSCs hubs and large destinations (Pels, 2008).This suggest that regional airports, seeing thinner routes, are less likely to experience direct competition between its own carriers. On the other hand, successful operations of a carrier may reveal the potential of the airport, thus attracting other airlines.

Contrarily to their public declarations, airlines tend to avoid competition. In Asia-Pacific, they seek a low level of competition in the first years of operations (Albers et al., 2010). Moving to Europe, the networks of the two largest LCCs (i.e. Ryanair and easyJet) overlap in around 5% of their routes (CAPA, 2015). A wider comparison of Ryanair, Wizzair, easyJet, Vueling and Norwegian showed that only 10% of routes are operated by more than one airline, and most of this 10% is between mature, big markets (Dunn, 2016). More often, the LCCs compete indirectly by operating the same city-pair market, but through different airports (e.g. Ryanair accesses Oslo through TRF while Norwegian uses OSL). Alternatively, direct competition may occur between FSCs and LCCs, especially if the former is facing business difficulties. This is the case in Italy, where underperformance of Alitalia caused growth of LCCs. Similarly, following bankruptcy of Malev, some of its routes in Budapest were continued by LCCs (Bilotkach et al., 2014). Nonetheless, the fact that the LCC entry happened only after Malev disappeared, suggests that airlines avoid direct competition where possible. Therefore, presence of an airline competitor, especially a direct one, should inhibit entry of other airlines.

3.3.11 Other factors

There are other airport- related factors that have been suggested as potentially influencing the scope of airline activity at the airport. These are: good catering and shopping at the airport, terminal design simplicity (Barrett, 2004), airport ownership, airport revenue structure (Warnock-Smith and Potter, 2005), airport potential to attract different types of passengers (Dziedzic and Warnock- Smith, 2016). They have not been discussed widely in the academic literature. Moreover, while it can be acknowledged that these elements do influence airline networks, it is beyond the scope of this paper to discuss them all given their limited impact compared to other factors.

3.4 Catchment area- related factors

It would be too simplistic to look at the airport's attractiveness only through the the airport lens as such. While the physical infrastructure and managerial aspects do matter, air services will not be provided just anywhere (Dobruszkes el al., 2011). It is also the airport's hinterland that speaks for its potential. In the literature, some of the airport choice factors refer to the characteristics of the airport's region. Therefore, this group describes the profile of the airport catchment area. It shows what potential the region has and what type of traffic it may expect to generate.

3.4.1 Population

Number of inhabitants living in the catchment area is one of the first factors airports include in their promotional material. Population size shows for how many people the respective airport is the most convenient point of departure. Thus, it is a proxy of the potential scale of origin traffic an airport may see.

Most of the relevant literature included the number of inhabitants as a factor influencing the volume of traffic received by the airport. For instance, LCCs are known to concentrate on populous, metropolitan zones (Dobruszkes, 2013). Population size is also positively associated with the likelihood of the LCC entry (Boguslaski et al., 2004), quickness of such entry (Muller et al., 2012) and with base establishment (Zuidberg and de Witt, 2016). Studies involving other airlines are scarce, although it may be expected that FSCs would seek high populations on both ends of the route, while charter carriers could rely on the population of their origin markets only.

Apart from size, it is also the structure of and trends within the population that matter. A high population growth rate propels aviation, although it needs to be underpinned with the simultaneous income growth (Vasigh et al, 2013). This means, a large population is not enough for a carrier to serve the region if these inhabitants cannot afford an airline ticket. Furthermore, migration flows and the resulting expatriate communities further strengthen the demand for air transport services (Dobruszkes, 2009). Not only do they create demand for air travel between their place of residence and the country of origin, but they also propel the resulting wave of their relatives and friends travelling on the same route. The resulting ethnic traffic may be the key argument for maintaining long-haul routes for some airlines, even from small regional airports (e.g. medium-sized FSCs, Doganis 2006).

3.4.2 GDP and business activity

A strong economy is essential for regions to attract traffic. Economic activity not only boosts employment and thus business travel, but also increases the discretionary income of people and propels leisure trips. The most intuitive and common proxy of the economic potential is GDP. Doganis (2002) found a positive relationship between changes in the global revenue passenger kilometres and GDP. Contrarily, economic crises negatively affect air transport although this impact is not geographically uniform (Dobruszkes and Van Hamme, 2011).

Considering regions, positive causality between GDP and air traffic was identified for US and Asia-Pacific LCCs (Boguslaski et al, 2004; Muller et al., 2012; Albers et al., 2010), while budget airlines in Europe showed either no or mixed patterns (Klein et al., 2015; Zuidberg and de Witt, 2016). This is due to the intensive labour traffic originating from the regions with higher unemployment and thus lower GDP. In practice, the effect of lower GDP was counterbalanced by the economic migrant traffic. Again, no analyses were carried out with respect to other types of carriers, although it may be assumed that FSCs and CCs generally concentrate on high GDP areas, following the aforementioned study of Doganis, which was carried out before the major growth of LCCs.

However, even though GDP is highly illustrative, there are other factors also describing the business potential of the region, such as the number, structure and type of entrepreneurships. Particular industries involve often face-to-face meetings with customers in different countries, which leave a scope for air travel. Presence of the largest global companies is one of the determinants of the air traffic volume in the metropolitan zones (Dobruszkes et al., 2011). Therefore, having attracted a unit of a worldwide company, a region may expect that airlines will be interested in providing business travel to its employees . Even medium- sized companies may generate significant demand for air travel. To give an example, it is estimated that part of the airport's growth in Krakow is due to the high number of outsourcing companies located in the area (Krakow Airport, 2017).

3.4.3 Tourism attractiveness

Tourism potential of the region is yet another argument the airport can use to attract airlines. The inbound tourism traffic may not only be central to the airport's strategy, as it is for warm-water destinations, but it can also balance the outbound traffic, so that airlines record high load factors on both directions of routes.

Clearly, tourism traffic is crucial for CCs. It is not ignored by other airlines, either. For example, many FSCs operate summer scheduled services to holiday destinations to exploit the seasonal demand which disappears over winter. Also, the tourism functions of the regions, measured either by the number of beds available (Zuidberg and de Witt, 2016), or by some form of tourism appreciation (Dobruszkes et al., 2011), positively affect LCC traffic. Naturally, the rate of correlation varies among airlines, but especially Ryanair shows a strong relationship in this respect (Zuidberg and de Witt, 2016).

Tourism potential is often stressed by regional airports and LCCS launching a new route (e.g. Ryanair, 2017). Airport operators may see tourism as a determinant of new routes on one hand, but also as the result of the acquired route on the other.Therefore, it could be used as a justification for subsidising such routes.

3.4.4 Knowledge and scientific research

The last of the discussed factors involves the level of academic and high-technology development. These two branches can generate business travel demand (e.g. when the region is an important specialistic centre) and conference tourism. Therefore, existence of higher education units, advanced research and development activities or availability of a knowledge-intensive sector may attract attention of the airlines. Even though these aspects were found to affect the level of air traffic in metropolitan areas less than the previously compared factors, (Dobruszkes et al., 2011), knowledge and scientific research may play bigger role at the regional level. In the light of weaker economy or lesser tourism potential, smaller cities may differentiate themselves through the academic development, research and innovation. Thus, the relative importance of the latter factors may be adequately higher for regional airports.

4. Methodology

4.1 Introduction

Two major methods were applied in this study. The main one- a multiple linear regression (MLR)- was used to examine the determinants of air traffic volume at regional airports. The second one - built around correlation analysis- aimed to detect patterns in the airports' traffic structure.

The MLR was run to estimate the impact of several factors, identified in the previous chapter, on the air traffic volume received by airports. This method was chosen following other similar studies measuring determinants of location of air transport services, mainly Dobruszkes et al. (2011). Regression was carried out for 146 airports (observations), where the dependent variable was represented by the total number of passengers handled by the airport annually and the independent variables included 11 different factors to either the airport itself or the airport's catchment area.

In the second stage, the dependent variable was replaced with the volume of particular types of traffic, i.e. low- cost (LCC), full- service (FSC) and charter (CC), in order to investigate the relationship between the same independent variables and the type of the traffic the airports receive. The following chapter introduces more detail about the research philosophy, methodology, data collection and analysis, as well as providing justification for the methods applied.

4.2 Philosophical standpoint

In Chapter 2, airport choice factors were shown to have been studied using different approaches. This study adoptes a positivist philosophy and sets to explore the airport- airline relationship using quantitative methods and empirical data. In the author's belief, the nature of airline network development can be understood through analysis of numerical data and statistics. This is justified by the nature of the study in that its purpose is to analyse dependencies between variables (i.e. characteristics of the airport, its region and traffic) that can be expressed numerically. Moreover, given the size and structure of the airport sample, coherent qualitative research is unattainable. As airports are located in different countries, methods such as questionnaires and interviews would be time-consuming to administer and could also involve linguistic biases. Another point is that similar studies involving qualitative research methods have been traditionally limited by a low response rate, especially among small airports (Halpern and Graham, 2016). This may be the reason why quantitative research appears more popular in this type of study. By assuming a quantitative approach and providing retrievable sources of data, this paper makes the analysis replicable in the future, so that potential changes can be monitored over time by other researchers. Finally, a quantitative approach was chosen for practical reasons. Actual route network decisions in the industry are made following thorough analyses of rough, usually numerical data.

Summing up, while there are arguments against a positivistic philosophy and quantitative research methods, mainly involving the human factor, it is still practicability, replicability and popularity that support use of the quantitative approach. As MLR has been applied mainly to larger airports (Dobruszkes et al., 2011), the following study is also a test for the appropriateness of this research method for analysing the determinants of air traffic at small, regional gateways.

4.3 Multiple linear regression (MLR)

MLR is a method commonly used to analyse how different variables can be used to predict a certain outcome. Using the observed data, it constructs a model describing the relationship between two or more independent variables and the dependent variable (Wilson et al., 2012).

As shown in Table 4.3, the MLR included 11 independent variables that explain the dependent variables, i.e. the number of passengers served by the airport annually. In each case, the latest available data were used, although in some cases the base year was different This is a phenonmenon experienced elsewhere in the literature (Dobruszkes et al., 2011) and does not significantly affect the results of the study, as respective factors show rather low fluctuations over the considered time span of 3-5 years.

4.4 Correlation analysis

The second stage of the study involved a complex analysis of the structure of regional airports' traffic. The core of this part was undertaken through the use of correlation analysis, although further descriptive statistical tools were used to capture additional phenomena.

The Pearson's Correlation was measured between the same 11 variables as in the case of MLR. Instead of the absolute annual number of passengers, however, three other variables were added. These were the percentage share of different types of airlines (i.e. CC, FSC and LCC) in the airport's total traffic as measured by the number of seats available on departing flights.

4.5 Airport sample- selection process

When selecting the airport sample, the initial intention of the author was to include all operative airports below 1 mppa in EU, Norway and Iceland, forming together the core of the European Common Aviation Area (ECAA). This would allow the capture of the entire deregulated market in ECAA. Later in the process of data collection, however, it was identified that the latter two countries had to be excluded from the sample because of either data availability or unique market characteristics. As a result, the study technically discusses the EU market only, although its findings may be applied across most of the ECAA.

The steps involved in defining the sample of airports to be used in this study are identified in Table 4.1.

Step	Number of airports before	Types of airports excluded	Number of airports after
1	494	Airports serving above 1mppa	311
2	311	Airports without IATA code (Halli Airport)	310
3	310	Norwegian airports	268
4	268	Airports relying on PSOs for at least 50% of routes	220
5	220	Very small airports (Average number of passengers <10 000 in the last 3 years), except newly opened	199
6	199	Recently downsized/closed airports	192
7	192	Airports serving different purposes (GA, military, SAR, AC manufacturers' airports)	182
8	184	Airports with a runway shorter than 4675 ft	176
9	178	Not regional airports	171
10	171	Airports with missing data	146

Table 4.2 Steps applied in establishing the airport sample

At Step 1, official statistics from appropriate organisations were gathered. These included data from aviation agencies, transport ministries, airport associations, airport websites and official statistical offices in particular countries. Data on total yearly passenger traffic were collected**.** 311 airports were identified at this stage.

However, certain airports did not focus on typical, commercial traffic. This included minor airports: serving small communities, relying on public service obligation (PSO) routes; recently downsized and closed airports serving other traffic (general aviation, military, search and rescue); airports with particularly short runways; and airports with missing or incomplete data.. These airports were removed from the sample at Steps 2-10 as follows:.

Step 2: Lack of IATA code indicates no focus of the airport on commercial traffic.

Step 3: The Norwegian airport system relies to a large extent on PSO routes. This would introduce bias to the sample, as the traffic these airports receive is a result of governmental subsidy rather than a natural outcome in the commercial environment. More details on this step can be found in Appendix 1.

Step 4: Other individual airports relying on PSO routes in at least 50% of the number of routes further bias the results as their existence is maintained artificially by PSO, not the commercial environment. Therefore, they should not be presented on a par with other airports. More details on identifying the PSO- dependent airports can be found in Appendix 1. It needs to be remembered, however, that for some airports the PSO routes can be the only way forward. Due to their different nature (i.e. being subsidised), a separate study could investigate determinants of route choice for both the PSO subsidisers and tenders.

Steps 5-7: The aim was to exclude airports handling a very small amount of traffic (controlling for those newly opened), those recently closed/ downsized, or those primarily serving other types of traffic. Such airports do not aspire to attract traditional commercial traffic and therefore including them in the sample may bias the results.

Step 8: Several airports, typically located on small islands, see frequent operations by small aircraft to nearby islands and in this way generate a reasonable amount of traffic. However, due to the short runways they operate, traditional airlines using bigger aircraft do not even consider them as potential destinations. Therefore, a limit of 4675 ft, which equals the take-off distance for Bombardier Dash Q-400 (Bombardier, 2017) was applied to exclude such airports. This particular aircraft type was chosen because while it is one of the most popular ones in Europe, it requires less distance than even more popular B737 and A320. Therefore, using the less strict 4675 ft. limit allowed more airports to remain in the sample.

Step 9: Airports located close to major cities (e.g Stockholm-Vasteras) are likely to serve a metropolitan area and therefore should not be considered equal to regional airports.

Step 10: Last, airports with incomplete data record were removed. This involved mainly Icelandic, Swiss and other airports. Lack of reliable data is an inevitable problem of studies involving this particular segment of the market. 25 out of 171 airports were excluded in step 10. This translates to the 85% coverage of the market (maintaining limitations introduced by previous steps), and means that the total sample of 146 observations is big enough to provide meaningful results (Wilson et al., 2012[2]).

[2] The rule of thumb for the minimum number of observations in MLR is 10 times the number of independent variables (11x10=110 in this case).

