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The Comparative Study of Connectivity, Performance and Socio-Economic Impact of Low-Cost Carriers in Poznan and Wroclaw (Poland)

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ABSTRACT

This article reviews the dimensions of the low-cost carriers' (LCC) spatial development and socio-economic impact in the Polish cities of Poznan and Wroclaw. The LCC spatial effect, measured via the connectivity and network structure analysis in 2005-2019, figured out that both airports experienced connectivity growth due to rapid network development of the leading budget airlines in Central and Eastern Europe – Ryanair and Wizz Air, and Wroclaw developed higher connectivity over Poznan. The airports' passenger traffic analysis showed that the LCC entered the market after Poland's accession to the European Union and that type of carriers represents a significant share of total passenger traffic at both airports (approximately 60%), and the numbers have had a positive dynamics of growth, but the LCC passenger traffic was higher in Wroclaw due to local demographics, state of the economy, better tourism potential, better financial conditions offered to the airlines (i.e., landing and passenger fees). Despite the fact, that there is a statistical connection between passenger traffic growth and socio-economic indicators, including tourism variables, both in Poznan and Wroclaw, further research on the role of such factors, as business environment, local governance, state of the economy is needed. The entrance of the LCC provided socio-economic benefits to the studied airports. The opening of the operational bases of Ryanair and Wizz Air increased numbers of investments and potential jobs supported at both airports. The data shows that Wroclaw, succeeding in attracting the LCC, had better performance and had more economic benefits over Poznan.

KEYWORDS

Low-Cost Carriers, Airports, Connectivity, Socio-Economic Impact, Ryanair, Wizz Air, Tourism.

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1. Introduction and Theoretical Framework

Since the early 2000s, low-cost carriers (*hereafter LCC abbreviation is used, as well as terms budget airlines or budget carriers*) entry and rapid growth in Europe have resulted in their market share increase from 5% in 1998 to 30% in 2008. According to Akgüç, Beblavý & Simonelli (2018) by 2015 the LCC have represented 48 % of intra-European capacity. Over the last two decades, LCC market had increased significantly in Central and Eastern Europe (CEE), and Poland, in particular, due to the accession to the European Union (EU, in 2004), and that resulted in market liberalization and more leisure and business trips between the East and the West. Wroclaw, Warsaw Chopin, and Poznan were among the first airports to welcome the Irish and Hungarian LCC in 2005. In 2004, the LCC seat supply in international flights was 4.6 million, of which only 9% came from LCC, while in 2017, that number for Poland had increased to 59% (ANNA, 2018). In 2004 the LCC carried 14% of the passengers in the scheduled regular traffic; in 2005, the share was 31,4%, in 2009 – 51,8%, in 2019 – 55,1% (Pijet-Migoń, 2012; Civil Aviation Authority (ULC), 2020). The leading airline in the CEE in 2019 was Wizz Air (Wizz Air, 2020), but the leader in the Polish market was Ryanair (50,9% of LCC traffic). Two major budget airlines operating in Poland in 2019 were Ryanair and Wizz Air, accounting for 91,1% of all the LCC traffic and 55,1% of total regular scheduled traffic (see table 1).

Table 1. The LCC ranking by low-cost and total market share in Poland, 2009-2019

	2009		2014		2019	
No.	**Total**	**LCC**	**Total**	**LCC**	**Total**	**LCC**
1	LOT (29,1)	Wizz Air (44,3)	Ryanair (29,9)	Ryanair (54,9)	LOT (28,1)	Ryanair (50,9)
2	Wizz Air (21,5)	Ryanair (40,5)	LOT (22,7)	Wizz Air (34,9)	Ryanair (27,5)	Wizz Air (40,2)
3	Ryanair (19,6)	easy Jet (7,2)	Wizz Air (19)	Norwegian (5,2)	Wizz Air (21,8)	easy Jet (4,2)
4	Lufthansa (6,7)	Norwegian (5,8)	Lufthansa (7,4)	easy Jet (3,6)	Lufthansa (5)	Norwegian (3,5)
5	easy Jet (3,5)	Germanwings (2,2)	Norwegian (2,9)	Eurowings (1,4)	easy Jet (2,3)	Eurowings (0,8)
	Share of all LCC (49,4%)		Share of all LCC (56,2%)		Share of all LCC (55,1%)	

Source: Civil Aviation Authority (ULC), Wizz Air.

According to theoretical assumptions, air transportation reflects and measures dynamic socio-economic relations and connections between actors and places at global and regional scales, making it essentially geographical. Therefore, airports' LCC connectivity was analyzed in this research, as an indicator, showing the ability to move a passenger faster from one point to another with the lowest possible number of connections (ICAO, 2013). The main objective is to prove that budget airlines (the LCC point-to-point network model avoids connecting stops) had increased it, by connecting the cities directly to major economic centers and tourist destinations. Therefore, the city with better LCC connectivity has a better access to markets, capital, ideas, labor force, or tourism destinations.

Budget airlines support urban and regional socio-economic development through several contributions, including employment in companies at the airport, which is considered a direct impact. The creation of additional jobs at the companies, operating in the city, and in the region within the local supply chain, as well as contribution to the local economy via expenses on goods and services, can support employment and Gross Domestic Product (GDP) growth of the city and the region (*indirect* and *induced* economic impacts). According to the Airport Council International (ACI) Europe estimations, at middle-sized airports (1 to 10 million passengers) 1 million passengers carried support 950 onsite direct jobs. However, due to the cost-cutting business model correction the budget airlines could support up to 20% fewer jobs (thus, 760) (ACI Europe, 2015; Ryanair 2017).

The LCC, while creating significant passenger traffic, have a strong impact on tourism, providing substantial economic benefits for all those involved in the tourism sector value chain. According to IHGL report, approximately 1,4 billion tourists were crossing borders every year before COVID-19 pandemics (57% of whom arrived by air). Through a synergetic relationship, aviation supports almost 37 million jobs

within the tourism sector, contributing roughly 897 billion USD a year to global GDP (IHGL, 2019). Thus, the research's overall objective is to systematically study, analyze and compare the spatial (connectivity) and socio-economic changes caused by the low-cost carriers' entrance and performance in cities and airports of Poznan and Wroclaw in Poland. Specific research aims are the following:

a) to analyze and visualize the factors behind historical development and current spatial stucture of LCC connectivity in Poznan and Wroclaw within the general context of the LCC business model origin and development peculiarities;
b) to analyze the dynamics of LCC passenger traffic growth and to discuss the factors affecting it (i.e., demographic potential, city attractiveness, airport governance and fees), as well as the benefits to the cities of Poznan and Wroclaw;
c) to discuss and to test the methodology of evaluation of the potential socio-economic impact of LCC, based on the time-series data and the statistical relationship between the selected indicators on transportation, economic, demographical, tourism, and migration (using correlation analysis and Johansen cointegration test);
d) to estimate the benefits from the LCC to the studied airports.

2. Literature Review

Out of significant amount of research on LCC that had influenced the general research methodology of this article, this review structures and discusses the most crucial existing publications about: a) the general peculiarities of the LCC business model; b) geographic analysis of the LCC development and socio-economic impact; c) the existing literature on the LCC in Wroclaw and Poznan.