4.6 Discussion of the final sample

The final sample includes 146 airports from 21 countries. As shown in Table 4.2, most countries are represented by less than 10 airports. Greece, the United Kingdom, Finland, Sweden, Spain and France remain the most represented countries. The relatively high position of Finland and Sweden results from a well-developed airport infrastructure in more remote regions. Seven EU countries: Cyprus, Estonia, Ireland, Luxembourg, Latvia, Malta and Portugal remain unrepresented due to the size, nature of the airports, or data unavailability.

Country	**Number of airports**
Hungary	1
Slovenia	1
Bulgaria	1
Lithuania	2
Netherlands	2
Slovakia	2
Austria	3
Belgium	3
Czech Republic	4
Croatia	4
Germany	5
Poland	6
Denmark	6
Italy	7
Romania	9
Greece	10
United Kingdom	12
Finland	15
Sweden	15
Spain	16
France	22
TOTAL	146

Table 4.3 Number of airports studied by countries

Geographical spread presented on the map below indicates a balanced coverage of regions. Thus, the airport sample could provide a comprehensive, unbiased picture of the European market.

Figure 4.2Geographical location of airports included in the sample

The resultant airports' sample is skewed towards smaller airports (see Table 4.3). This is the result of heavy competition in the market. Not all the airports are able to grow significantly, but those which manage to increase traffic automatically face few competitors. Also, the Table 4.3 shows that the desired focus of the study especially on small airports has been achieved. The average size of airport is 311,000 passengers, and the smallest one is Romanian Suceava, with 5,726 passengers recorded in 2016. Suceava, however, has been chosen by Wizzair for several connections in 2018, making the airport worth considering in this study.

Airport traffic (passengers yearly)	Number of airports
0-200000	56
200000-400000	45
400000-600000	24
600000-800000	12
800000-1000000	9
TOTAL	146

Table 4.4number of airports by traffic volume

4.7 Variables- explanation and data sources

Table 4.4 presents the airport and airport catchment area factors used as variables in the MLR, along with the reference year and source for each of them.

Group	Factor	Time	Data source
Dependent variable	Total number of passengers	2016	Respective CAAs
Airport related	Turnaround fee for short-range aircraft [€]	2017	airport-charges.com
	Turnaround fee for medium-range aircraft [€]	2017	
	Availability of incentives (0-1)	2017	Airport websites
	Capacity constraints (0-1)	2017	IATA list of coordinated airports
	Distance to the nearest competitor [km]	2017	Google Maps
	Motorway access (0-1)	2017	
	Rail access (0-1)	2017	
Catchment area related	Population	2016	Eurostat
	GDP per capita [€]	2015	
	Non-resident tourism arrivals	2015	
	Research and development expenditure per inhabitant [€]	2013	

Table 4.5 Variables used in the MLR

Variables used in the correlation analysis, investigating the traffic structure, are presented in Table 4.5

Group	Factor	Time	Data source

Airport related	Turnaround fee for short-range aircraft [€]	2017	airport-charges.com
	Turnaround fee for medium-range aircraft [€]	2017	
	Availability of incentives (0-1)	2017	Airport websites
	Capacity constraints (0-1)	2017	IATA list of coordinated airports
	Distance to the nearest competitor [km]	2017	Google Maps
	Motorway access (0-1)	2017	
	Rail access (0-1)	2017	
Catchment area related	Population	2016	Eurostat
	GDP per capita [€]	2015	
	Non-resident tourism arrivals	2015	
	Research and development expenditure per inhabitant [€]	2013	
Traffic structure data	LCC % share in airport traffic	2017	Flightradar24 database
	FSC % share in airport traffic	2017	
	CC % share in airport traffic	2017	

Table 4.6 Variables used in the correlation analysis

Traffic numbers were retrieved from official sources of civil aviation authorities and airport associations in respective countries. The total number of passengers, including transfer, was considered.

Airport charges, measured as the total fee for a complete turnaround were collected from airport-charges.com. Total turnaround fee covers, where applicable: landing, parking, passenger, airport development, infrastructure, security, en-route, user development, passenger security, aircraft security, noise, air navigation and government fees. In other words, this is the closest to the real price the airline pays to the airport for one aircraft rotation. However, the literature suggests that airports may adjust their landing charges to the aircraft type they wish to attract, for instance by favouring use of larger B737s, or smaller regional aircraft (Graham, 2014). Thus, separate fees for Boeing 737-800 and Bombardier DHC-8 Q400 were collected in order to capture this potential real market situation. In both cases the same scenarios were used, i.e. arrival from Milan Bergamo at noon local time on 27th of July 2017 and departure to the same airport 45 minutes later, 90% load factor. As capacities and declared MTOW of the same aircraft may differ among the carriers, the aircraft were assumed to be operated by Flybe and Ryanair respectively, the main operators of these aircraft types in Europe and thus the most likely partners for airports. A further explanation should be given about the chosen origin and destination; i.e. Milan Bergamo airport. It was the intention of the author to select a Schengen airport, as passengers travelling within Schengen area do not undergo an additional passport control, which eventually impacts the passenger fee. Since most of the countries are signatories of the Schengen agreement, an airport located in the Schengen area was selected. This may potentially impact the results obtained for airports in the UK, Ireland, Romania and Bulgaria, although it is the best possible configuration for the sample overall.

Availability of incentive schemes offered to airlines was verified based on the airport charging schemes, published on their websites, and was expressed by a 0-1 dummy.

Another dummy variable represented whether IATA slot restrictions apply to the airport. It was determined through the current list of IATA slot coordinated airports and assumed the value of 1 if any restrictions were present.

Distance to the nearest competitive airport was computed manually through the straight line length on Google Maps. Any airport belonging to the sample or larger than 1mppa was assumed to be competitive to the respective airport.

Airport ground access was measured by two separate dummy variables which assumed values of 1 if the airport was linked to a railway station or to motorway/express road within 10 km radius according to Google Maps. Stations requiring a passenger to use additional, paid transport in order to access the terminal were not considered in order to exclude cases where the airport is indirectly linked by public transport to the city's main station.

All remaining catchment area related factors were sourced from Eurostat database. Where any information for NUTS2 region was not available for a specific year, it was replaced with the most recent data available.

4.8 Selection of variables

The regression analysis included airport and catchment area related factors.. This is because these factors are the most controllable ones for the airport operator and the regional government (Graham, 2014). This means that by influencing and stimulating these factors, the authorities and airport managers can try to grow traffic. Second, comparisons of these two groups should allow to examine whether it is the airport or the airport's region that attracts airlines. Most of the papers so far investigated just one of these sides, and this research will be the first one to compare them extensively.

Selection of factors was based primarily on the literature review. Moreover, data availability and lack of multicollinearity further constrained the selection. The former excluded some clearly important factors, such as airport terminal capacity. The latter aimed to eliminate those factors which are mutually related in order to avoid double counting effect. For example, number of business units in the region was excluded as it showed high correlation with local GDP per capita.

At this point, it needs to be recognised that one of the key limitations is the nature of the factors describing airport catchment areas. The fundamental point is that it is impossible to determine the actual range of catchment area. Even though it is traditionallydetermined by the 2 hours drive time radius, although in fact the distance people travel to use an airport can be longer and depends on the air fare or airline type (Pantazis and Liefner, 2006; Lieshout, 2012). Since just the range of catchment area is not easy to measure, it is equally difficult to analyse its economy and population.. For instance, it is unattainable to establish how many business units exist in the area, or what its GDP is. Therefore, some simplification is necessary. This study assumes the NUTS2[3] region of the airport to be an approximation of its catchment area.. One should be aware that NUTS2 regions are slightly different from the actual catchment areas. In practice, an airport may be used by people from outside its NUTS2 region, especially if it is located on the regions' borders. This limitation has been overcome in the literature by using a similar or the same statistical unit to describe the airport's hinterland (e.g. Dobruszkes et al., 2010; Maartens, 2012).

4.9 Traffic structure data

In the second stage, the relationship between airport/ airport catchment area features and traffic structure was analysed. While the airport and airport catchment area features used were the same as in the previous stage, the additional data on traffic structure was gathered as explained below.

Raw data on traffic was imported from Flightradar24 database which provides the flight number (and thus, the airline name), origin and destination airport, frequency and aircraft type, for all flights (Fig. 4.2). Airline name and type (LCC, FSC, CC) were added manually based on the flight number and the airline's general business model. Also, assumptions about the aircraft capacities were made based on airline manufacturer specifications. Appendix 2 explains in detail the assumptions made in these two steps.

[3] NUTS is a system used by Eurostat for dividing European economies. Its second level represents basic regions and is used for the application of regional policies (European Comission). There is no equivalent of NUTS2 among British administrative units, although in practice a NUTS2 region consists of several counties and remains smaller than a region

AIRPORT	FLIGHT	JUN 26	JUN 27	JUN 28	JUN 29	JUN 30	JUL 1	JUL 2
Ajaccio Napoleon Bonaparte Airport AJA / LFKJ - 1 080 km	V72847	-	**10:25 AM** 319	-	**7:10 PM** 319	-	**10:25 AM** 319	**11:05 AM** 319
Bastia Poretta Airport BIA / LFKB - 1 063 km	V72963	-	-	**11:05 AM** 319	-	-	**10:15 AM** 717	**10:15 AM** 717
Bordeaux Merignac Airport BOD / LFBD - 484 km	CE52	**1:30 PM** B190	**1:30 PM** BEH	**1:30 PM** BEH	**1:30 PM** BEH	**1:30 PM** BEH	-	-
Figari Sud-Corse Airport FSC / LFKF - 1 131 km	A56261	-	-	-	-	-	**11:25 AM** CR7	-
	V72849	-	-	-	-	-	**10:50 AM** 717	**10:50 AM** 717

Figure 4.2 Example of raw data retrieved from Flightradar24 (here for Caen)

As collection of data for the complete year was not possible, a sample week of 26 June- 2 July 2017 was selected. A random summer week was chosen because airports usually see higher traffic in the summer season and the purpose of this paper is to present them during their peak periods. In order to check the quality of data, a sample of results from 25 different airports in the Flightradar24 database were compared against the actual departures retrieved from the airport websites. 93% of all the operations listed on the airports' websites were also included in the Flightradar24 database. Such fitness of data is satisfactory and presumably compares to other, paid sources of data such as typically used OAG. Owing to minor improvements (i.e. removal of cargo operations and charter stopovers) the goodness of data fit was further increased to around 94.5%

4.10 Data analysis

Initially, relationships between the general level of airport traffic and different independent variables were considered. At the second stage, relationships between the same independent variables and levels of LCC/ FSC/ CC traffic were analysed.

In the first case, MLR model was run using Excel AnalysisToolPak. The model was then evaluated following the four step procedure advised by Wilson et al. (2012), as summarised by the points below.

- The first step assessed whether or not the model makes logical sense and is consistent with the view of the situation being investigated. If it does, the relationships between the independent and dependent variables, expressed by the value of the slopes, are logical. The expected values can be deduced from section 4.11.

- The second step tested the statistical significance of each slope based on the p-value. Following the most common confidence intervals, values lower or equal to 0.05 were considered to be statistically significant.
- Thirdly, the explanatory power of the model was evaluated. This is expressed by the adjusted R squared value. In general, the adjusted R squared value presents what percentage of variation in the dependent variable is explained by the model.
- Finally, multicollinearity was tested. Due to the fact that high multicollinearity limits the reliability of the model and makes the slope assume unexpected values, normally the correlation of coefficients should not exceed 0.7. However, values slightly above this limit can be sporadically accepted in business analyses (Wilson et al., 2012).

At the second stage, Excel Analysis Toolpak was used also to run the correlation analysis between the variables. The Pearson correlation coefficients between variables, along with their statistical significance, were discussed. Typical thresholds were accepted for low, moderate, high and perfect correlations, i.e. respectively +/-0.3; +/- 0.5; +/- 0.7 and +/-1. A typical p-value lower or equal to 0.05 was required to consider the relationship statistically significant.

4.11 Hypotheses creation

The following hypotheses were created prior to running the analysis.

Regression model (overall traffic level)

- In line with the law of demand, the more an airline pays for the operation, the less incentivised it is to use the airport. Therefore:

H_{01}: Turnaround costs are not related to the level of airport traffic.

H_1: Turnaround costs are related to the level of the airport traffic.

- Wherever an incentive scheme is in place, airlines are more likely to use the airport. Therefore:

$H_{02:}$ Availability of incentive schemes is not related to the level of the airport traffic

H_2: Availability of incentive schemes is directly related to the level of the airport traffic.

- Intuition could suggest that the existence of capacity constraints would inhibit the level of traffic. However, such constraints are imposed on large airports rather than smaller ones. Thus, capacity is expected to be linked with airports receiving more traffic. Therefore:

H_{03}: Capacity constraints are not related to the level of airport traffic.

H_3: Capacity constraints are directly related to the level of airport traffic.

- The farther the airport is from another airport, the lower the level of competition it faces and the more traffic it attracts. Conversely, airports laying in closer proximity to each other should find it more difficult to grow traffic simultaneously. Therefore:

H_{04}: Distance to the competitor is not related to the level of airport traffic.

H_4: Distance to the competitor is directly related to the level of airport traffic.

- Rail and road networks increase the airport catchment area and thus the potential number of passengers. Therefore:

H_{05}: Landside accessibility is not related to the airport traffic level.

H_5: Landside accessibility is directly related to the airport traffic level.

- The higher the GDP/ population number/ tourism potential/ R&D spending, the more attractive the region is and the more traffic it should generate for airlines. Therefore:

H_{06}: No catchment area related factor is related to the level of airport traffic.

H_6: Each catchment area related factor is directly related with the airport traffic level.

Correlation analysis (traffic structure)

- LCCs aim to minimise the overall costs of running an airline, a significant part of which is constituted by the airport fees. Therefore:

H_{07}: Turnaround fees are not related to the LCC market share in airport traffic.

H_7: Turnaround fees are negatively related to the LCC share in the airport traffic.

- Developed regions generate business and conference traffic, which is associated with traditional carriers. Therefore:

H_{08}: R&D spending per capita is not related to FSC market share

H_8: R&D spending per capita is positively related to FSC market share

- Incentive schemes are a popular tool used by regional airports to attract traffic. LCCs have been the biggest beneficiaries of such schemes. Therefore:

H_{09}: There is no relationship between incentive schemes and LCCs share in airport traffic

H_9: The relationship between availability of incentive schemes and LCC share in airport traffic is positive.

- Tourism traffic has been vital for growth in CC services in the regions. Therefore:

H_{010}: Non-resident tourism arrivals are not related to the share of CC in airport traffic.

H_{10}: Non-resident tourism arrivals are positively related to the share of CC in airport traffic.

- Wealthier regions have stronger economies and generate traffic appropriate for traditional carriers. Therefore:

$H_{011:}$ GDP per capita is not related to FSC market share in airport traffic

H_{11}: GDP per capita is positively related to FSC share in airport traffic.

4.12 Limitations

Apart from those relating to the philosophical standpoint declared in section 4.2, the limitations related to data collection and analysis in this research are as follows:.

- Firstly, the study assumes the NUTS2 region of the airport to be consistent with its catchment area. Doubtlessly, an artificial and geopolitically created statistical unit will never correspond ideally to the actual, living geographical region the airport serves. Nevertheless, due to availability of reliable data on a pan-European scale and usage of the same method in similar studies, this approach is currently the most feasible for research of this kind.
- Secondly, the research is burdened with complexity, especially due to the extensive data collection and processing. To maximise transparency and replicability of the research, complete data processing protocol is attached to this paper. Extensive methodology description, additional graphs and explanations aim to make the research process mode understandable to the reader.
- Thirdly, the study focuses on a very narrow group of airports in terms of the traffic served. Bearing in mind that the largest airports in Europe serve around 75 mppa, those handling just a tiny fraction of this (i.e. 0-1 mppa) may not necessarily show strong patterns in terms of

traffic trends. On the other hand, the study should still provide a valuable insight into the market that has not been researched extensively so far.

4.13 Summary

Summing up, the methodology of this study was designed to investigate the determinants of the air traffic volume and structure. A sample includes 141 regional airports, evenly spread across 21 EU countries. Firstly, it employs multiple linear regression to examine how the airport characteristics are related to the number of passengers using the airport. For that purpose, 12 variables explaining both the airport itself and the airport catchment area, are selected, based on literature review and data availability. Secondly, correlation analysis is run in order to analyse how the same variables affect the share of particular airline type (i.e. LCC, FSC, CC) at the airport. Four major data sources are used in this study: Eurostat, Flightradar24, airport-charges.com and airport websites. The major constraint of the applied methodology lays in its assumption that NUTS2 regions represent the airport catchment areas, although adoption of the same assumptions in similar studies appear not to have biased the results.

5. Results[4]

5.1. Results of the linear regression- four step analysis

The results of the multiple linear regression (MLR) showed that the air traffic volume at a small regional airport can be expressed by a linear function

$$y = -17{,}843 + 35.5 \times \text{Boeing Turnaround fee} + 0{,}038645 \times \text{Population} +$$

$$+168{,}758 \times \text{IATA coordination variable}$$

It should be, however, acknowledged that the process of air traffic growth does not occur uniformly across Europe and these variables combine to account for only 23% its variation.. The relationship between these three variables and airport traffic volume is statistically significant.

Coefficients

Table 5.1 illustrates the coefficients obtained and their statistical significances, all of which are discussed in the respective sections below.

	Coefficient	**p-value**
Intercept	-17843	0.858124
Population	0,038645	0.008647
GDP [€]	2.165545	0.393405
Tourism	0.00853	0.362685
R&D	-99.109	0.109311
Boeing	35.48077	0.006628
Dash	-12.6418	0.69733
Incentives	78803.85	0.079925
Distance	190.1108	0.765644
Capacity	168758.4	3.99E-06
Train	58675.16	0.337427
Motorway	17323.85	0.67980

Table 5.1 MLR results

[4] Note: As the role of this chapter is to present the results, the below section refrains from broader discussion of the findings, which will be done in chapter 6.

Population size, GDP per capita, tourism attractiveness of the region, as well as Boeing turnaround fee, presence of incentive schemes, distance to the competitor, airport capacity constraints and ground accessibility are associated with higher traffic served by an airport. On the other hand, R&D spending and Dash turnaround fee appeared to be negatively related to the volume of traffic. Excluding R&D and Boeing variables (discussed in section 6.2), it can be said that variables generally show coefficients as predicted, satisfying the first step suggested by Wilson et al. (2012).

Statistical significance of coefficients

Only three relationships are statistically significant for the model, i.e.: population size, Boeing turnaround fee and IATA coordination dummy. Thus, there is enough support for the statement that the more people live within the airport's catchment area, the more traffic it attracts. Also, airports facing operational constraints may still attract significant amounts of passengers. Finally, airports charging more for Boeing turnaround see more traffic.

Model exploratory power

The multiple R=0.54, indicates a moderate linear relationship between the independent variables and the level of airport traffic (see Table 5.2). The model's explanatory power, measured by the adjusted R squared value, equals 0.23 suggests that less than a quarter of variation in airport traffic can be explained by the variables eventually included in the mode[5]l. The standard error is significantly high and equals 217,748. In other words, an estimation of the model can be different from the actual traffic by more than 200,000 passengers, i.e. a fifth of the spread analysed.

Regression statistics	
Multiple R	0.537803
R squared	0.289232
Adjusted R squared	0.230885
Standard Error	217747.8
Observations	146

Table 5.2 Regression statistics

Collinearity

Collinearity, shown in Table 5.3, exceeds the absolute value of 0.7 for only one pair of variables. R&D spending per capita is correlated with the GDP per capita at the rate of 0.742889. This is caused by the fact that one of the methods which regional authorities can use to improve the local economy (GDP)

[5] Logarithmic regression and logarithmic transformation of data was performed to check whether the results change and no significant differences were found.

is investment in research and development. Since these two variables are related to the broadly understood economic activity and the correlation just slightly exceeds 0.7, both variables can be maintained in the regression model, following the argumentation[6] by Wilson et al. (2012).

[6] According to Wilson et al. (2012), values slightly higher than 0,7 are acceptable for business and economic analyses, as they typically involve higher correlations.

	Population	GDP	Tourism	R&D	Boeing	Dash	Incentives	Distance	Capacity	Train	Motorway
Population	1.00										
GDP	-0.14	1.00									
Tourism	0.54	-0.16	1.00								
R&D	0.00	0.74	-0.10	1.00							
Boeing	0.02	0.27	-0.06	0.20	1.00						
Dash	-0.02	0.28	-0.02	0.15	0.69	1.00					
Incentives	0.12	-0.09	0.12	-0.01	-0.27	-0.13	1.00				
Distance	-0.07	-0.14	-0.13	-0.08	-0.30	-0.24	0.29	1.00			
Capacity	-0.06	-0.15	0.09	-0.12	-0.10	-0.06	-0.22	-0.01	1.00		
Train	0.06	0.02	0.01	0.10	0.16	0.19	0.11	-0.19	0.03	1.00	
Motorway	0.25	0.05	0.14	0.05	0.13	0.12	0.04	-0.26	-0.15	0.21	1.00

Table 5.3 Correlation matrix of the variables used in the MLR

5.2. Results of the correlation analysis

Correlations between the analysed variables and shares of different airlines are presented below in Table 5.4. Colours indicate the strength of correlation, appropriately to its absolute value, i.e. white and green denote low and moderate correlations respectively. Table 5.5 provides further information on statistical significance of each correlation. Values lower or equal to the accepted significance level (0.05) are highlighted.

	Charter %	FSC %	LCC %
Population	0.01550	-0.22996	0.22364
GDP	-0.15569	0.37946	-0.29224
Tourism	0.11583	-0.15427	0.08781
R&D expenditure	-0.13988	0.36991	-0.29191
Boeing turnaround	0.01281	-0.03138	0.02420
Dash turnaround	-0.04265	-0.00876	0.03404
Incentives	-0.11731	0.01470	0.05435
Distance	-0.11146	-0.00175	0.06755
Capacity	0.30620	0.00656	-0.18734
Train	0.09977	0.06212	-0.12176
Motorway	0.01973	-0.00594	-0.00563

Table 5.4 Results of the correlation analysis

	Charter %	FSC %	LCC %
Population	0.85577	0.00627	0.00790
GDP	0.06624	0.00000	0.00046
Tourism	0.17293	0.06878	0.30226
R&D expenditure	0.09928	0.00001	0.00047
Boeing turnaround	0.88056	0.71285	0.77653
Dash turnaround	0.61684	0.91815	0.68969
Incentives	0.16747	0.86312	0.52363
Distance	0.18985	0.98363	0.42779
Capacity	0.00023	0.93870	0.02666
Train	0.24088	0.46593	0.15183
Motorway	0.81698	0.94443	0.94737

Table 5.5 Correlation analysis results- statistical significances

Low-cost carriers (LCC) share in airport traffic

Percentage share of LCCs at the considered airports show weak correlations with the discussed variables. It is positively correlated with the size of population and tourism potential of the region, as well as with incentive schemes and distance to the competing airport. In turn, GDP and R&D levels, along with slot coordination and ground accessibility show an inverse correlation with the LCC share. Relationships with population, GDP, R&D and capacity are statistically significant.

Charter carrier (CC) share in airport traffic

Correlations between the variables and the share of CC traffic reveal similar patterns as in the case of LCCs. Population size shows almost no relation. GDP and R&D spending per capita are negatively correlate d with the CC share. Lastly, tourism shows a positive correlation with the CC traffic Considering airport variables, airport costs show almost no correlation. Negative relationships were found for the share of CCs and the incentive schemes and distance to the competitor. Contrarily, slot coordination and ground accessibility were linked with higher CC share in airport traffic. Only Capacity was significantly related to the share of CC traffic.

Full service carrier (FSC) share in airport traffic

Out of all the airline types, FSCs' traffic has the strongest correlations with airport catchment area features. A weak inverse correlation for population size and tourism attractiveness was found. For all airport characteristics, the derived correlation rates remain close to zero. This means that there is hardly any relationship between the airport offer and the share of FSCs. Correlation of CC share and population, R&D and GDP is statistically significant.

5.3. Testing the hypotheses

Finally, the hypotheses formulated for the multiple linear regression (MLR) and correlation analysis (CA) can be tested (Table 5.6).. The column 'sup.' indicates whether the results support the hypothesis, while the column 'Sign.' indicates whether the result is statistically significant. Column 'Result' provides the final outcome.

Analysis	Hypothesis	Sup.	Sign.	Result
MLR	H_{01}: Turnaround costs are not related to the level of airport traffic. H_1: Turnaround costs are inversely related with the level of airport traffic.	No	Yes[7]	Fail to reject H_{01}
	H_{02}: Availability of incentive schemes is not related to the level of airport traffic H_2: Availability of incentive schemes is directly related to the level of airport traffic.	Yes	No	Fail to reject H_{02}
	H_{03}: Capacity constraints are not related to the level of airport traffic. H_3: Capacity constraints are directly related to the level of airport traffic.	Yes	Yes	Reject H_{03}
	H_{04}: Distance to the competitor is not related to the level of airport traffic. H_4: Distance to the competitor is directly related to the level of airport traffic.	Yes	No	Fail to reject H_{04}
	H_{05}: Landside accessibility is not related to the airport traffic level. H_5: Landside accessibility is directly related to the level of airport traffic.	Yes	No	Fail to reject H_{05}
	H_{06}: Any catchment area related factor is not related to the level of airport traffic.	Yes	Yes[8]	Reject H_{06}

[7] For Boeing turnaround
[8] For population size

	H_6: Each catchment area related factor is directly related with the airport traffic level.			
CA	H_{07}: Turnaround fees are not related to LCC market share in airport traffic. H_7: Turnaround fees are negatively related to LCC market share in airport traffic.	No	No	Fail to reject H_{07}
	H_{08}: R&D spending per capita are not related with FSC market share H_8: R&D spending per capita is positively related with FSC market share	Yes	Yes	Reject H_{08}
	H_{09}: There is no relationship between incentive schemes and LCCs share in airport traffic H_9: The relationship between availability of incentive schemes and LCC share in airport traffic is positive.	Yes	No	Fail to reject H_{09}
	H_{010}: Non-resident tourism arrivals are not related with the share of CC in airport traffic. H_{10}: Non-resident tourism arrivals are positively related with the share of CC in airport traffic.	Yes	No	Fail to reject H_{010}
	$H_{011:}$ GDP per capita is not related with the FSC market share in airport traffic H_{11}: GDP per capita is positively related with the FSC share in airport traffic.	Yes	Yes	Reject H_{011}

Table 5.6 Hypotheses - the results

In total, the data indicates some trend towards supporting nine of the eleven alternative hypotheses, although only in four cases the observed figure is significant enough to accept it. In terms of air traffic volume, this refers to its relationship with capacity constraints and catchment area factors. As long as small regional airports in Europe are considered, those which are either slot-coordinated or serve densely populated areas are likely to generate more traffic. Considering the structure of the traffic, a significant relationship between two factors: GDP and R&D spendings per capita is visible.

Availability of incentive schemes, airport landside accessibility and distance to the nearest competitor do show a positive association with airport traffic, but the relationships are not significant. The same applies to relationship between the share of FSC/CC/LCC in the traffic structure and availability of incentive schemes as well as the region's tourism attractiveness.

Finally two relationships have been found to show a trend different from what might have been expected. Firstly, turnaround costs for Boeing operations are significantly and directly related to the volume of airport traffic. Secondly, turnaround fees in general appear to be inversely correlated with the LCC share at the airport, although the results are not statistically significant.

Further descriptive statistics on airport traffic structure will be provided in chapter section 6.4.

5.4 Conclusion

The volume of airport traffic at an airport appears to be related to the number of inhabitants living within its catchment area, as well as to turnaround fee for Boeing 737-800, and finally to having its capacity coordinated. These three variables explain 23% of variation in the total number of passengers using a regional airport in Europe. All other variables except R&D level and turnaround fee for Bombardier Dash Q-400, are positively related to the airport traffic volume. However, the trends were not strong enough in most cases to allow for statistical significance. Considering traffic structure, GDP and R&D per capita levels were identified as positively related to the share of FSC traffic at the airport, while CCs showed medium positive correlation with the slot-constrained airports. Finally, data indicated a trend towards supporting most of the hypotheses, although they could not be accepted due to low significance level. Summing up, certain patterns can be seen among the sample airports, although they are not strong enough to make definite judgments.

6. Discussion of results

6.1. Main results of the MLR in the light of literature

The explanatory power of the model [23%] is lower than those obtained in a similar study by Dobruszkes et al. (2011)involving metropolitan areas [70%]. The lower explanatory power means that regional airports are more diverse in terms of traffic, which may be caused by more intense competition they face. The common point of these studies is that only a few factors were found to be significantly important for air traffic volume. This confirms that while there are many trends in the industry, not all of them are strong enough to make generalisations regarding the determinants of air traffic. Also the industry appears to take note of this fact, as airports diversify their strategies and look for their own recipe for success.

Moreover, the significant variables are different in the two studies. While GDP, tourism, economic decision power and distance to the main air transport market are more important for metropolises, it is the population size, capacity and turnaround fees that show higher correlation with the air traffic volume at regional airports. Naturally, both analyses involved slightly different factors, although for the common ones the relationships were usually weaker in this study, meaning that trends among regional airports are more blurred.