The existing literature analysis showed that economic topics usually prevail when it comes to the scientific discourse about low-fare airlines. Classical works in airline or airport economics by Doganis (2006) and Gross & Schröder (2007) or Rekowski (2012) provide a general overview of the origin and development of various airline business models. They explain the approach towards costs cuts, networks development, airports' selection, and competition between full-service carriers (FSC) and low-cost carriers. Whyte & Lohmann (2016), Almeida, Costa & Abrantes (2020) also deliver a characterization of airline business models, including LCC. Magdalina & Bouzaima (2021) carried out an empirical investigation of European airline business models. Lange & Bier (2019) analyzed business models of 58 European airlines and their network structures.

Bowen (2019) traces the geographic peculiarities of low-cost carriers' development in the established markets in the USA, Europe (including Eastern Europe), Asia, Latin America, the Middle East, and Africa. The spatial analysis of the LCC performance in Eastern Europe was carried out by Bjelicic (2016). Dobruszkes (2009) analyzed the LCC market, and the geography of the newly emerged west-east routes, that reflected the new forms of mobility, such as migration flows from Eastern to Western Europe (thus, pointing to the impact of the LCC on migration flows). Olipra (2011) and Wenerowska (2016) studied the development of low-cost airlines in the European Union and, briefly, in Poland, describing the LCC impact on the market competition, while Trzepacz (2007, 2014) presented an analysis of the LCC influence on the airport hierarchy in Europe, as well as the overview of the Polish airports' development in 2003-2013. The work of Pijet-Migoń (2012) contains a detailed economico-geographic analysis of the changes that happened with the passenger aviation market in Poland after joining the European Union (the timeframe covers the years 2004-2009), as well as the analysis of the development of the Polish airports (including Poznan and Wroclaw), analyzing the aspects of the entrance, network development, and performance of the LCC.

The publications on LCC direct and indirect effects mainly discuss economic development, migration, and tourism. The cost-benefit analysis model, discussed by Almeida & Costa (2015), proved the positive impact of LCC on the Portuguese local economy in 2005-2012 (through job creation, increased consumption in the tourism and other sectors) in Lisbon, Porto, Faro, and Funchal. The same authors later (2018) presented the detailed results of the LCC impact on tourism destination development (the case of Porto, Portugal). Rey, Myro & Galera (2011) investigated the effect of low-cost airlines on tourism in Spain. Huderek-Glapska (2013) studied the employment and income benefits of airport operations in Warsaw (the case of Chopin airport). Lassen, Smink & Smitt-Jensen (2015) explains the complexity of the impact of the

largest LCC in Europe on the socio-economic development of regional communities and cities (i.e., the case of Ryanair and the Stockholm Skavsta airport on Nykoping). Some works analyze the impact of the LCC entrance on the airport performance (the case study of Croatian airports by Mandic & Petric, 2017). Some existing research on the topic indicate, that there is a statistical relationship between LCC and tourism (Chung & Wang, 2011; Alsumairi & Hong Tsui, 2017). Still, there is little research about the impact of LCC operational base being opened or closed – on the network development and airport performance.

The geographic literature on the LCC in Poznan and Wroclaw is scarce, and this article aims to fill the existing gap and enhance the current discourse with a geographic accent and perspective, based on the case studies of Poznan and Wroclaw. The economic impact of the Wroclaw airport, based on the estimation of the arriving tourists' expenses, was explained by Olipra (2016). Pancer-Cybulska, Szostak & Olipra (2011) studied the relationship between the migration from Poland and the LCC routes development, and the direct impact of chosen airports (including Wroclaw airport) on Poland's regional labour markets (Pancer-Cybulska, Cybulski & Olipra, 2014).

3. Methodology

3.1 The Methodological Algorithm of the Research

The research procedure includes the analysis of two selected regional airports in Poland. There were several justification criteria for the airports' selection. Firstly, both airports are characterized by a significant share of the LLCs in the structure of passenger traffic and network geography during the period of investigation. Secondly, both airports have similarities in *geographic location and proximity* towards each other and bigger capital cities (Berlin, Warsaw, and the case of Wroclaw – Prague). That geographic location feature affects the competition between the airports, as far as their catchment areas intersect (Augustyniak & Olipra, 2014). Additionally, the airport cities have similar *demographic and economic potential*, *airport class* by traffic figures. After the LLCs started operating from these airports, they have upgraded their status (Wroclaw in 2007, Poznan in 2008) from the category D (small regional airports with less than 1 million passengers) to category C (large regional airport with 1 to 5 million annual passengers). The classification is based on the European Commission's Atlas of the Sky airport traffic database (European Commission, 2020).

This research methodology incorporates several general (comparative, logico-structural, statistical analyses) and particular geographic (network and connectivity analysis, GIS (Geographic Information System) modeling, and cartographic visualization) research methods. The goal of the comparative analysis was to distinguish, describe and explain similarities and variances between LCC network development, performance and socio-economic impact in Wroclaw and Poznan. Based on the results of the content analysis of various data sources (see section 3.2), the following methods have been used depending on the specific research aims.

In order to analyze the LCC impact on the geographic structure of connectivity, the method of network analysis was used to study how LCC routes changed in time to assess the connectivity evolution (the detailed results for 2009, 2014, and 2019 are presented). The spatio-temporal data from airports' and airlines' schedules (destinations, carriers, frequencies) was collected and processed in ArcGIS software to create a model of the past and existing connections. The network analysis had helped to visualize the geography of spatial interactions between the origin airports and destination cities/countries.

The connectivity was analyzed within the context of passenger traffic growth in 2003-2020 (total and LCC). The general and LCC air mobility indexes for 2004-2019 were calculated, in order to show the increase in the number of total and LCC passengers per population of the selected cities.

To quantitatively evaluate other forms of the impact of the LCC in Poznan and Wroclaw, a comparative analysis of two blocks of indicators in dynamics was conducted. The first block was related to airports performance and connectivity and the second - to socio-economic data of the cities. The original hypothesis was that trends and changes of indicators may reflect the LCC impact on airports, tourism, investments, economics. The data had been analyzed for the following years: 2005 (entrance of the LCC in Poznan and

Wroclaw), 2010, 2015, and 2019. On several occasions, if the data was not applicable for the pivotal year, the data from the nearest available year was used, which was sufficient to analyze the occurring change.

In order to investigate the possible statistical relationship between the performance of the LCC and selected 12 indicators, the standard correlation analysis was performed (using the non-stationary time-series data for 2005-2019; as expressed in table 4). Some methods can be used to access statistical connection between time-series variables: i.e., causality test (i.e. with Granger causality test; but the data needs to be stationary, which is not the case of the collected data for Poznan and Wroclaw cities and airports) or cointegration test (Johansen cointegration test establishes if there is a correlation between non-stationary time series data). In this research, Johansen cointegration test was performed in EViews software to see if there is a statistical relationship (cointegration) between the LCC passenger traffic and the number of foreign tourists. The assumption was that a short-run (considering the number of observation years) dynamic includes trend, and cointegration exists when the probability coefficient is less than 0,05, as well as Trace and Max-Eigen statistic values being higher than the Critical value.