6.2. Determinants of air traffic volume

By showing a positive relationship between air traffic level and population size, the model extends applicability of the results from other studies (e.g. Mueller et al, 2011; Lu and Mao, 2014) to regional airports. Therefore, regional authorities should be advised to avoid over-ambitious plans of building an airport in scarcely populated regions, such as in the Ciudad Real in Spain, the population of which is approximately 75,000.

Following Doganis (2006), the model indicates a direct relationship between air traffic volume and GDP. According to the results, an increase of GDP per capita by €1 is associated with additional 2 passengers using the airport. Also Airbus (2016) forecasts indicate a clear and positive (albeit logarithmic) relationship between these variables. Small airports are thus no different and also benefit from the economic activity of the region.

Non-resident tourism arrivals show a direct relationship with the level of airport traffic. The more people visit the region, the more passengers the respective airport can handle, which has been noted also in the literature (e.g. Graham et al. 2008). The relationship is weaker than one could perhaps expect - each additional hundred of non-resident visitors translates into nine additional passengers using the airport. This means that either tourism does not generate as many passengers, or that they come to the regions using the ground transport. The example of Croatian markets suggests it is probably the latter. It was found that despite significant distance and availability of a convenient air connection, Polish tourists prefer to drive to Croatia with their own car, even if it requires ferry transfer onto one of the islands (Goic, 2015). On the other hand, if the airport targets tourists from more distant regions in order to exclude ground transport alternatives, it would indirectly compete with stronger, popular tourism destinations. For example, a niche Romanian airport aiming to attract German tourists would face competition from well-known, Spanish resorts which are located at a similar distance from Germany and therefore equally accessible to potential German tourists. Concluding, regional airports do not easily benefit from tourism. They are limited by competition from ground transport on one side and other destinations on the other one.

The negative R&D relationship with air traffic volume is different from that found for similar variables by Dobruszkes et al. (2011). This suggests scientific research and academic activities in the regions do not translate to air traffic demand, although further studies should be carried out to make definitive conclusions.

Regarding turnaround fees, mixed results appear from the model - the one for Boeing is significantly, directly related to traffic level, while Dash shows an insignificant negative relation. The former may suggest two phenomena. Firstly, airline demand for airport services is inflexible and higher airport costs cannot stop a carrier from serving a destination, which has been noted by, for instance, Warnock-Smith and Potter (2005). Secondly, the airports handling more traffic face higher costs which increases their pricing, in accordance with the general recommendation of IATA (2014). In essence, however, the results show that pricing is not an effective tool for constructing air traffic at the airport, contrary to the ideas presented by Graham (2014).

Incentive schemes are positively related to airport traffic volume. The relationship is strong and indicates that when an airport offers discounts to its carriers, it is likely to serve more passengers. Such a finding fills the gap specified by Malina and Kroll (2012) and shows that incentive schemes effectively help airports generate traffic and air services. This postulate may naturally have its opponents who question the long-run sustainability of incentive schemes. Indeed, as Malina et al. (2012) noted, many new routes may disappear when favourable contract conditions terminate. However, the author refrains from assessing the appropriateness of the incentive schemes and limits to the observation that in many cases they are clearly related with increased traffic- according to the results, airports operating such mechanisms statistically can serve 80,000 passengers more per year.

Airports having their slots coordinated by IATA is positively related to airport traffic volume. In other words, airports attracting more traffic are more likely to be slot- coordinated.. Moreover, those airports that are slot coordinated still maintain high traffic numbers, as airlines do not want to redirect services to alternative non-coordinated locations. Instead, operations are properly reorganised in order to still serve the desired airport. Thus, availability or lack of capacity will not affect the airline decisions as long as it is technically possible to use the congested airport. This is an important message to regional authorities who sometimes see development of new infrastructure as the main method to attract carriers.

Distance to the nearest commercially attractive competitor shows a direct relationship with airport traffic volume. The further the airport is from its competitors, the higher the potential for monopoly and the more traffic it can attract. This is consistent with the results obtained for bigger metropolises (Dobuszkes et al., 2011). On the other hand, this means that construction of new airports in areas which already have one is not easily justifiable. Neighbouring regions should work together to promote one airport rather than construct new infrastructure and compete against each other. This is particularly true for the regions which are served by a major airport and which experienced a sudden LCC or charter growth at smaller gateways. The results indicated that traffic in such places may decrease as quickly as it increases. To give an example, Lleida airport in Spain was built by the Catalan government on the wave of Girona airport popularity, with an ambition to accommodate part of the traffic. Eventually, however, the airlines concentrated more on the main El Prat airport, and left the smaller gateways, as in many other regions of Spain, under-served (Dziedzic and Warnock-Smith, 2016).

Last but not least, even though both rail and motorway/highway access show a positive relationship with the airport throughput, the correlation is too low to claim they increase the airlines' interest at a particular destination. This confirms previous findings that generally air carriers do not focus much on the non-aeronautical part of their passengers' journey (Dziedzic and Warnock-Smith, 2016). Also, one may notice that many airports with less developed ground transport links perform better than those with convenient rail and motorway access. Hence, good accessibility is not a decisive factor for air traffic volume.

6.3. Airport traffic structure

The results also bring additional information on where low-cost (LCCs), charter (CCs) and full-service network carriers locate their capacity.

Population size appears to have the strongest correlation with the traffic share, which is consistent with previous studies in this segment of the market (e.g. Boguslaski et al, 2004; Mueller et al., 2012, Lu and Mao, 2014). In more populated regions, LCCs offer more capacity than other airlines[9]. Such correlation means that really small airports should not expect intense interest from LCCs and cooperate with the FSCs, most likely the national carrier. The negative relationship between FSC share and population size further confirms this point.

The opposite conclusions can be drawn with respect to GDP per capita level and R&D expenditures. Stronger economies appear to be more favoured by FSCs while avoided by LCCs and CCs. This numerically confirms general statements made elsewhere in the literature (e.g. Dobruszkes, 2006) that FSCs focus on richer regions**.** If the other end of the spectrum is to be considered, less economically developed regions should build their networks based on the low-cost and holiday links mainly.

The same principle applies to the airports located in tourism-attractive locations. Such airports are handling mainly CCs and LCCs, while the FSC share is negatively correlated with the number of non-resident tourism arrivals to the region. Thin, low-yield markets are not central to the FSCs' strategy. Airports should however pay attention to the fact that the relationship is nearly the same for FSCs and CCs, which means that they could transfer market segments. In other words, CCs do not monopolise leisure traffic in the regions and can be substituted by LCCs.

Marginal correlation occurs between the turnaround fees and the share of each airline type in airport traffic. This means that prices are not discriminatory and assure fair treatment of all types of airlines. On the other hand, the results again negate suggestions that airports could use its tariffs as a tool not only to grow traffic as such, but to develop a particular type of traffic (e.g. Graham, 2014). Airport managers should be aware that the current EU regulations hardly leave scope for such practices. Instead, it needs to be recognised that while airport charges should correspond to the actual operating costs, the level of charges is in fact of moderate interest to the airlines. This challenges much of the research carried out so far, although supports those authors who openly stated that complaining about airport charges is somehow natural for airlines (Adler and Berechman, 2001) and that eventually the carriers are able to pay the price if the potential gains are enough.

Another factor, availability of incentive schemes, was found to be negatively correlated with CC and positively correlated with the FSC and LCC share. This is because such schemes usually favour scheduled traffic (Jones et al., 2013). On the other hand, it is symptomatic that this relationship is

[9] it needs to be remembered that the study considers only airports below 1mppa. Therefore, FSCs may still dominate gateways over 1mppa located in the same, more populous regions.

stronger for FSCs than for LCCs. If we assume that FSCs' networks are usually more stable over a period of years (Copenhagen Economics, 2012), this would suggest that incentive schemes can be associated with the long-term, sustainable growth of the number of routes. This is definitely good news for regional airports, yet requires further study to allow for a definite answer to the question raised by Malina et al. (2012) regarding the efficiency of incentive schemes in establishing long-run air transport services.

An airport's distance to the nearest competitor demonstrates mixed correlations according to types of traffic. The further an airport is from its competitor, the less dominated it is by charter traffic. This is probably due to the fact that many tourism attractive regions are served by several airports located close to each other. Very weak relationships were found with respect to FSCs and LCCs, suggesting that it is the latter that operates higher share of capacity at remoter airports, although the results are rather inconclusive.

The CCs were found to be more active at slot-coordinated airports, which has not been discussed in the literature so far. Thus, airports willing to focus on this leisure segment of the market should be aware of the possible capacity constraints involved - i.e. that it may be literally impossible to attract an LCC or FSC once the slots have been occupied by the CCs. Also, such airports should especially care about maintaining good relationships with local inhabitants so that possible night operations would not face intense opposition.

Finally, ground accessibility of the airports did not show significant correlations with the share of any airline type. It is especially the case for motorways and highways, which suggest that a regional airport can be served by less developed road systems. According to the gathered data, there are 47 airports without railway or motorway/highway access, although it should be remembered that some of them are located on islands, which usually do not require developed road infrastructure.

6.4 Discussion of descriptive statistics[10]

Table 6.1 below shows the overall split of the seats offered by different airline types at airports. FSCs and LCCs control an almost equal share of the seats departing from regional airports, which contradicts the possible belief that LCCs dominate small regions. Charter traffic is responsible for the remaining average 15% of capacity offered over the reference period. Interestingly, despite offering just 40% of

[10] Note: It needs to be clarified that due to unavailability of traffic data, the sample for descriptive statistics was reduced by 4 airports compared to the sample used in the MLR

capacity, the FSCs operate more than half of all the flights. This is due to the smaller aircraft they use and greater frequency of operations to the regions in order to feed their hubs.

We can also compare the landing figures with the European average for all the airports provided by Eurocontrol (2015), according to which CCs, FSCs, LCCs operate 4%, 63% and 33% of flights respectively[11]. While the LCC share in the regions is similar, the share of CCs is surprisingly high. 10% of flights departing from small airports are charter services, 6 pp. more than the average. This shows that charter traffic is clearly of greater importance for regional airports than it is for larger gateways. To make definitive judgments, however, a longer period should be analysed in order to exclude charter seasonality, as lower charter traffic throughout the rest of the year could equally neutralise this result.

Traffic type	**Weekly seats**	**Seats % share**	**Weekly departures**	**Departures % share**
Charter	123 338	15%	725	10%
Full- service	339 725	40%	3 693	53%
Low- cost	371 517	45%	2 525	36%
SUM	834 580		6 943	

Table 6.1 Capacity offered from the considered airports. Split according to airline types

Considering the differentiation between domestic and international traffic (Table 6.2) the advantage of the latter is visible. Six out of ten seats departing from regional airports reach foreign countries. Only in Sweden and Denmark does domestic traffic share exceed 50%. Therefore, it can be said that regional airport managers think globally and do not rely on internal flights. Also, flag carriers can no longer be sure of their dominance in the regions if they fail to provide international connections.

Traffic type	**Weekly seats**	**Percentage share**
Domestic	334 542	40%
International	500 038	60%
SUM	834 580	

Table 6.7Type of traffic served from the considered airports

Table 6.3 takes a closer look at individual airlines and presents the top 10 carriers according to the capacity offered from the airports studied. The two ultra LCCs, as Ryanair and Wizzair are sometimes referred to, offer the highest number of seats. The third largest airline at small airports is a regional

[11] If other types of traffic are excluded

FSC, Flybe. The remaining positions are occupied mainly by FSCs, but also by LCC easyJet and CC Thomson Airways, which offer between 20 and 30 thousand seats weekly.

Airline	Weekly seats offered
Ryanair	120 582
Wizzair	47 740
Flybe	36 216
Iberia	29 616
easyJet	28 752
Air France	26 822
Vueling	26 792
Thomson Airways	25 578
SAS	25 232
Lufthansa	23 856

Table 6.3 Most popular airlines at regional airports

Ryanair is an undisputable leader in the regions- the airline alone offers more capacity than the next three carriers together and as much as 14% of the total sum of seats. It is therefore understandable that LCCs, and especially the Irish carrier is the first thought for airports wishing to attract traffic. On the other hand, the position of FSCs is remarkable. Despite the size of their networks and greater frequencies, they are not leaders in their regions. This, combined with the results of the previous two tables, shows that gone are the days when regional airports were reliant on the domestic carrier's faith and nowadays foreign carriers, especially LCCs, can effectively serve these airports. Thus, conclusions on the positive effect of deregulation on the aviation market are also applicable to small and medium regional airports (e.g. Starkie, 2006).

Considering the most popular destinations offered from regional airports, London Stansted is classified first, although Madrid Barajas and Stockholm Arlanda are serving similar capacity. This is due to the fact that while Iberia and FSCs generally connect airports directly with just one hub, LCCs can offer non-stop connections to whatever airport in Europe. Therefore, Stansted is linked with more airports but the connections of Madrid and Stockholm see higher frequency. Interestingly, Palma de Mallorca is classified destination number four with over 27 thousand seats arriving from regional airports. The result is driven by German tourists. 13 thousands of seats weekly are offered on flights to German airports, although the UK-bound capacity is not much smaller.

Destination Airport	Weekly seats offered
STN	32 589
MAD	31 932
ARN	31 172
PMI	27 588
ORY	26 203
MUC	25 428
HEL	24 998
BCN	24 155
ATH	23 555
LTN	21 617

Table 6.4 Most popular destinations served from regional airports

Finally, when talking about the dominance of the main carrier over an airport (Table 6.5), one can see that 22 small regional gateways are reliant on a capacity provided solely by one airline. For 95 airports in total, the dominant carrier represents over half of the capacity. Only 47 airports managed to diversify their networks enough to cater at least three carriers, none of which dominates the market and these airports are significantly larger handling, on average 452,000 passengers annually, compared to 250,000 by other airports. Just one airport, Romanian's Oradea, sees annual traffic of less than 100,000 and is not dominated by one airline. This means that the smallest airports are almost inevitably reliant on just one airline, which is consistent with the reports by Copenhagen Economics (2012). The other end of the spectrum further confirms this, as the 22 airports dominated entirely by one carrier serve on average as little as 140,000 passengers per year. This puts airports in a difficult situation, where they need to choose whether they wish to diversify the network at all cost, or accept the reliance on just one carrier and develop a long-term cooperation with it. Finally, this phenomenon sheds a different light on the issue of an airport's monopolistic position. While traditionally it is the airport that is considered a natural monopolist in its region (Starkie, 2002), which airlines often complain about (e.g. O'Halloran, 2017), it should be noted that airlines do not avoid dominating such airports in order to eventually become the monopolistic capacity provider in the region. .

Dominant airline share	Number of airports
<50%	47
50-80%	61
80-99%	12
100%	22

Table 6.5 Number of airports according to the dominant airline share

It is also interesting to identify the ten airports which have seen the biggest drops in traffic over the last decade. This can be done by comparing 2016 traffic figures with the maximum yearly passenger throughput they have recorded since 2007, (Table 6.6)

Airport code	Airport name	Traffic 2016	Maximum traffic since 2007	Traffic drop
REU	Reus	817 611	1 706 609	888 998
FMO	Münster	781 753	1 606 425	824 672
GRX	Grenada	753 142	1 468 000	714 858
XRY	Jerez	916 451	1 608 000	691 549
MME	Durham Tees	131 487	733 676	602 189
PAD	Paderborn	706 868	1 209 000	502 132
TMP	Tampere	208 930	709 356	500 426
VGO	Vigo	954 006	1 406 000	451 994
RMI	Rimini	473 103	920 641	447 538
BOH	Bournemouth	666 219	1 083 379	417 160

Table 6.6 Top 10 airports seeing the largest traffic drops

There are a few commonalities these airports share. Firstly, in most cases, they recorded their maximum traffic in 2007 and since then have been witnessing systematic decreases. This means that they were severely hit by the financial crisis. Secondly, half of them is located in tourism-attractive regions. The number of foreign visitors in the areas of Reus, Grenada, Jerez, Vigo and Rimini averaged at 8 millions in 2015. Also Bournemouth used to be the base airport for charter airlines serving the needs of British tourists and it saw traffic decreases following the crisis. Thus, the potential which tourism brings cannot be taken for granted as it may equally be an insufficient argument for airlines to maintain services in the long run. Third, some of these airports play a tertiary role and are neighboured by at least two bigger airports in the area. For instance, Reus sees competition from Gerona and Barcelona, while Munster competes with Hanover, Dortmund or even Dusseldorf. Therefore, in the regions where competition is particularly intense and where major airports are located, the smallest airports are the most vulnerable and fragile to traffic changes, not to say they are bound to lose traffic when the economic climate becomes unfavourable.

Also, at some stage of the recent history of these airports, the issue of subsidies paid to airlines by local authorities appears. For instance, Ryanair withdrew all its flights from Granada in 2010 as regional authorities could not repay the debts owed to the airline (Cano, 2010), which eventually left the airport without a scheduled flight for 7 years. The role of artificial, financial support in maintaining such routes has been recognised also in Poland, where the equivalent of GBP665 million was paid in different forms by regional authorities to the airlines until 2013 (Sipinski, 2013).

Finally, it needs to be recognised that almost all these airports have managed to grow traffic over the threshold of 1 mppa in the recent past. Nevertheless, they did not manage to maintain such traffic. This again shows how fragile small airports are and that their growth is never certain.

6.5 The industry perspective

The author had some opportunities to to discuss the results informally with airport representatives and they commonly considered small regional airports as niche, complex structures which face increasing difficulties in extending their networks. They also shared the point that the impact of financial aspects, i.e. airport charges and incentive schemes, should not be overestimated by the airport operators. As these were not formal interviews, no other conclusions can be drawn from them.

Instead, the author reviewed the online platform Route-shop (2017).. It is a professional, online platform where airports promote themselves and advertise potential routes to airlines. Forty-seven airports with below 1 mppa have accounts on the platform, and Table 6.7 presents the factors these airports stress in their marketing and communication strategies towards carriers. Airport charges are held in a separate section of the platform indicating the importance placed on this factor by the airports themselves and not represented in table 6.7.

Factor	Number of times being mentioned
Population	36
Tourism	35
Ground accessibility	35
Incentives	18
Slots	18
Infrastructure	16
Number and type of enterprises	15
Distance to the city	15
Service quality	6
FDI/foreign trade	5
GDP	5
Employment	3
Academic development	3
Expatriate communities	3
Yields	2
Ecology	1
Ownership	1
Population age structure	1

Table 6.7 Most frequently mentioned airport choice factors. Source: Own interpretation of results gathered from Route Shop (2017)

Population is the most frequently mentioned airport choice factor which is in line with the results of the regression model. Indeed, airports do recognise that population is a necessary condition for many airlines to enter the market. Also slots are classified as being very important. Surprisingly, airports appear to find tourism and ground accessibility (ranked second and third) as crucial factors for airlines to launch services, something not supported by the results in this study. Therefore, airports should reconsider their communication to the airlines in this respect and stress other aspects. Incentives, infrastructure, number of business units and distance to the city are other factors found important in the industry. Finally, the list has numerous factors of minor importance. This means that airports are aware of the fact that many variables can be taken into consideration by potential airlines and therefore want to position themselves as unique, niche markets to serve.

There are also many official interviews which confirm the above results. To give an example, Anna Midera, Airport CEO of Poland's Lodz, has recently openly invited carriers to the airport, using some of these factors as enticements. The prospect of serving a catchment area of 16 million people and lack of capacity constraints are, among others, the key reasons why airlines (especially CCs) should select Lodz Airport in Ms Midera's opinion. In another interview, Ms Midera expressed her opinion that research and business activities in the area should also draw attention of the airlines (Rynek Lotniczy, 2017). This shows that the factors identified in this study as potential and actual determinants of traffic volume are also used by operators to promote their airports amongst carriers.

Finally, airlines' voice should be heard. The Chief Operating Officer of Wizzair put it straightforwardly and said that condition number one for the airline route network development is population size, followed by GDP indicators (Charnock, 2017). In turn, British Airways appears to look at the type of, rather than the number of passengers, when selecting new routes. As Alex Cruz pointed out, presence of high-yield passengers make several routes economically viable despite lower load factors (anna aero 2017). This is in agreement with the model results- LCCs target larger markets, while FSCs can make profit out of smaller, but more prosperous niche markets. Mixed conclusions can be drawn with respect to the airport charges- on one hand airlines in most cases expect them to be lower (Hoffman, 2016), however the tariff is rarely the only cause of an airline's exit from an airport. Finally, they also stress the links between aviation and tourism (e.g. CAPA, 2017). This relationship between tourism and airport traffic level has been found positive, although volatile in the model.

6.6 Summary

Summing up, several patterns revealed by the study can be seen in other sources as well. First, population appears to be factor number one when an airline selects airports to serve. This is proven not only by the results, but also by literature, statistics and industry members' words. These sources also confirm that the catchment area GDP is an important determinant of regional airport attractiveness. Most of the factors, e.g. tourism or distance to the competitor airport, show predicted relationships with airport traffic level. Their significance levels and thus actual impact on the airline decisions are, however, lower than airports could wish. These low significance levels and explanatory power of the model are caused by the complexity of the market. Regional airports face intense competition and therefore need to cautiously design their network strategies. There is no one size fits all solution how to develop a successful, large airport. Neither should regional airports be expected to grow just overnight.

Regarding the airport traffic structure at regional airports, most of the findings are consistent with the previous literature, especially in terms of LCCs, which constitute 45% of the total traffic these airports handle. Population size, tourism attractiveness and incentive schemes are usually related to higher shares of these airlines. FSCs (40%) in turn are able to serve the smallest areas and do not value tourism potential as other carriers, although they do take advantage of the incentives. Finally, CCs (15%) can be attracted by airports which are located in popular holiday destinations, are not necessarily constraint-free, and which see relatively more competition than other airports. On the other hand, they are more price inelastic as their share in the airport traffic shows little correlation with the airport charges level or the availability of incentive schemes.

There is also some inconsistency between the sources analysed. Whilst the literature and the results indicate that capacity restrictions are an effect rather than a constraint of a successful airport, the airport operators appear to consider lack of such restrictions as a source of advantage over competitors. Also, the results and literature indicate that airport charges have either mixed or limited impact on airline network decisions whilst the airline representatives very often refer to or complain about the level of airport charging. This is perhaps typical that airport users would like to pay less, although overall the airport costs cannot be used as a method to attract airlines.

Finally, the descriptive statistics provide additional data on the type of traffic served by the airportsstudied, In terms of capacity provided, LCCs provide its highest share, although it is FSCs that fly from such airports more frequently with smaller aircraft. This means the airports should not focus on just one type of carrier. Also, three out of five seats provided from regional airports depart on international routes. The destinations which regional airports are likely to attract in the first instance include bases of Ryanair and the major airports in their own countries. However, these airports can find themselves under dominance of just one carrier, which is the case for two thirds of them. Finally, airports aiming at tourism traffic need to be extremely cautious about the traffic fluctuations, as leisure traffic may fluctuate rapidly due to its sensitivity to economic downturns.

7. Conclusions and further research

The results of this study can help in understanding the airport-airline relationship. Also, in the light of the model explanatory power, it needs to be recognised that regional airports in Europe is a sector that denies easy generalisations and different airport operators may pursue different policies of route network development. Therefore, wherever possible, interpretation of results should be made in the context of a specific airport.

7.1 Recollecting the research goals

This paper set to explore the determinants of the volume and structure of traffic at small regional airports in Europe. In the first chapter, the general problem of route network development and airport choice factors was described. It was explained that little is known regarding how airports below 1 million passengers per annum develop their route networks and that the literature so far tended to concentrate on bigger gateways. At the same time, attention was drawn to the fact that these small gateways are often expected to grow rapidly by local communities and governments, which is difficult given the unfavourable market trends.

Therefore, two research questions were formulated to navigate the research, i.e.

- What are the determinants of air traffic **volume** at small and medium regional airports in Europe?
- What are the determinants of air traffic **structure** at small and medium regional airports in Europe?

To answer these questions, two aims were established:

Aim 1: To analyse the determinants of air traffic volume at small and medium regional airports in Europe.

- Objective 1.1 To examine and categorise airport choice factors for airlines.
- Objective 1.2 To investigate the importance of airport choice factors for airlines in the context of air traffic volume.

Aim 2: To examine traffic patterns at small and medium regional airports in Europe.

- Objective 2.1 To present the structure of traffic at the considered airports.

- Objective 2.2 To investigate the relationship between the airport choice factors and the airport traffic structure.
- Objective 2.3 To discuss volatility of traffic at the considered airports.

7.2. How the research goals have been achieved

After the introductory section, the second chapter reviewed the academic literature with respect to the airport choice factors for airlines. It established that not only do many factors influence airline network decisions, but it also showed that the literature is fragmented and concentrated around several major aspects, especially LCCs and larger airports, leaving scope for a study.

It was the third chapter where the airport choice factors for airlines were categorised for the purpose of clarity and discussed broadly. Relevant cases from the industry were also given in order to show practical examples and increase the reader's understanding of the airport choice factors. Chapter three proposed a division of factors into general, airline-related, airport-related and airport catchment area-related ones, which could be used in similar studies in the future.

Chapter four laid the technical foundations for achieving the remaining objectives. It explained the methodology used in this paper, as well as the process of selection of factors and airports for the study. Multiple linear regression and correlation analysis were introduced as the two major techniques used in the paper. The chapter also described how traffic data was gathered, which may be useful for future researchers to overcome the problem of data unavailability for similar markets.

Identifying the determinants of airport traffic volume, chapter five presented the results of multiple linear regression and correlation analysis with respect to the importance of airport choice factors. It showed that 23% of traffic level variation could be explained by the variables considered. Also, it identified three variables, i.e.: population size, airport charges and slot coordination as significantly correlated with airport traffic volume. The remaining variables did show relationships that were consistent with the literature in most cases (except R&D spending). GDP, tourism attractiveness, distance to the competitor and ground accessibility were positively related to airport traffic level. Nevertheless, these relationships were not statistically significant. Therefore, while the results indicate what factors may attract airlines to airports, one should consider them in the context of specific airports rather than make definitive generalisations in this aspect.

Chapter six discussed the results and concluded that indeed, population size is clearly the most important determinant of air traffic volume in the regions. In terms of airport charges and capacity constraints, it was stated that these variables are perhaps the effect, rather than drivers of the airport traffic volume. Therefore, airports and regional authorities should no longer expect air traffic to grow only due to lower charges or extensive capacity, even though many of them consider these areas as a source of competitive advantage, as industrial examples showed. The conclusions drawn in chapter 6 with respect to other factors should make airports and airlines reassess their growth strategies and development plans, as apart from big population, there is nothing that can actually guarantee high level of passenger traffic.

Then, data on the traffic structure was presented in chapter five and discussed in chapter six in order to understand what kind of operations the regional airports serve. This corresponded to objective 2.1. It was found that LCCs provide the highest share of capacity in the regions, although the FSCs lead the way in terms of the number of air traffic movements. For regional airports, this means that they are naturally more likely to attract LCCs, although some thin routes may be convenient for FSCs to feed their hub networks. Also, the CCs appear to control a higher share of capacity at regional airports than at bigger airports. This means there is a room and potential for all types of traffic at small regional gateways. Regarding the destination types, 60% of seats depart on international routes, which is probably due to the fact that LCCs can serve many countries owing to liberalised market conditions. Unsurprisingly, Wizzair and Ryanair are the most popular airlines in the regions. Thus, airport operators should naturally think of these carriers when planning to open a new, especially international connection.

Chapters five and six aimed also to establish the determinants of the traffic structure. They presented and discussed the determinants of the traffic structure at the airport, realising objective 2.2. According to the results, LCCs tend to grow especially in populated, less economically developed regions, the opposite to FSCs. Regarding the CCs traffic, it clearly concentrates around slot-constrained airports in popular tourism destinations. Pricing showed mixed or little correlation with the share of particular airline types, which means that the IATA guidelines for non-discriminatory tariffs are effectively implemented in the industry. The incentive schemes were found to correlate with scheduled, FSC and LCC traffic. The results also suggested that incentive schemes may positively affect long-term, sustainable development of routes, although further research is needed to give clear answers.

Finally, chapter 5 and six realised the objective 2.3 and provided more insight into traffic volatility at regional airports. Using descriptive statistics, it was identified that airports serving leisure traffic and those located in multi-airport regions are particularly prone to losing traffic. It was also found that, in accordance with industry reports, the majority of the airports studied (95 out of 142) are dominated by one carrier which provides over 50% of capacity and as many as 22 are being served solely by one airline. This indicates that regional airports are not able to choose between airlines and close cooperation with one or a few carriers is perhaps unavoidable.

7.3 Answering the research questions

Based on the above, the research brought the following answers to the research questions

Q1: Population size of an airports' catchment area is the main determinant of the traffic volume at small regional airports in Europe. GDP per capita, tourism attractiveness, incentive schemes, distance to the competitor and ground accessibility further influence the traffic scale, although their statistical significance is too low to allow for generalisations. Airport charges and capacity constraints are highly correlated with the airport traffic volume, although they should be interpreted as a result, rather than a determinant of the air traffic level.