The LCC's socio-economic impact at the airport level was measured by calculating the benefits (investments, potential jobs created or supported, general financial performance) from the operational base's opening or closures. Additionally, the airports' financial performance and the terms and conditions of their cooperation with the airlines were discussed.

Limitations of the research methodology include the results of the calculation of potential direct jobs that are related to the passenger traffic. The Airports Council International (ACI) calculations have been changing over the years, therefore, the number from the most recent available ACI report (760 jobs for LCC traffic) was used for calculations. One more research limitation is the absence of classification of tourists by type due to lack of official data available. Another limitation is the attitude towards the status of aircrafts which are based at operational bases, which are often positioned by the airlines as investments, which is not methodologically correct and should be analyzed with caution.

While this research delivers mostly geographic results and discussions on spatial dynamics of connectivity and comparison of LCC performance and impact between Poznan and Wroclaw, further in-depth research on the key factors behind, such as business environment, role of local authorities, demographics, state of the economy, foreign direct investments (FDI) will positively contribute to the research topic.

3.2 Data

The actual and historical data on the LCC entrance, development, and performance was collected from various statistical sources including C*ivil Aviation Authority (ULC) official statistics and reports, national and local statistic databases, airlines' and airports' press-releases, press-conference materials, and data bulletins, other media publications.* Additional airports' data, besides the named above, included reports from *Pasazer.com* analytical portal.

The data of the LCC network structure is based on the results of the analysis of the direct regular routes during the summer season (as the busiest during the annual airport performance). The data for 2004 and 2009 (Poznan) was obtained from the works of the Polish researchers (Pijet-Migoń, 2012), and the data for 2009, 2014, and 2019 was gotten from the published airport schedules.

Additional statistical and analytical data on the performance of LCC in general and in Poznan and Wroclaw was collected through the content analysis of open access publications and reports, provided by the following international agencies and institutions: European Parliament, EUROCONTROL, IATA (International Air Transport Association), ICAO (International Civil Aviation Organization), ANNA (was a weekly e-journal and website devoted to airline and airport network planning), and Centre for European Policy Studies (CEPS). Additional socio-economic data was collected from the national (GUS – Statistics Poland) and local (Statistic offices in Poznan and Wroclaw) statistic databases, local data portals (Badam in Poznan), and Public Information Bulletins (BIP).

4. Results and Discussions

4.1 Brief Characteristics of Poznan and Wroclaw Airports

Poznań-Ławica Henryk Wieniawski Airport (IATA code: POZ) was built in 1913 for the German army's needs (and partly performed the military functions until 2009). Prior to 1993 the Poznan airport served only internal routes, with regular connections to Warsaw (particularly, during the Poznan International Fair events), and non-scheduled to Szczecin, Krakow, Katowice, and Rzeszow. In 1993, Poznan's first international connection was established by LOT airline to Dusseldorf (Germany), followed up by two more routes in 2005 to Dresden by a then traditional carrier Eurowings, and to Copenhagen, by SAS. In 1998 and 2000, the Polish LOT airline had started operating the flights to Hannover and Brussels (closed in 2001-2002), and later – to Cologne and Munich. In 2002, the Austrian Airlines renewed and closed the operations to Vienna. The connectivity and network development before 2004 can be characterized as unstable, with routes being opening and closing unsystematically. In 2003 the first low-cost carrier Air Polonia (bankrupted in 2004) entered Poznan offering connections to London Stansted and Brussels (Pijet-Migoń, 2012).

The airport is located 7,8 km west from the city centre, and it takes 20-40 minutes to access it by car, or 1 hour by public transportation. Considered as one of Poland's oldest airports, POZ serves the city of Poznan (with a population of 534 thousand people in 2020) and the Greater Poland Voivodeship (3,5 million people). The city is known as the centre for "business, sport, and education" and specialized in trade, logistics, business services, science and education (more than 102 thousand students in 2019), innovations, information, and communication technologies (Stan Turystyki, 2016).

The airport's catchment area includes approximately 3,2 million people within a 1,5-hour drive, or 4,5 million people within 2-hour drive (Brol, 2014). The airport served 2,4 mln passengers in 2019 (showing 496% growth in comparison with 2005, although it is important to understand that *at both airports the starting point was low*). The largest closest competing regional airport is Wroclaw, located 189 km (2-2,5-hr drive) away.

The share of Poznan airport in total traffic of the Polish airports in 2004 was 4%, as in Wroclaw, and by 2009, the percentage had reached 7%. However, after 2010, Poznan's share in total passenger traffic started decreasing to 5,4% in 2014 and to 4,9% in 2019.

Wroclaw Strachowice Nicolaus Copernicus Airport (IATA code: WRO) was built in 1938 and started serving the city since 1958. In 1992 the joint-stock company "Wroclaw Airport" was established, owned by the city, the region, and the state enterprise "Polish Airports". Until 1993 the airport served only regular domestic routes, when the first international connection to Frankfurt had been established. In 1998 the connections to Copenhagen (operated by SAS) and to Vienna (Austrian, closed in 2002) had been opened, and in 1999 Lufthansa started flying to Munich. The network of connections from Wroclaw airport was concentrated on business and transit connections to Germany's hubs (37,5% of all connections), Denmark, and Austria. As in Poznan, the first LCC to start operations at WRO was Air Polonia (also opened the operational base there), offering domestic connections to Warsaw and Gdansk and international flights to Paris (Pijet-Migoń, 2012).

The airport is located 13,3 km west from the city centre, and it takes 30 minutes to get there by car, or 1 hour - by public transport. The airport serves Wroclaw's city (with a population of 643,8 thousand people in 2020) and the Lower Silesian Voivodeship (2,9 million people). The city is known as the largest labour market in South-Western Poland, the third-largest market for business services, one of the largest academic centres with more than 112 thousand students at 25 higher educational institutions (HEI) in 2018, a popular tourist destination, the host city of EURO 2012 (like Poznan), and the European Capital of Culture 2016. According to Książek & Suszczewicz (2017), the city positions itself as a "meeting place." The airports' catchment area serves approximately 3,9 million people within a 1,5-hour drive. In 2019 the number of passengers reached 3,55 mln, which indicates a 681% growth compared to 2005. The largest nearest competing regional airports are at a distance of 189 km in Poznan and 212 km in Katowice (2-hour ride).

The Wroclaw airport traffic data shows its relatively stable position among the Polish airports, with the following dynamics: 4% in 2004 (as in Poznan), 7% in 2009, 7,7% in 2014, and 7,2% in 2019.

4.2 The Entrance of the First Foreign LCC, Fast Traffic, and Network Growth

The first foreign low-cost airline to fly from *Poznan* in September, 2005 was the Hungarian carrier Wizz Air, followed by the Irish Ryanair. Both airlines started flying to London (Luton and Stansted, respectively).