Q2: The following variables show either a positive (+) or negative (-) relationship with the respective traffic types:

- for LCCs: population size, tourism, incentives, airport's distance to the competitor (+); GDP per capita, R&D expenditures, capacity constraints, ground accessibility (-)
- for FSCs: GDP per capita, R&D expenditure, incentive schemes, railway access (+); Population size, tourism (-)
- for CCs: tourism, capacity constraints (+); GDP per capita, incentive, R&D expenditure (-)

7.4 Limitations of the study

While providing answers to the research questions, this research naturally has its limitations. The most important one is that it assumes data for NUTS2 regions represents the characteristics of airport catchment areas. This inevitably causes some bias in the data, although its impact should be balanced across the entire sample of airports. Moreover, the paper employs only quantitative research, which is motivated by its practicality, replicability and popularity. There are other qualitative factors, such as human behaviour and personal perceptions of airline managers, which definitely have an impact on the location of traffic. Again, due to the scale of this study, they could not be monitored for each airport.

Finally, the study failed to prove strong relationships between most of the airport choice factors and the level/structure of traffic. The author supposes that this is mainly due to the diverse, dynamic environment of small regional airports and the different strategies these airports employ.

Nevertheless, it may also be the case that other methods would be more appropriate to analyse this sector of the market, or that analysis by geographical region (e.g. East-Central Europe) may yield greater insights.

7.5 Conclusions and further research

This research delivered results which are in most cases consistent with previous studies, although it extends their findings onto regional airports or finds new patterns in some cases. The main conclusion which can be drawn from this paper is that small regional airports in Europe constitute a complex part of the air transport market. There are few factors which are related to the traffic volume at regional airports, the most important of which is the size of the population living within the perimeters of the airport catchment area. Airport charges and capacity constraints are also significantly related to the number of passengers using the airport, although it appears they may be considered a result, rather than determinant, of the air traffic volume.

Secondly, several relationships between airlines' preference to specific airport profiles have been confirmed. In many cases, factors that attract LCCs to the airport are a deterrent to FSCs and vice versa. Airports serving more populous areas are more likely to attract LCC traffic while those located in more economically developed regions can expect higher FSC growth. Naturally, regions where tourism is developed are likely to serve more charter traffic. They, however, should be extremely careful in building route networks, as recent years showed that airports focusing on tourism traffic experienced more rapid downturns.

Thirdly, other factors studied in this paper, such as GDP and R&D spending per capita, tourism attractiveness, airport competition, airport ground accessibility or availability of incentive schemes also show correlation with airport traffic volume. These relationships should be studied further in order to draw specific conclusions, as they are not statistically significant.

The aforementioned conclusions should be also articulated by the airport operators to their local communities and regional authorities. The results showed that airlines do not locate their services anywhere, but many conditions have to be fulfilled before a new route is launched. Therefore, both the local inhabitants and politicians should be more critical and restrained in their desire for rapid airport growth. Instead, closer cooperation between these units, underpinned with appropriate population size, seem to be necessary to attract traffic. Considering airports themselves, it appears that the incentive programmes are the only tool they can use to influence the volume of traffic.

Future research should focus on deeper analysis of the airport choice factors which have been found to not be statistically significant as it is possible they do reveal some patterns within specific countries or different regions of the world. For instance, other research methods, such as direct interviews or time series analyses, or a focus on smaller, specific airport groups (e.g. on country level), could capture these potential trends. Another area worth consideration is the viability of alternative strategies for airports to secure their position in the market. It seems that those airports which are easily dominated by one carrier, could try to balance their growth, for instance by developing cargo traffic or constructing aircraft maintenance infrastructure. Finally, this study can be replicated in the future if new market dynamics appear. The attached database and extensive methodology chapter provide a sound basis for future researchers willing to investigate the determinants of air traffic.

APPENDIX 1- Airport sample selection. Identification of PSO-reliant airports

This appendix further clarifies how the airport sample was selected, mainly in terms of identification of PSO- reliant airports, extending thus section 4.5

According to EC (2015), there are around 253 airport-pairs served under Public Service Obligation. This number is not fixed, as several PSO routes are operated between more than two airports, linking different airport pairs on different days. Also the validity period is missing for many of the routes, which makes it impossible to state how many of them are currently operated. For the purpose of clarity, this analysis assumes each PSO route listed on the EC document to be operated currently.

1.Excluding Norwegian airports

As table 1 indicates, Norway, France and Greece see the highest numbers of PSO routes. Norway and France had been classified as the two most PSO-intensive countries also in the past (e.g. Wittman et al, 2016). Greece appears to have overtaken Italy and Germany recently.

Country	Number of airport-pairs served under PSO (2015)
Norway	51
France	45
Greece	40
Italy	22
United Kingdom	22
Portugal	21
Spain	18
Croatia	13
Sweden	10
Estonia	4
Finland	3
Ireland	3
Cyprus	1
TOTAL	253

Table A.1 Number of airport-pairs served under PSO routes (own calculations based on EC,2015)

There are several aspects that make the whole system of Norwegian airports unique. First, the structure of PSOs is significantly different in Norway than in France and Greece. In Norway, all PSO services involve routes within mainland airports. By comparison, in France 12 routes are operated to/from Corsica (Bastia/ Figari/ Ajaccio/ Calvi) and 13 involve outermost territories (Saint Martin/

Martinique/ Mayotte/ Guadalupe/ French Guyana/ Reunion). Only 20 routes connect two mainland cities. In Greece there are only 2 mainland pairs and the high number of PSO routes is the outcome of the country's island character.

Another difference is that tourism traffic is a natural opportunity for Greek and French airports, which is not the case for Norwegian airports. Admittedly, several Nordic airports do facilitate inbound tourism traffic related to winter sports, northern lights or Santa Claus, although the scale of such charter market is limited. With smaller potential to attract incoming leisure traffic, they need to rely on the PSO routes to higher extent. Therefore, PSO routes are likely to bias the real commercial potential of airports in Norway more than in other countries.

Third, Norway operates the highest number of PSO routes among airports below 1mppa. It is also Norway where the highest number of airports below 1mppa are involved in PSO scheme. More than half of Norwegian airports below 1 mppa (28/45=62% of airports) receive PSO services. This ratio is in fact higher for Greece (81%; just 33% for France). Theoretically thus, Greek airports below 1mppa appear to be more PSO-oriented than Norwegian ones. However, a further look into the average size of an airport receiving PSO in those two countries reveals that a typical Greek airport is almost twice the size of the Norwegian one (163 vs 96 thousand ppa). This is because of the already mentioned purely commercial, charter and seasonal traffic received by airports in Greece. This leads to the conclusion that while in percentage terms, Norwegian airports below 1mppa rely on PSOs less than the airports in Greece, in practice PSO routes are the only lifeline for most of them.

Based on the mentioned distortions the PSOs bring to the Norwegian market, a decision was made to exclude Norwegian airports from the sample, as they not necessarily operate for commercial purposes.

2. Excluding PSO-dependent airports

The other step was to identify airports that rely mainly on PSO services. For this purpose, the following data was collected for each airport:

- number of PSO routes operated from the airport.
- number of non-PSO routes operated from the airport. Data was obtained using Google Flight search engine.
- ratio of PSO/ non-PSO routes
- average yearly traffic for the recent 8/9 years (subject to availability);

As of February 2017, 40 airports received no scheduled services other than PSOs and another 20 served at least as many non-PSOs as PSO routes (Table 3). The list does not include non-scheduled charter and seasonal-scheduled traffic.

Country/ city	PSO routes	non PSO routes	Avg traffic	PSO/non-PSO
Croatia				
Pula	2	0	335394	n/a
Zadar	1	0	332828	n/a
Rijeka	3	0	106007	n/a
Osijek	6	0	17315	n/a
Finland				
Pori	1	0	39879	n/a
Savolinna	1	0	14343	n/a
France				
Bastia	3	3	1035876	1
Figari	3	0	443991	n/a
Calvi	3	0	295886	n/a
La Rochelle	1	0	211977	n/a
Lorient	1	0	176701	n/a
Rodez	1	1	137274	1
Poitiers	1	1	116051	1
Brive	1	0	46943	n/a
Lannion	1	0	36018	n/a
Castres	1	0	34832	n/a
Annecy	1	0	33209	n/a
Aurillac	1	0	23459	n/a
Dijon	2	0	20291	n/a
Greece				
Zakinthos	2	0	996150	n/a
Mytillini	1	0	488879	n/a
Samos	2	2	412926	1
Aktion	2	1	322082	2
Skiathos	1	0	266654	n/a
Alexandroupolis	1	1	239923	1
Chios	2	2	222658	1
Karpathos	2	1	179807	2
Limnos	5	0	103642	n/a
Sitia	4	0	36438	n/a
Paros	1	1	36345	1
Milos	1	0	34684	n/a
Ikaria	2	0	33856	n/a
Kithira	2	0	30515	n/a
Naxos	1	0	28298	n/a
Kalymnos	2	1	19291	2
Astypalaia	2	0	13856	n/a
Skyros	2	0	12306	n/a

Syros	1	1	11037	1
Kastellorizo	1	0	8322	n/a
Kassos	1	1	5215	1
Kastoria	1	1	4457	1
Ireland				
Galway	1	0	79447	n/a
Donegal	1	0	74612	n/a
Inishmore	1	0	10268	n/a
Italy				
Reggio Calabria	2	1	537369	2
Bolzano	1	0	54151	n/a
Sweden				
Gallivare	1	1	39769	1
Vilhelmina	1	1	15094	1
Hemavan	1	0	13633	n/a
Sveg	1	1	5206	1
Pajala	1	0	4217	n/a
Torsby	1	1	2835	1
Hagfors	1	1	2635	1
United Kingdom				
Kirkwall	6	4	140579	1,5
Dundee	1	0	49467	n/a
Benbecula	2	0	32276	n/a
Barra	2	0	10679	n/a
Campbeltown	1	0	8947	n/a
Tiree	3	0	8598	n/a
Lerwick	4	0	4544	n/a

Table A.2: Airports with at least 50% routes operated under PSO. Airports in italics were re-included in the sample

The results show that these airports rely on PSO routes at least in 50%, which justifies excluding them from sample, as their existence is maintained artificially by the PSOs. That is why they cannot be considered equal to other airports, the route networks of which depend on competitive market conditions.

Nevertheless, it should be remembered that the above results cannot capture charter and seasonal-scheduled operations. This traffic is vital for many airports and increases the number of passengers, especially in Greece, Croatia and France. Thus it would be too restrictive to exclude all the above airports just on the basis of insufficient amount of scheduled services in February. The airports attracting seasonal traffic should be brought back to the sample.

This has to be done through an analysis of traffic levels at airports in particular countries. No uniform threshold could be applied, as different countries attract different volumes of seasonal traffic. Based on the average number of passengers, and on a study of individual profile of each airport, decision was made to re-include 12 airports into the sample. Names of these airports are indicated in italics in Table 3.

Appendix 2- Classification of airline types and aircraft capacities.

This appendix explains the division of airlines into LCCs, FSCs and CCs (Table 1), as well as gives more details on the assumed aircraft seating capacitites (table 2). It refers to section 4.9 of the paper.

The table below presents the division of airlines into Full service carriers (FSCs), low-cost carriers (LCCs), charter (CC) and cargo airlines. First, the first two symbols were extracted from the flight number in the flightradar database. These symbols denote the operating airline (code share effect is excluded). Each code was then assigned to the actual airline name based on IATA code list. Finally, based on the author's general knowledge of the industry, the airlines were classified according to their business models and countries they come from.

Airline code (first two symbols of the flight number)	Airline	Type of airline	Country
OS	Austrian	FSC	Austria
4U	Germanwings	LCC	Germany
EW	Eurowings	LCC	Germany
AB	Air Berlin	FSC	Germany
LH	Lufthansa	FSC	Germany
KL	KLM	FSC	Netherlands
HG	NIKI	LCC	Austria
LX	SWISS	FSC	Switzerland
TK	THY - Turkish Airlines	FSC	Turkey
BM	bmi Regional	FSC	United Kingdom
FR	Ryanair	LCC	Ireland
TB	Tui Airlines Belgium	CC	Belgium
WX	CityJet	FSC	Ireland
MS	Egyptair	FSC	Egypt
5S	Global Aviation Services Group	CARGO	Libya
QR	Qatar Airways	FSC	Qatar
4W	Allied Air	CARGO	Nigeria
ET	Ethiopian Airlines	FSC	Ethiopia
3V	ASL Airlines Belgium	CARGO	Belgium
5C	C.A.L. Cargo Airlines	CARGO	Israel
PS	Ukraine International Airlines	FSC	Ukraine
4E	Stabo Air Limited	CARGO	Zambia
V8	ATRAN	CARGO	Russian Federation
FI	Icelandair	FSC	Iceland
LY	EL AL	FSC	Israel
NN	VIM Airlines	FSC	Russian Federation

OU	Croatia Airlines	FSC	Croatia
TO	Transavia France	LCC	France
U2	easyJet	LCC	United Kingdom
VY	Vueling	LCC	Spain
LG	LuCargoair	FSC	LuCargoembourg
LO	LOT Polish Airlines	FSC	Poland
SX	Skywork Airlines	FSC	Switzerland
BE	flybe	LCC	United Kingdom
FB	Bulgaria air	FSC	Bulgaria
C3	Trade Air	FSC	Croatia
BT	Air Baltic	FSC	Latvia
DY	Norwegian Air Shuttle	LCC	Norway
SK	SAS	FSC	Sweden
AY	Finnair	FSC	Finland
D8	Norwegian Air Shuttle	LCC	Norway
EI	Aer Lingus	LCC	Ireland
S7	S7 Airlines	FSC	Russian Federation
WZ	Red Wings	FSC	Russian Federation
JU	Air SERBIA a.d. Beograd	FSC	Serbia
6B	Tuifly Nordic	CC	Sweden
PE	Altenrhein Luftfahrt	FSC	Germany
WK	Edelweiss Air AG	CC	Switzerland
7W	Wind Rose	CC	Ukraine
BY	Thomson Airways	CC	United Kingdom
LS	Jet2.com	LCC	United Kingdom
BA	British Airways	FSC	United Kingdom
OK	Czech Airlines j.s.c	FSC	Czech Republic
QS	Travel Service	CC	Czech Republic
TU	Tunisair	FSC	Tunisia
W6	Wizzair	LCC	Hungary
6I	Air Alsie	CC	Denmark
W2	FleCargoFlight	FSC	Denmark
DY	Norwegian Air Shuttle	LCC	Norway
PF	Primera Air	CC	Iceland
2N	NeCargotjet	FSC	Sweden
V7	Volotea	LCC	Spain
CE	Chalair	FSC	France
A5	HOP!	FSC	France
L5	Atlantique Air Assistance	CC	France
AF	Air France	FSC	France
IB	IBERIA	FSC	Spain
AC	Air Corsica	FSC	France
HV	Transavia Airlines	LCC	Netherlands
GR	Aurigny	FSC	United Kingdom
TE	SkyTaCargoi	CC	Poland
SN	Brussels Airlines	FSC	Belgium
5O	ASL Airlines France	CARGO	France
GM	Germania Flug	CC	Germany
T7	TwinJet	FSC	France

M4	Mistral Air	CC	Italy
3O	Air Arabia Maroc	FSC	Morocco
A3	Aegean Airlines	FSC	Greece
AH	Air Algérie	FSC	Algeria
CX3	TuiFly Gmbh	CC	Germany
PC	Pegasus Airlines	LCC	Turkey
CXQ	SunECargopress	CC	Turkey
ST	Germania	LCC	Germany
IS	AIS	CC	Netherlands
XC	Corendon Airlines	CC	Turkey
NO	Neos	CC	Italy
DP	Pobeda	LCC	Russian Federation
U8	Tus Airways	FSC	Cyprus
DK	Thomas Cook Scandinavia	CC	Denmark
DE	Condor	CC	Germany
0B	Blue Air	LCC	Romania
GQ	Sky ECargopress Greece	FSC	Greece
OA	Olympic Air	FSC	Greece
MT	Thomas Cook Manchester	CC	United Kingdom
BV	Blue Panorama	FSC	Italy
IG	Meridiana fly	FSC	Italy
HQ	Thomas Cook Belgium	CC	Belgium
KK	AtlasGlobal	CC	Turkey
A2	Astra Airlines	FSC	Greece
3Z	Travel Service Polska	CC	Poland
CD	Corendon Dutch	CC	Netherlands
7O	Travel Service Magyar	CC	Hungary
6D	Travel Service Slovensko	CC	Slovakia
ZB	Monarch	CC	United Kingdom
EL	Ellinair	FSC	Greece
B2	Belavia - Belarusian Airlines	FSC	Belarus
5F	Fly One	LCC	Moldova
2B	Albawings	CC	Albania
AZ	Alitalia	FSC	Italy
R3	Yakutia	FSC	Russian Federation
U6	Ural Airlines	FSC	Russian Federation
SU	Aeroflot	FSC	Russian Federation
IU	SW Italia	CARGO	Italy
6F	Primera Air Nordic	CC	Iceland
YB	BoraJet Havacilik Tacimasilk	CC	Turkey
7R	Rusline	FSC	Russian Federation
7L	Silk Way West Airlines	CARGO	Azerbaijan
U3	Sky Gates Airlines	CARGO	Russian Federation
RJ	Royal Jordanian	FSC	Jordan
P8	Sprintair	FSC	Poland
JP	Adria Airways	FSC	Slovenia
P7	Small Planet Airlines	CC	Poland
RO	TAROM	FSC	Romania
TP	TAP Portugal	FSC	Portugal

UX	Air Europa	FSC	Spain
EY	Etihad Airways	FSC	United Arab Emirates
CK	China Cargo Airlines	CARGO	China (People's Republic of)
CA	Air China Limited	FSC	China (People's Republic of)
EK	Emirates	FSC	United Arab Emirates
RU	AirBridgeCargo Airlines	CARGO	Russian Federation
E9	Evelop	CC	Spain
KE	Korean Air	FSC	Korea
TF	Braathens Regional Aviation AB	FSC	Sweden
HP	Amapola	CARGO	Sweden
DC	Braathens Regional	FSC	Sweden
HB	Asia Atlantic	CC	Thailand
8H	BH AIR	CC	Bulgaria
T3	Eastern Airways	FSC	United Kingdom
IO	IrAero	FSC	Russian Federation
5Y	Atlas Air	CARGO	United States

Table A.3 Airline classification applied in the study

The next table presents the assumed seating capacities of all the aircraft types included in the flightradar database. Assumptions had to be made because the same type of aircraft may actually have different number of seats on board, even within the fleet of one carrier. Therefore, assumptions were made based on the general specification of aircraft manufacturers.

Aircraft code	Aircraft name	Assumed aircraft capacity
ABF	A306 Cargo	0
AT4	Aerospatiale/Alenia ATR 42-300 / 320	48
AT43	Aerospatiale/Alenia ATR 42-300 / 320	48
AT45	Aerospatiale/Alenia ATR 42-500	48
AT46	Aerospatiale/Alenia ATR 42-600	48
ATR	Aerospatiale/Alenia ATR 42-600	48
AT7	Aerospatiale/Alenia ATR 72	78
AT72	Aerospatiale/Alenia ATR 72	78
AT75	Aerospatiale/Alenia ATR 72-500	78
AT76	Aerospatiale/Alenia ATR 72-600	78
A310	Airbus A310	220
31Y	Airbus A310-300 Freighter	0
318	Airbus A318	132
A318	Airbus A318	132
A319	Airbus A319	156
319	Airbus A319neo	156
A320	Airbus A320	180
32A	Airbus A320	180

32S	Airbus A320	180
320	Airbus A320neo	180
A20N	Airbus A320neo	180
A321	Airbus A321	236
32B	Airbus A321	236
321	Airbus A321neo	236
33F	Airbus A330 Freighter	0
33CARGO	Airbus A330 Freighter	0
A332	Airbus A330-200	246
340	Airbus A340	380
A32	Antonov AN-32	50
AR1	Avro RJ100	112
RJ1H	Avro RJ100	112
ARJ	Avro RJ85	100
AR8	Avro RJ85	100
RJ85	Avro RJ85	100
B462	BAe 146-200	100
143	BAe 146-300	112
B190	Beechcraft 1900	19
BEH	Beechcraft 1900	19
717	Boeing 717	134
B712	Boeing 717	134
73F	Boeing 737 Freighter	0
733	Boeing 737-300	149
B733	Boeing 737-300	149
73C	Boeing 737-300	149
734	Boeing 737-400	168
B734	Boeing 737-400	168
73P	Boeing 737-400 Freighter	0
735	Boeing 737-500	132
B735	Boeing 737-500	132
736	Boeing 737-600	130
B736	Boeing 737-600	130
737	Boeing 737-700	148
73G	Boeing 737-700	148
B737	Boeing 737-700	148
73W	Boeing 737-700	148
738	Boeing 737-800	189
B738	Boeing 737-800	189
73H	Boeing 737-800W	189
74F	Boeing 747 Freighter	0
74N	Boeing 747 Freighter	0
74Y	Boeing 747 Freighter	0
75F	Boeing 747 Freighter	0
B744	Boeing 747-400	416
75W	Boeing 757	228
75M	Boeing 757 miCargoed	228
752	Boeing 757-200	228

B752	Boeing 757-200	228
757	Boeing 757-200	228
75T	Boeing 757-300	280
763	Boeing 767-300	290
77CARGO	Boeing 777	440
77F	Boeing 777 Freighter	0
772	Boeing 777-200 / Boeing 777-200ER	440
B772	Boeing 777-200 / Boeing 777-200ER	440
B77L	Boeing 777-200LR / Boeing 777F	440
CS1	Bombardier CS100	133
ATP	British Aerospace ATP	70
J31	British Aerospace Jetstream 31	19
JS31	British Aerospace Jetstream 31	19
J32	British Aerospace Jetstream 32	19
JS32	British Aerospace Jetstream 32	19
J41	British Aerospace Jetstream 41	30
JS41	British Aerospace Jetstream 41	30
CRJCARGO	Canadair Regional Jet 1000	104
CRK	Canadair Regional Jet 1000	104
CR2	Canadair Regional Jet 200	50
CRJ2	Canadair Regional Jet 200	50
CR7	Canadair Regional Jet 700	78
CRJ7	Canadair Regional Jet 700	78
CR9	Canadair Regional Jet 900	90
CRJ9	Canadair Regional Jet 900	90
ABCARGO	Cargo	0
DHC6	De Havilland Canada DHC-6 Twin Otter	20
DHT	De Havilland Canada DHC-6 Twin Otter	20
DH4	De Havilland Canada DHC-8-400 Dash 8Q	82
DH8	De Havilland Canada DHC-8-400 Dash 8Q	82
DH8D	De Havilland Canada DHC-8-400 Dash 8Q	82
ERJ	Embraer 145	50
E170	Embraer 170	78
E70	Embraer 170	78
E75	Embraer 175 (long wing)	37
E75S	Embraer 175 (short wing)	50
E190	Embraer 190	78
E90	Embraer 190	78
EMJ	Embraer 190	78
E195	Embraer 195	114
E95	Embraer 195	114
EM2	Embraer EMB 120 Brasilia	124
E135	Embraer RJ135	37
ER3	Embraer RJ135	88
E145	Embraer RJ145	78
ER4	Embraer RJ145	88

FRJ	Fairchild Dornier 328JET	33
J328	Fairchild Dornier 328JET	33
D228	Fairchild Dornier Do.228	19
D28	Fairchild Dornier Do.228	19
D328	Fairchild Dornier Do.328	33
D38	Fairchild Dornier Do.328	33
100	Fokker 100	124
F100	Fokker 100	124
F50	Fokker 50	58
F70	Fokker 70	85
M1F	M1 Freighter	0
M11	McDonnell Douglas MD-11	410
M83	McDonnell Douglas MD-83	172
BNI	Pilatus Britten-Norman BN-2A/B Islander	9
S20	Saab 2000	58
SB20	Saab 2000	58
SF3	Saab SF340A/B	34
SF34	Saab SF340A/B	34

Table A.4 Aircraft capacities assumed in the study

Appendix 3 - Database

The next pages include the complete record of data used in this study, especially in the MLR. The respective columns indicate:

- Country- country the airport is located in
- NUTS2 - NUTS2 region the airport is located in, according to Eurostat classification
- IATA - airport code according to IATA list
- City- City the airport is located in
- Traffic - total number of passengers served by the airport in 2016
- Population- number of inhabitants
- GDP- GDP per capita [€]
- R&D- R&D spendings per capita [€]
- Tourism- number of non-resident tourism arrivals to the region
- Dash- turnaround fee for a rotation operated by Bombardier Dash Q400
- Boeing- turnaround fee for a rotation operated by Boeing 737-800
- Incentives- dummy representing whether the airport operates incentive schemes
- Distance- distance (km) to the nearest competitor
- Capacity- dummy representing whether the airport is slot coordinated/facilitated
- Railway- dummy representing whether the airport has a railway link
- Motorway- dummy representing whether the airport has a motorway link

Country	NUTS2	IATA	City	Traffic	Population	GDP	Tourism	R& D	Dash	Boeing	Incentives	Distance	Capacity	Railway	Motorway
Austria	AT21	KLU	Klagenfurt	194989	559846	33300	1410811	912	472	1303	1	50	1	1	1
Austria	AT22	GRZ	Graz	981706	1230756	35400	1136586	1654	467	1288	1	60	1	1	1
Austria	AT31	LNZ	Linz	435468	1451918	40300	1052880	1225	530	1462	1	100	1	1	1
Belgium	BE21	ANR	Antwerp	257058	1828927	43200	983452	1108	207	641	1	30	0	1	1
Belgium	BE25	OST	Ostend	422869	1184418	35500	1683514	465	197	542	1	70	0	1	1
Belgium	BE33	LGG	Liege	378416	1103490	26400	435073	406	242	666	1	40	0	1	1
Bulgaria	BG42	PDV	Plovdiv	77398	1436216	4400	180294	9	145	400	1	130	0	0	0
Croatia	HR03	BWK	Aerodrom Brač	12251	1394290	10000	11271355	42	464	1280	1	40	0	0	0
Croatia	HR03	ZAD	Zadar	498306	1394290	10000	11271355	42	339	936	1	100	0	0	1
Croatia	HR03	RJK	Rijeka	138950	1394290	10000	11271355	42	310	856	1	60	0	0	1
Croatia	HR03	PUY	Pula	438656	1394290	10000	11271355	42	319	880	1	60	0	0	1
Czech Republic	CZ04	KLV	Karlovy Vary	25235	1120654	11800	703610	41	369	855	1	90	0	0	0
Czech Republic	CZ05	PED	Pardubice	31174	1507209	13000	481487	177	263	726	1	110	0	0	0
Czech Republic	CZ06	BRQ	Brno	417725	1684500	14800	554308	401	334	922	1	120	0	0	1
Czech Republic	CZ08	OSR	Ostrava	258223	1213311	13100	180045	149	329	907	1	110	0	0	1
Denmark	DK03	SGD	Sønderborg	58000	1211770	43400	458323	729	164	451	0	90	0	0	1

Denmark	DK02	RKE	Roskilde	21000	827499	32900	101988	372	243	670	0	30	0	0	1
Denmark	DK01	RNN	Bornholm	273000	1789174	61600	1595901	2748	655	1806	0	100	0	0	0
Denmark	DK03	EBJ	Esbjerg	108000	1211770	43400	458323	729	222	613	1	40	0	0	1
Denmark	DK04	AAR	Aarhus	383000	1293309	42900	212724	1113	195	537	1	90	0	0	1
Denmark	DK04	KRP	Karup	155000	1293309	42900	212724	1113	117	322	0	60	0	0	0
Finland	FI20	MHQ	Mariehamn	59544	28983	46500	112890	140	106	374	1	120	0	0	0
Finland	FI1D	ENF	Enontekiö	22273	1298457	31300	671357	950	106	374	1	90	0	0	0
Finland	FI1D	IVL	Ivalo	179627	1298457	31300	671357	950	106	374	1	150	0	0	0
Finland	FI1D	KAJ	Kajaani	85853	1298457	31300	671357	950	106	374	1	130	0	0	0
Finland	FI19	KOK	Kruunupyy	88766	1379116	34200	206211	1092	106	374	1	100	0	0	0
Finland	FI1D	KAO	Kuusamo	76848	1298457	31300	671357	950	106	374	1	170	0	0	0
Finland	FI1D	KTT	Kittilä	257545	1298457	31300	671357	950	106	374	1	90	0	0	0
Finland	FI1D	JOE	Joensuu	122543	1298457	31300	671357	950	106	374	1	90	0	0	1
Finland	FI19	VAA	Vaasa	288520	1379116	34200	206211	1092	106	374	1	100	0	0	1
Finland	FI1C	TKU	Turku	324077	1160491	33800	292853	802	106	374	1	120	0	0	1
Finland	FI1D	KEM	Kemi-Tornio	61314	1298457	31300	671357	950	106	374	1	100	0	0	1
Finland	FI19	JYV	Jyväskylä	62448	1379116	34200	206211	1092	106	374	1	130	0	0	0
Finland	FI19	TMP	Tampere-Pirkkala	208930	1379116	34200	206211	1092	106	374	1	120	0	0	1