Before that, in late March 2005, the Irish low-cost carrier Ryanair inaugurated the first-ever flight from Poland, from *Wroclaw* to London Stansted. Later that year, Wizz Air started operations from WRO to Dortmund. In 2006, Ryanair expanded the network, offering connections to more places in the UK and Ireland, as well as to Germany (Frankfurt-Hahn) and Italy (Milan Bergamo).

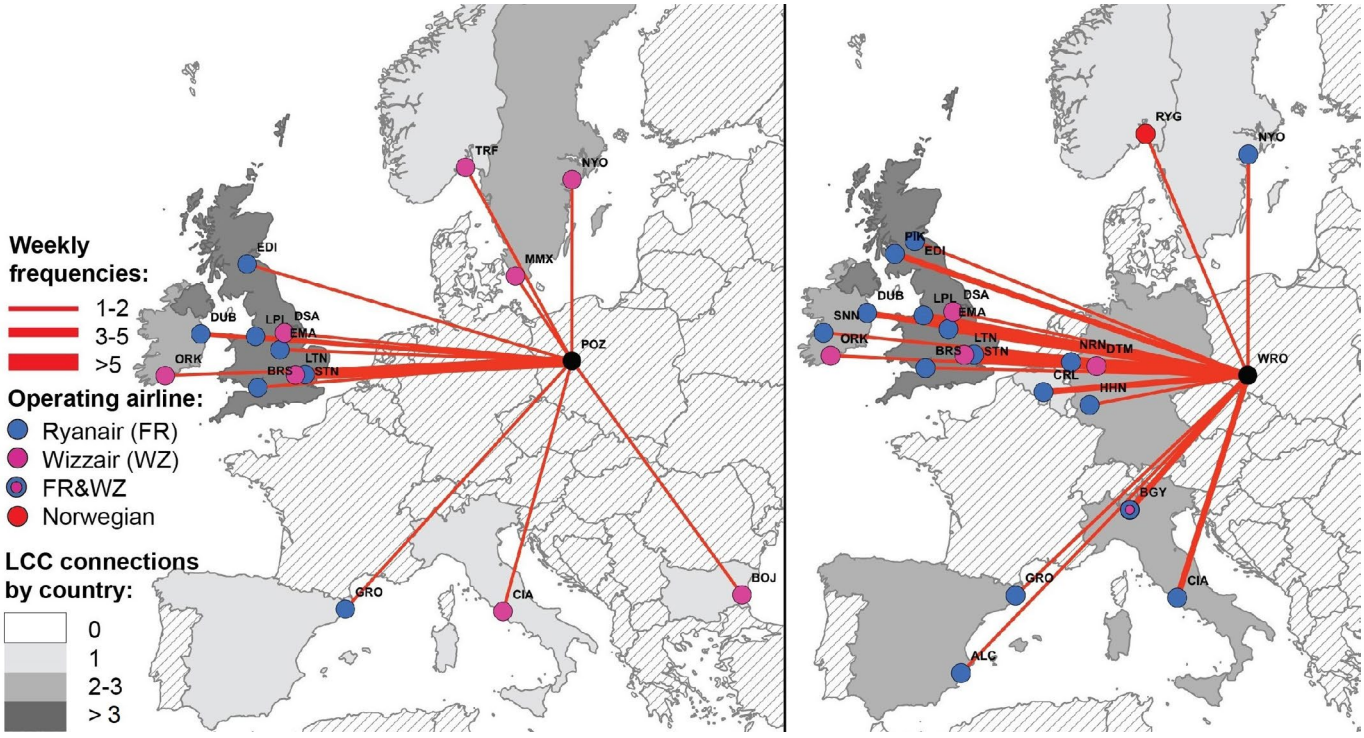
Both airports recorded significant growth in numbers of total passengers in between 2005 and 2009, from 0,4 to 1,3 million in Poznan (225% growth) and 0,4 to 1,4 million in Wroclaw (250% growth). The airports had also recorded a significant increase in the LCC passenger traffic during that period: 1339% growth for POZ, and 787% in WRO.

In 2009, Wizz Air and Ryanair had offered 14 destinations (78% of total destinations) to 7 countries from *Poznan*. The top destination country was the United Kingdom (almost 50% of routes), followed by Ireland and Sweden, explained by the Poles' migration flows' spatial patterns. The leading LCC by the number of destinations offered was Wizz Air (57% of all POZ routes).

The number of LCC connections from *Wroclaw* airport in 2009 was 21 (81% in total), covering 8 countries, with the largest number of connections to the UK (38%), Germany, and Ireland (14% each). That year, 3 LCC (Ryanair, Wizz Air, and Norwegian) operated flights from WRO, with most of network destinations being operated by Ryanair (74%, as shown in fig. 1).

There was no direct competition between the airlines, except the WRO-BGY (Milan-Bergamo) route. The indirect competition was over the UK's economic and financial centre – London – with connections to Stansted (Ryanair base) and Luton (Wizz Air base) airports. It is worth noticing that Ryanair was more cautious regarding the geography of Poznan's network development than from Wroclaw. From POZ, the airline targeted the UK mostly, while from Wroclaw, the network has had broader expansion to the "low-cost airports" in Germany (Frankfurt-Hahn, Dusseldorf Weeze), Italy (Milan Bergamo, Rome Ciampino), Belgium (Brussels Charleroi), and Sweden (Stockholm Skavsta).

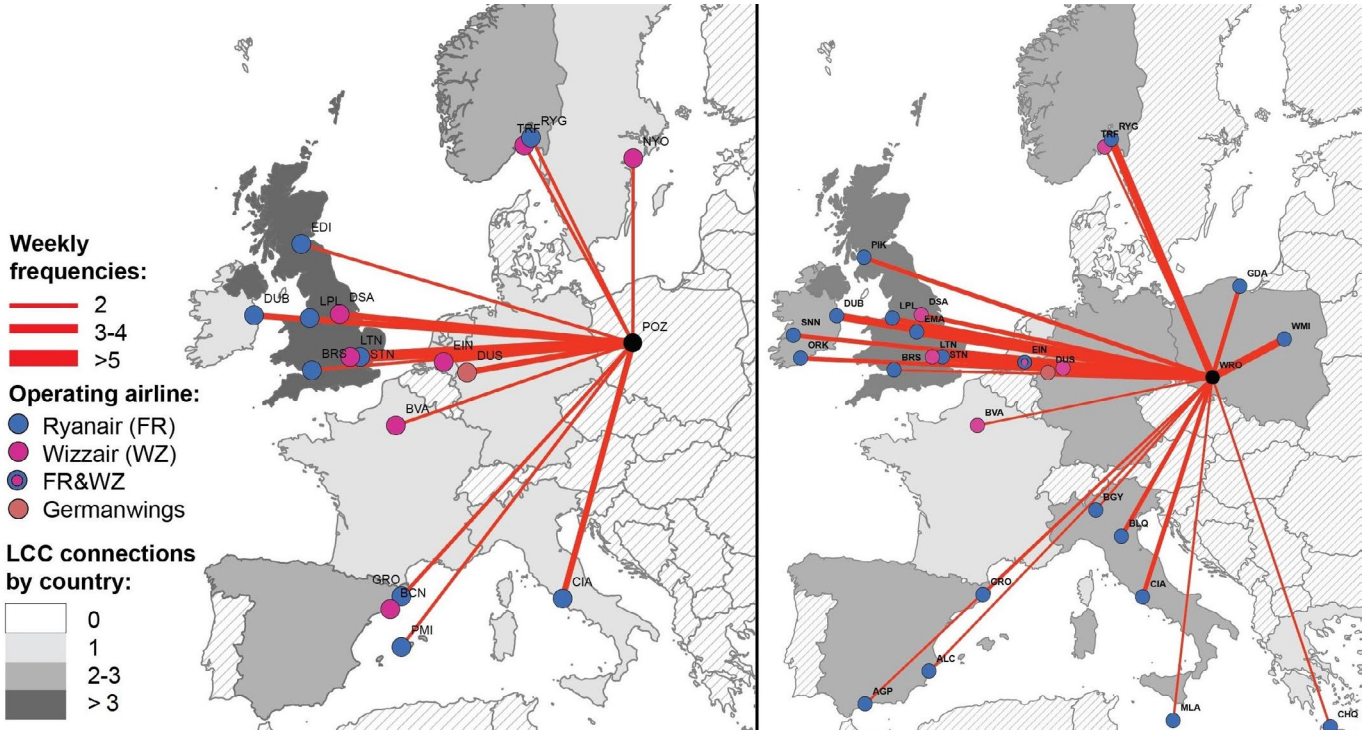
Figure 1. The LCC connections from Poznan and Wroclaw airports, 2009