Finland	FI1D	KUO	Kuopio	227194	1298457	31300	671357	950	106	374	1	100	0	0	1
Finland	FI1D	RVN	Rovaniemi	487857	1298457	31300	671357	950	106	374	1	100	0	0	0
France	FR82	AVN	Avignon	16549	5024192	30500	5649320	754	90	no data	0	40	0	0	1
France	FR25	CFR	Caen	139016	1479133	26100	1076606	328	81	412	0	50	0	0	1
France	FR81	BZR	Beziers	243430	2802885	24500	1807858	578	82	371	0	60	0	0	1
France	FR71	CMF	Chambery	212018	6574708	32700	4080922	887	59	258	1	60	0	0	1
France	FR81	CCF	Carcassone	392148	2802885	24500	1807858	578	no data	no data	no data	40	0	0	1
France	FR52	RNS	Rennes	640768	3310341	27800	1172296	539	99	247	0	60	0	0	1
France	FR82	TLN	Toulon	500046	5024192	30500	5649320	754	87	432	1	80	0	0	1
France	FR52	UIP	Quimper	86452	3310341	27800	1172296	539	38	183	0	60	0	0	1
France	FR52	DNR	Dinard	110455	3310341	27800	1172296	539	112	275	1	60	0	0	1
France	FR61	EGC	Bergerac	305323	3399091	28500	1941950	450	70	298	1	80	0	0	0
France	FR53	LRH	La Rochelle	221195	1808710	27000	603119	242	62	301	0	110	0	0	1
France	FR23	LEH	Le Havre	198897	1864114	28300	564922	400	173	620	no data	20	0	0	1
France	FR71	EBU	Saint Etienne	164519	6574708	32700	4080922	887	no data	no data	no data	70	0	0	1
France	FR83	CLY	Calvi	321507	330354	26300	738436	77	47	226	0	60	0	0	0
France	FR24	TUF	Tours	198897	2587004	27000	1287427	437	141	551	0	100	0	0	1
France	FR63	LIG	Limoges	291564	735295	24800	179690	243	30	123	1	90	0	0	1
France	FR81	FNI	Nimes	213005	2802885	24500	1807858	578	95	400	0	40	0	0	1
France	FR83	FSC	Figari	639916	330354	26300	738436	77	100	406	0	50	1	0	0
France	FR81	PGF	Perpignan	377214	2802885	24500	1807858	578	no data	no data	no data	70	0	0	1
France	FR61	PUF	Pau	608222	3399091	28500	1941950	450	40	198	0	40	0	0	1
France	FR25	DOL	Deauville	139900	1479133	26100	1076606	328	142	625	1	20	0	0	1

France	FR43	DLE	Dole Jura	104732	1179465	25300	458454	652	128	614	1	100	0	0	1
France	FR62	LDE	Tarbes Lourdes	381549	3027281	29300	1451940	1378	387	192	1	40	0	0	1
France	FR72	CFE	Clermont	400461	1365944	26800	404794	585	158	508	1	90	0	1	1
France	FR41	ETZ	Metz	229278	2333587	25000	957868	302	91	444	0	70	0	0	1
France	FR71	GNB	Grenoble	304700	6574708	32700	4080922	887	49	284	0	50	0	0	1
Germany	DEC0	SCN	Saarbrücken	427556	995597	35400	159189	464	189	520	1	70	1	0	1
Germany	DEA3	FMO	Münster/Osnabrück	781753	2614229	31300	254941	320	203	560	1	70	1	0	1
Germany	DEA4	PAD	Paderborn/ Lippstadt	706868	2057996	35200	211483	644	258	712	0	70	0	0	1
Germany	DE13	FDH	Friedrichshafen	523888	2224535	36000	1932842	893	342	944	0	20	0	1	1
Germany	DE80	RLG	Rostock	250199	1612362	24900	375413	426	142	384	1	100	0	0	1
Germany	DEG0	ERF	Erfurt	235331	2170714	26300	244551	532	no data	no data	no data	100	1	0	1
Greece	EL61	JSI	Skiathos	397646	729442	12100	379599	68	55	150	0	90	2	0	0
Greece	EL42	JMK	Μυκόνου-Mykonos	997822	334791	18100	3512068	45	52	144	0	90	2	0	0
Greece	EL41	SMI	Samos	349539	196654	12400	326465	107	60	166	0	70	2	0	0
Greece	EL54	IOA	Ιωαννίνων-Loannina	86523	336834	11500	173509	116	34	113	0	80	0	0	1
Greece	EL41	MJT	Mytillini	408572	196654	12400	326465	107	52	145	0	90	2	0	0
Greece	EL54	EFL	Kefellonia	542359	336834	11500	173509	116	63	174	0	50	2	0	0
Greece	EL41	KLX	Kalamata	230100	196654	12400	326465	107	34	113	0	130	2	0	1
Greece	EL62	PVK	Aktion	476333	206141	15100	1549996	39	52	145	0	90	2	0	0
Greece	EL51	KVA	Καβάλας - Kavala	261100	604504	11300	407869	71	61	168	0	110	2	0	1
Greece	EL63	GPA	Αράξου-Araxos	129738	668258	11900	285290	117	34	113	0	70	2	0	0

Hungary	HU32	DEB	Debrecen	284400	1474383	7000	183916	83	232	640	1	60	0	1	1
Ireland	IE02	WAT	Waterford	13511	3474626	48100	2155185	673	other focus	other focus	other focus	100	0	0	0
Ireland	IE02	KIR	Kerry	325670	3474626	48100	2155185	673	no data	no data	1	70	0	0	0
Ireland	IE01	NOC	Knock	735869	1250094	24600	511662	403	flexible	flexible	1	140	0	0	0
Italy	ITC1	CUF	Cuneo	136609	4404246	28900	1883866	569	75	266	1	70	0	0	1
Italy	ITH5	PMF	Parma	192170	4448146	33600	2619025	539	68	285	1	70	0	0	1
Italy	ITI2	PEG	Perugia	221941	891181	24000	709031	201	38	149	0	90	0	0	1
Italy	ITF1	PSR	Pescara	572217	1326513	24500	171265	207	28	94	1	150	0	0	1
Italy	ITI3	AOI	Ancona	482580	1543752	26200	405249	208	76	247	1	80	0	1	1
Italy	ITH5	RMI	Rimini	473103	4448146	33600	2619025	539	121	408	page not working	80	1	1	1
Italy	ITC4	VBS	Brescia	19239	10008349	35700	8129895	464	other focus	other focus	other focus	40	0	0	1
Italy	ITH4	TRS	Trieste - Ronchi Dei L.	727409	1221218	29100	1104118	430	49	161	0	90	0	0	1
Lithuania	LT00	PLQ	Palanga	232630	2888558	12900	1388487	112	306	843	1	130	0	0	0
Lithuania	LT00	KUN	Kaunas	740540	2888558	12900	1388487	112	437	1205	1	90	0	0	1
Netherlands	NL11	GRQ	Gronningen	154006	583721	44800	198626	877	330	990	0	130	0	0	1
Netherlands	NL42	MST	Maastricht Aachen	179781	1116260	33700	975098	593	278	991	0	40	0	0	1
Poland	PL61	BZG	Bydgoszcz	337556	2062006	9100	105118	26	312	669	1	100	0	0	0
Poland	PL11	LCJ	Lodz	241271	2479350	10500	199712	64	131	358	1	120	0	0	1
Poland	PL42	SZZ	Szczecin	467877	1684025	9500	577099	26	485	1338	1	60	0	0	1
Poland	PL31	LUZ	Lublin	377606	2118528	7700	112055	45	250	688	1	110	0	1	1

Poland	PL32	RZE	Rzeszow	664068	2083496	7900	120427	91	208	574	1	140	0	0	1
Romania	RO12	TGM	Targu Mures	287412	2341749	7400	426203	9	36	100	1	70	0	1	0
Romania	RO11	OMR	Oradea	41867	2576777	7100	208170	20	102	280	1	60	0	0	0
Romania	RO21	IAS	Iasi	881157	3256282	4900	117015	14	87	240	1	90	0	0	0
Romania	RO21	SCV	Suceava	5726	3256282	4900	117015	14	87	240	1	110	0	0	0
Romania	RO11	SUJ	Satu Mare	23796	2576777	7100	208170	20	12	32	0	100	0	0	0
Romania	RO21	BCM	Bacau	414676	3256282	4900	117015	14	203	560	1	90	0	0	0
Romania	RO41	CRA	Craiova	222230	1993741	5700	50839	10	87	240	1	160	0	0	0
Romania	RO12	SBZ	Sibiu	390688	2341749	7400	426203	9	183	504	1	80	0	0	1
Romania	RO22	CND	Constanta	94594	2469801	7200	95794	4	87	240	1	140	0	0	1
Romania	RO42	TSR	Timisoara	1161612	1802040	8100	161987	20	160	440	1	40	0	0	1
Slovakia	SK03	SLD	Silac	no data	1343458	11600	340862	71	348	960	0	90	0	0	1
Slovakia	SK04	TAT	Poprad	84030	1617347	10100	312170	55	380	1048	0	90	0	0	1
Slovakia	SK04	KSC	Kosice	436696	1617347	10100	312170	55	408	1129	1	90	0	0	1
Slovenia	SI03	MBX	Maribor	31000	1092193	15500	671768	294	257	708	0	60	0	0	1
Spain	ES21	EAS	San Sebastian	264422	2164144	30800	1180754	610	80	220	1	20	1	0	1
Spain	ES23	RJL	Logrono	17374	312815	25200	131416	192	80	220	1	60	0	0	1
Spain	ES22	PNA	Pamplona	153476	637540	29100	343219	496	80	220	1	70	1	0	1

Spain	ES61	XRY	Jerez De La Frontera	916451	8405304	17100	8689393	175	121	334	1	80	1	1	1
Spain	ES11	VGO	Vigo	954006	2720544	20500	1278216	170	121	334	1	70	0	0	1
Spain	ES13	SDR	Santander	780000	582548	20900	307226	187	121	334	1	80	1	0	1
Spain	ES51	REU	Reus	817611	7408853	27600	12625720	396	121	334	1	80	1	0	1
Spain	ES41	SLM	Salamanca	15526	2454858	21700	1198080	211	80	220	1	100	0	0	1
Spain	ES43	BJZ	Badajoz	32963	1085115	15900	251381	118	80	220	1	180	0	0	1
Spain	ES61	GRX	Granada	753142	8405304	17100	8689393	175	80	220	1	90	1	0	1
Spain	ES41	LEN	Leon	36554	2454858	21700	1198080	211	80	220	1	110	0	0	1
Spain	ES41	VLL	Valladolid	231868	2454858	21700	1198080	211	80	220	1	100	0	0	1
Spain	ES61	LEI	Almeria	919808	8405304	17100	8689393	175	121	334	1	130	1	0	1
Spain	ES21	VIT	Vitoria	36716	2164144	30800	1180754	610	80	220	1	50	0	0	1
Spain	ES24	ZAZ	Zaragoza	419529	1318738	25500	635761	223	121	334	1	130	0	0	1
Sweden	SE23	THN	Trollhättan/ Vänersborg	43740	1963466	44700	1510763	1579	no data	no data	no data	70	0	0	1
Sweden	SE22	AGH	Ängelholm	416622	1459880	38500	640969	1492	449	1238	1	40	0	1	1
Sweden	SE21	VBY	Visby	463687	834276	38300	413753	572	72	335	1	150	1	0	0
Sweden	SE33	LYC	Lycksele	17851	513111	41000	439891	1083	101	612	1	110	0	0	0
Sweden	SE32	KRF	Kramfors-Sollefteå	8735	371273	39000	265850	319	92	253	0	60	0	1	0
Sweden	SE32	OER	Örnsköldsvik	76178	371273	39000	265850	319	241	665	0	70	0	0	0
Sweden	SE21	KLR	Kalmar	238691	834276	38300	413753	572	195	537	0	80	0	0	1
Sweden	SE32	SDL	Sundsvall Timrå	280077	371273	39000	265850	319	197	586	1	60	0	0	1
Sweden	SE33	SFT	Skellefteå	280926	513111	41000	439891	1083	90	248	0	100	0	0	0

Sweden	SE21	VXO	Växjö/Kronoberg	172353	834276	38300	413753	572	195	537	1	80	0	0	0
Sweden	SE12	LPI	Linköping	157780	1638825	39100	404031	1547	no data	no data	no data	40	0	0	1
Sweden	SE12	NRK	Norrköping /Kungsängen	99609	1638825	39100	404031	1547	243	669	0	40	0	0	1
Sweden	SE21	JKG	Jönköping	112506	834276	38300	413753	572	111	603	1	100	0	0	1
Sweden	SE22	KID	Kristianstad	30873	1459880	38500	640969	1492	no data	no data	no data	60	0	0	0
Sweden	SE23	HAD	Halmstad	122960	1963466	44700	1510763	1579	no data	no data	no data	40	0	0	1
Sweden	SE31	BLE	Borlänge	26804	838747	36400	573534	502	no data	no data	no data	110	0	0	1
Sweden	SE22	RNB	Ronneby	231562	1459880	38500	640969	1492	72	335	1	80	1	0	1
Sweden	SE33	AJR	Arvidsjaur	56940	513111	41000	439891	1083	no data	no data	no data	120	0	0	0
Sweden	SE32	OSD	Ostersund	495700	371273	39000	265850	319	72	335	1	130	1	0	0
Sweden	SE33	KRN	Kiruna	260318	513111	41000	439891	1083	72	335	1	80	1	0	0
Sweden	SE31	KSD	Karlstad	85848	838747	36400	573534	502	90	314	0	70	0	0	1
Sweden	SE12	ORB	Örebro	108990	1638825	39100	404031	1547	239	660	1	100	0	0	1
United Kingdom	UKM6	LSI	Sumburgh	249050	468546	33700	810426	187	630	1738	1	140	0	0	0
United Kingdom	UKM6	ILY	Islay	27973	468546	33700	810426	187	630	1738	1	110	0	0	0
United Kingdom	UKH1	NWI	Norwich	506007	2477141	37400	418634	1388	697	1952	0	110	0	0	0

United Kingdom	UKD4	BLK	Blackpool	36269	1479227	30400	105727	220	566	1340	0	50	0	0	1
United Kingdom	UKM6	INV	Inverness	782245	468546	33700	810426	187	630	1738	1	120	0	0	0
United Kingdom	UKN0	LDY	Derry	290671	1858540	28800	96756	384	687	1894	0	70	0	0	0
United Kingdom	UKK4	EXT	Exeter	847132	1171817	30600	235298	203	776	2139	1	90	0	0	1
United Kingdom	UKE1	HUY	Humberside	201279	927490	29800	42066	19	764	2107	1	50	0	0	1
United Kingdom	UKM6	SYY	Stornoway	124338	468546	33700	810426	187	630	1738	1	150	0	0	0
United Kingdom	UKK2	BOH	Bournemouth	666219	1316014	33000	402493	213	786	2167	0	40	0	0	0
United Kingdom	UKC1	MME	Durham Tees Valley	131487	1190295	27000	57888	219	631	1741	0	60	0	1	1
United Kingdom	UKK3	NQY	Newquay	370247	554342	27800	279636	44	731	2016	1	60	0	0	0

Table A.5 Database used in the study. Source: Eurostat, airport-charges.com, airport websites, Google Maps

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