Source: Pijet-Migoń (2012). Airports' magazines and schedules.

In 2014 the number of the LCC destinations from *Poznan* had increased to 17 (74% of the entire network), connecting the city with nine countries, with the leading destination still being the UK, accounting for 35,6% of all routes, Spain, and Norway. The airlines indirectly competed over London, Oslo (flying to Torp and Rygge), and Barcelona (El Prat and Girona). Ryanair offered 53% of connections from POZ, while Wizz Air accounted 41%, as in fig. 2 below.

Figure 2. The LCC connections from Poznan and Wroclaw airports, 2014



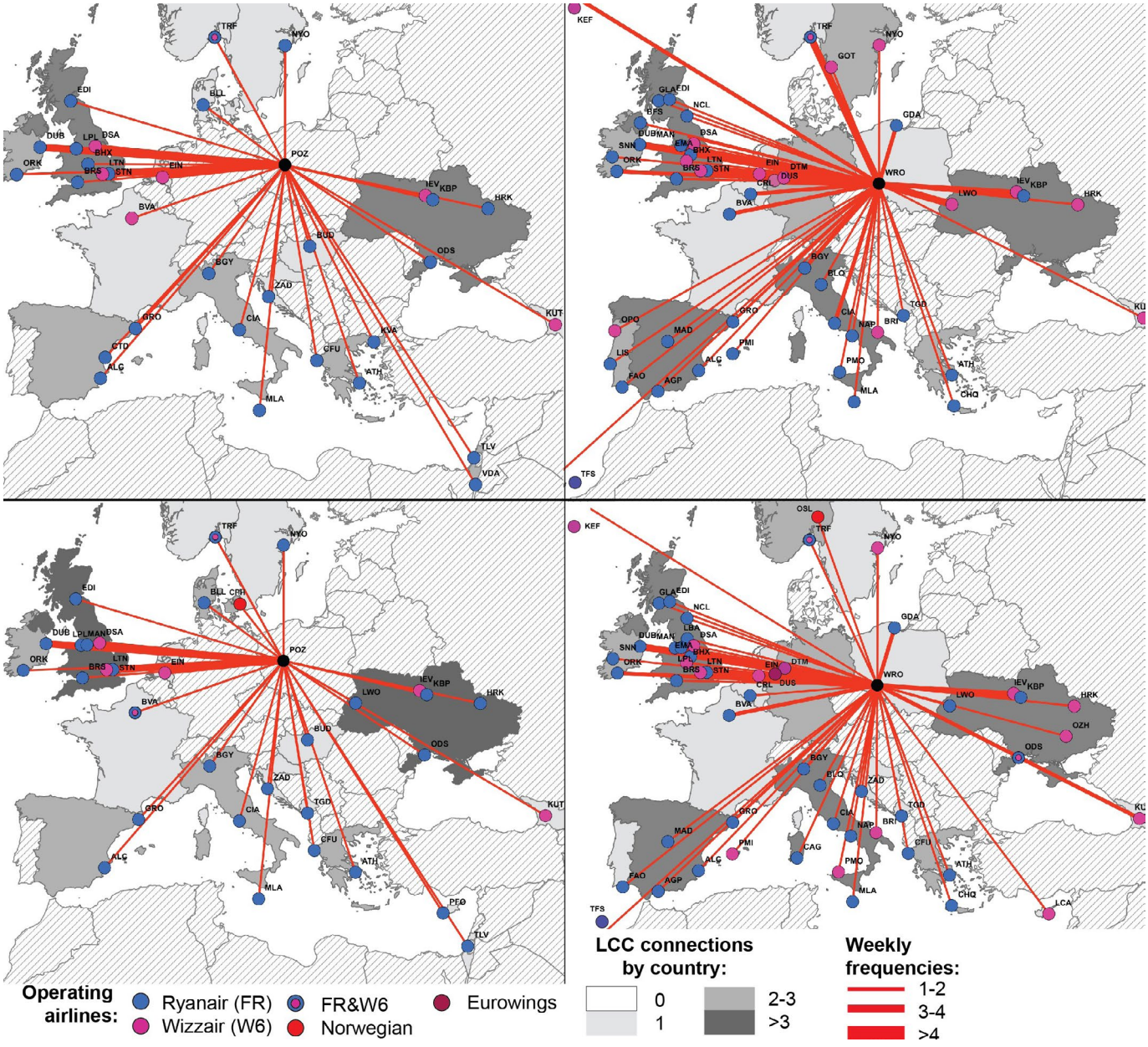
Source: Airports' magazines and schedules.

The network of LCC connections from *Wroclaw* airport grew to 26 destinations (79% of total) in 11 countries in 2014, with the UK accounting for 27% of all routes. Ryanair was operating 75% of the network, directly competing with Wizz Air over Eindhoven (and indirectly – over Oslo and London, as in Poznan). Ryanair also started operating domestic flights from WRO to Gdansk and Warsaw (Modlin). The number of the LCC had increased to 3 – Germanwings (operating as LCC in 2014) was the new airline flying both from POZ and WRO, connecting the cities to Dusseldorf.

The LCC passenger traffic in both airports in 2009-2014 showed growth, which was higher at WRO (28%) and lower at POZ (4,5%, what can that be explained by higher charges, and, as a result, smaller network with fewer destinations).

In 2014-2019 Wroclaw airport experienced higher growth (95,6%) over Poznan (66,5%). Higher fees can explain this difference, combined with a smaller network, closure of the Wizz Air operational base in 2018, and an increase in the Ukrainians' presence in Wroclaw (the city had historically a significant presence of the Ukrainian diaspora). A noticeable annual increase in Poznan's passenger traffic was recorded in 2017 after Ryanair opened the base. In 2019 the number of the LCC destinations from *Poznan* had increased to 32 (86% of the network, see fig. 7), connecting the city with 16 countries, with the leading destination being the UK (18,8% of all routes) and Ukraine (12,5%).

Figure 3. The LCC connections from Poznan and Wroclaw airports, 2019 and 2021 (plans)



Note: maps on top are for 2019; maps below are for summer 2021 (monitored in Nov. 2020).
Source: Web pages of the LCC (date of access – 06-15/10/2020), airport schedule (WRO), Let's Fly airport mag (POZ).

The geography of countries served by the LCC more than doubled since 2009, providing the customers with new destinations and following the general trend of expansion of the LCC to the Balkans (Croatia, Montenegro), Eastern Europe and Caucasus (Ukraine and Georgia), and the Eastern Mediterranean (Cyprus, Israel), as expressed in fig. 3. The share of LCC routes within the network of the regularly scheduled destinations from POZ exceeded 85% in 2019, with the most frequent destinations being London (Stansted and Luton) and Dublin. The spatial expansion towards the East, to Ukraine, a country with significant demographic potential, was a logical strategy of the LCC, responding to the market liberalization and growing demand from migrants and tourists on affordable transportation to and from Poland. Ryanair and Wizz Air did directly compete on the one route only (Oslo Torp), and the new destination of the indirect competition of the airlines appeared – Kyiv (the largest city and capital of Ukraine with two airports – Boryspil (KBP) and Zhuliany (IEV)). Ryanair offered 78% of POZ routes in 2019, Wizz Air – 22% (significant reduction of 10 destinations after the airline decided to close the base in 2018).

The network of LCC connections from *Wroclaw* airport grew to 49 destinations (88% of total) in 17 countries in 2019, with the UK accounting for 22,4% of all connections, followed by Spain (14,3%) and Italy (12,2%). Ryanair was operating 68,4% of the network, directly competing with Wizz Air (29,6%%) only over

Oslo (Torp), with the only domestic connection left – Gdansk - due to the conflict with the airport operator in Warsaw. The number of the LCC had remained the same with Eurowings, connecting Wroclaw with Dusseldorf.

Table 2. Dynamics and geographic structure of the LCC performance in Poznan and Wroclaw

Indicators	Poznan Airport				Wroclaw Airport			
	2004**	**2009**	**2014**	**2019**	**2004**	**2009**	**2014**	**2019**
Share of total Polish air pax. traffic, %	**4**	**7**	**5,4**	**4,9**	**4**	**7**	**7,7**	**7,2**
No. of Airlines*	5	5	7	7	6	7	7	10
Share of LCC (of total no. of airlines), %	20	40	42,8	42,8	17	43	42,8	40
Destinations, total	10	18	23	37	8	26	33	56
Countries (LCC)	2	7	8	16	2	8	11	17
Share of LCC destinations, %	20	77,8	73,9	86	24	81	78,8	88
Most frequent LCC destination (per week)	-	STN	STN, LTN	STN, LTN, DUB	-	STN	STN, WMI	STN
No. of passengers, mln.	0,4	1,3	1,5	2,4	0,4	1,4	2,1	3,55
Share of LCC pax., %	12,8	71,7	47,8	48,4	5,7	64	54	62

Annual growth of the LCC traffic at the selected airports, % (2004 = 100 %)

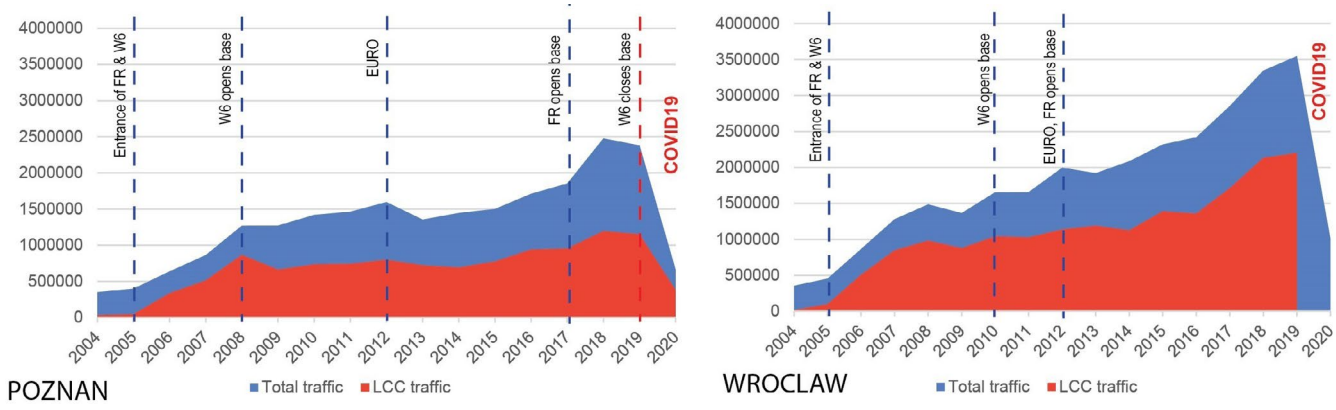
Year (2000s)	**05**	**06**	**07**	**08**	**09**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Poznan	44	639	53	69	-24	11	1	8	-10	-4	12	21	2	25	-4	-65
Wroclaw	505	412	67	16	-11	19	-1	11	5	-5	24	-2	26	25	3	ND

Note: * - Regular traditional and low-cost carriers only; ** - data for 1993-2004 network; STN – London Stansted, LTN – London Luton, DUB – Dublin, WMI – Warsaw (Modlin).
Source: Airports' magazines, web pages, schedules, ULC.

It is important to mention that in 2014-2019 in both cities the geography of the LCC destinations partly corresponded with the origin of accommodated foreign tourists: tourists from Germany, the UK, Spain, Ukraine and the USA were leading in the structure in Poznan, while tourists from Germany, Russia, the UK, Ukraine, and the USA - in Wroclaw.

Both airports have had a significant increase in total passenger traffic after 2005 when Ryanair and Wizz Air have started operating from them. A positive trend of general traffic growth was observed afterward, with exemptions during the 2008 economic crisis and after EURO 2012. As seen in the figure 4, Wroclaw had a more sustainable performance and better traffic numbers over the years, including the LCC traffic. In 2019, WRO served 1,2 million more passengers than POZ, mostly at the cost of the LCC traffic. Share of LCC passenger traffic was 48% in POZ and 62% in WRO in 2019, what should be considered as an important factor, determining the role and impact of LCC on connectivity and socio-economic development, comparing to other carriers.

Figure 4. Structure of scheduled passenger traffic at Poznan and Wroclaw airports in 2004-2020



Note: FR – Ryanair IATA code, W6 – Wizz Air; 2020 data for LCC in Wroclaw is not available.
Source: Own calculations based on data from UCL, Olipra (2011), Wroclaw and Poznan airport websites.

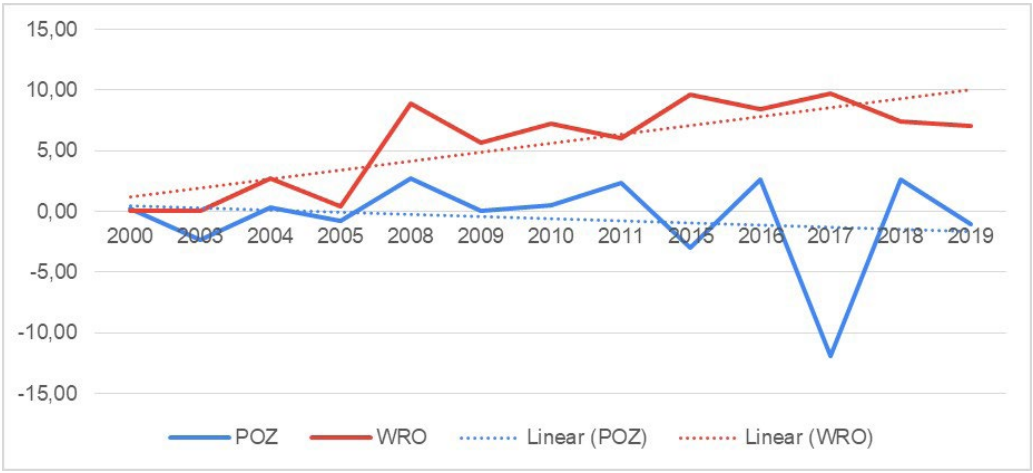
4.3 Social and Economic Impact of the LCC on Cities and Airports

Both Poznan and Wroclaw hosted the matches of the EURO 2012 football championship, which attracted thousands of tourists. The airports were supposed to receive funds for investments from both State and the EU levels to upgrade the infrastructure. It is interesting, that the final investments were almost two times lower in Poznan than in Wroclaw – 209 mln. Polish Zloty (PLN) vs. 448 million PLN, according to Rejestr.io (2020).

It is important to understand additional external factors affecting passenger traffic and financial results, like the airport business strategy on landing, parking, and departing passenger charges. Those costs are essential for the LCC, making the airport more or less attractive for the airline. Even considering the airports' discount schemes to the airlines that provide significant passenger traffic and connections, the landing charges were more than two times higher in Poznan (3400-3950 PLN vs. 1560 PLN per aircraft) in 2019. Parking charges were also lower in Wroclaw. Additionally, Wroclaw offers free parking for 4 hours, a good economic benefit for LCC, known for a short turnaround time.

The analysis of both airports' financial performance reveals that Wroclaw has achieved better goals than Poznan Lawica to sustain a positive trend of net income dynamics (the difference between income and expenses) in 2005-2019. The worst financial result of Poznan airport (a loss of more than 11 million PLN) was registered in 2017, a year when Ryanair had opened an operational base, followed by a profit of 2,6 million PLN in 2018. The closure of the operating base of Wizz Air may have had a negative impact on the airport finances in 2019 (1 million PLN loss was registered, as in fig. 5).

Figure 5. Financial results of Poznan and Wroclaw airports (net income/loss), million PLN



Note: Linear is a trend line for the selected airport.
Source: ULC

Wizzair stationed 2 Airbus A320 aircrafts in *Wroclaw* until 2018, with 78 employees. It is interesting that airlines often position those aircraft as an investment, worth approximately $101 million each. During 10 years the airline had performed 12425 take-offs and carried approximately 4,2 mln passengers, stimulating the related sectors' local job market.

In March 2017, Ryanair had announced the opening of new operating base in Poznan, 5th in Poland. The airline stationed one Boeing 737-800 at the airport (an "investment" of $100 million) and added 14 new routes to the schedule. By February 2020, there were 3 Ryanair aircraft based in Poznan, and the airline had declared the plan to add one more aircraft (increasing it to potential $400 mln of investments). The opening of the operational base at POZ had resulted in 25% LCC traffic growth in 2018, comparing to 2017.

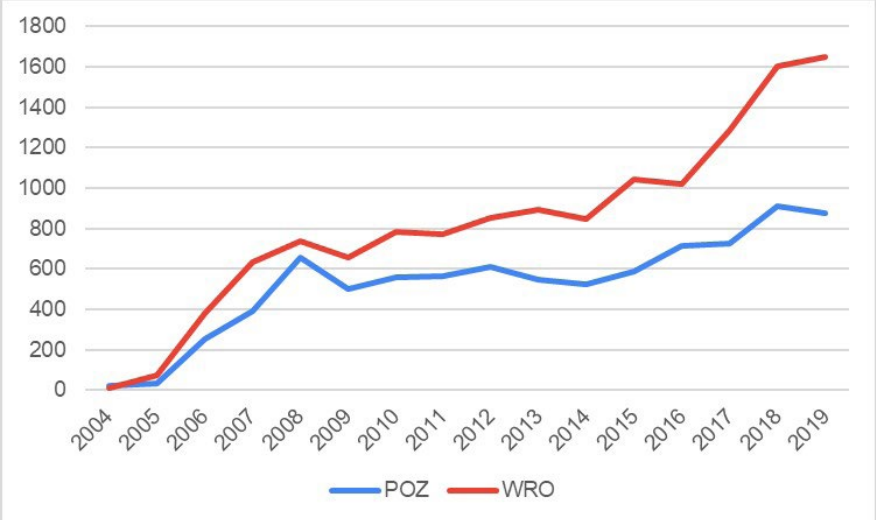
In 2018 Wizz Air has decided to close the Poznan base with the following consequences: 1) fleet relocation with direct (relocation of 78 employees to other bases) and indirect job losses; 2) reduction of the connectivity: liquidation of 6 connections (50% of all Wizz Air routes, and further cuts in 2019); decrease in connectivity competition with the Wroclaw airport (i.e., the route to Reykjavik); 3) inconvenient connecting times to London (Luton) and general loss of elasticity: all routes were served from other bases; 4) risk of Ryanair's monopoly regarding the network development and passenger traffic (SIP, 2019).

The first airline to open an operational base in *Wroclaw* was also Wizz Air. In 2010 the airline inaugurated its 12th base, adding 6 new routes and increasing service to the most frequent destination – London (Luton) airport. The carrier stationed one Airbus A320, employing approximately 35 people. In 2018 Wizz Air announced an expansion of the base and added one more aircraft (2 in total). Developing its operations in 2018, Wizz Air increased the number of the based crew team to 71 (Wizz Air, 2018).

Ryanair opened its first Polish base in Wroclaw in 2012, stationing one aircraft, employing 37 people (ANNA, 2011). In 2013 the airline decided to station second aircraft. In 2018 the carrier had 4 aircraft at WRO, and in 2019 the airline was the leader by the number of destinations offered - 88% of total.

According to the ACI estimations on direct jobs created per 1 million passengers carried (on annual basis), the approximate amount of jobs for Poznan related to LCC traffic varied from 35 (in 2005) to 908 (in 2018), while the numbers for Wroclaw vary from 74 (in 2005) to 1650 (in 2019) as mentioned in fig.6.

Figure 6. Number of potential direct jobs, related to LCC traffic at Poznan and Wroclaw airports, 2004-2019



Source: Own Elaboration

Further Ryanair investments in Wroclaw resulted in the opening of a maintenance base in 2015-2016 with two aircraft hangars for Boeing 737-800. The airline had declared that it would invest 6 million euros in that project, officially called Wroclaw Aircraft Maintenance Service, what will lead to the creation of approximately 150 jobs. The airline also conducted negotiations with the Aviation Education Center in 2015 to start specializations in aviation for the positions on the new base (HiFly, 2015). Also, in 2016, Ryanair opened the digital hub IT Lab – Ryanair Labs Wrocław, employing 120 people.

Overall, a few research had evaluated the opening or closure of the operational base before. Malighetti, Paleari & Redondi (2016) studied base abandonments by LCC and concluded that the impact of LCC downsizing on airports depends on the carrier level of dominance, and presence of alternative regional airports. The closure of Wizz Air' base in Poznan led to network, employment, and financial cuts, and the opening of Ryanairs' base resulted in traffic growth in Poznan in 2017-2018.

The mechanisms of collaboration between the airports and cities with the budget carriers remain, normally, commercially classified. Still, the available evidence shows that airport charges may strongly affect the LCC plan on cooperation with the airport regarding network development and traffic (Francis, Fidato & Humphreys, 2003). Wroclaw, with lower airport charges, demonstrated better LCC network development, higher passenger traffic, more sustainable financial performance, and economic input from the airlines, than Poznan.

The data presented in table 3 shows the change of the selected indicators in Poznan and Wroclaw in 2005-2019. The cities with similar GDP (approximately 56 billion PLN in 2019) and slightly different demographic potential (536 thousand inhabitants in Poznan versus 641 thousand in Wroclaw in 2019) deliver different results of LCC passenger traffic, airport's financial performance, number of foreign tourists, the number of hotels, development of hotel industry, migration, etc. That is also applicable to the indicators of tourism development (numbers of foreign tourists accommodated, tourists per capita, hostels, overnight stays).

Table 3. Change of selected indicators related to the impact of the LCC, 2019 vs. 2005

	Indicator	Impact type*	Block type*	The change of the indicator	
				Poznan	Wroclaw
	General impact on the airport				
1	Airport revenue	D	T	**-428%**	**1760%**
2	Number of passengers, total	D	T	**496%**	**681%**
3	Share of LCC passengers	D	T	**188%**	**156%**
4	LCC air mobility index	D	T	**2682%**	**2039%**
5	Connectivity (2003-2019)	D	T	**240%**	**525%**
6	Investments into the airport from the LCC	D	T	**Decline**	**Growth**
	Socio-economic impact on the city				
7	GDP total	C	E	**83%**	**142%**
8	GDP per capita	C	E	**94%**	**141%**
9	City budget (revenue)	C	E	**119%**	**108%**
10	Employed in the transportation sector, total	I	E	**15%**	**5%**
11	Employed in the hotel and catering sector, total	C	E	**-13%**	**55%**
12	The monthly average salary in Transportation	Induced	E	177%	148%
13	Tourists per 1000	IC	SE	**124%**	**199%**
14	No of hotels	IC.	E	**68%**	**58%**
15	No. of hostels (2010-2020)	IC.	E	**-43%**	**133%**
16	No. of foreign tourists (FT) accommodated	IC.	E	**26%**	**79%**
17	No. of overnight stays (FT); WRO - 2018	IC.	E	**33%**	**64%**
18	Population, total	IC	SE	**-6%**	**1%**
19	Number of Students, HEIs, total	IC	SE	**-25%**	**-21%**
20	Immigration from abroad	IC.	SE	**-59%**	**44%**
21	Emigration abroad	IC.	SE	**-99,9%**	**-53%**

Note: * D – direct, I – indirect, C – cumulative, T – transportation, E – economic, SE – combined socio-economic.
Source: National and cities statistical data portals (GUS, Badam), UCL.

However, it is clear that, in reality, these indicators' growth dynamics can be the result of many factors. It is difficult to assess to what extent it is affected by the increase in LCC traffic (or vice versa). State of the economy, urban and regional governance, touristic attractiveness, demand for direct LCC connections, demographics of the city play a crucial role for the LCC, and the final results of network development and passenger traffic depend on the combination of those factors, as well as on confidential terms and conditions for the LCC entrance to the airport.

The existing research papers show that the impact of air transportation and the LCC on the city's economic situation may have several forms and dimensions. For instance, it can lead to the growth of GDP, as observed in Nykoping, Sweden (Lassen et al., 2015). In Poznan and Wroclaw, the GDP, GDP per capita, and the city budget revenue have had a trend of growth in 2005-2019. The last indicator had shown a high correlation with the LCC traffic, but it is important to be careful while analyzing that statistical relationship.

As discussed above, the LCC impact as carriers, delivering a significant number of tourists to the city (known as a catalytic impact), has a broad explanation in the academic literature. However, considering the existing data on the LCC passenger numbers, significant share in total passenger traffic (around 60% in both cities), and the correlation analysis results, it is possible to make an assumption that the LCC traffic have had a relatively positive impact on Poznan and Wroclaw's tourism sector in 2005-2019. As seen from the table 3, some indicators had shown growth in 2005-2019: number of tourists per city inhabitant (124% in Poznan and 199% in Wroclaw accordingly), number of foreign tourists accommodated (26% and 79%), number of overnight stays (33% and 66%), and number of hotels (68% and 58%). To measure probable statistical relationship between the selected indicators (with available time-series data for 2005-2019) the correlation analysis was performed, and the probable statistical associations between the LCC traffic and the rest of the database was calculated. Such indicators, as number of foreign tourists accommodated, number of overnight stays, and number of hotels significantly correlate with the LCC traffic, with coefficients varying from 0.5 to 0.9, with higher results in Wroclaw, which attracts more tourists, than Poznan, as expressed in table 4.

Table 4. Correlation matrix of 12 parameters for Poznan and Wroclaw cities

POZNAN		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1	LCC traffic	1.00											
2	LCC AM index	1.00	1.00										
3	City budget revenue, mln	**0.85**	**0.87**	1.00									
4	Employed in the transportation sector, total	**-0.55**	**-0.56**	-0.54	1.00								
5	Employed in the hotel and catering sector, total	**-0.63**	**-0.65**	-0.83	0.69	1.00							
6	No of hotels	**0.84**	**0.85**	0.94	-0.69	-0.83	1.00						
7	No. of foreign tourists (FT) accommodated	**0.57**	**0.60**	0.86	-0.25	-0.73	0.75	1.00					
8	No. of overnight stays (FT.)	**0.72**	**0.74**	0.87	-0.38	-0.82	0.82	0.91	1.00				
9	Airport revenue	**0.00**	**-0.01**	-0.30	0.10	0.38	-0.26	-0.39	-0.29	1.00			
10	Transport Tax	**0.20**	**0.21**	0.36	0.39	-0.10	0.18	0.59	0.51	-0.35	1.00		
11	Students	**-0.58**	**-0.61**	-0.88	0.48	0.80	-0.83	-0.91	-0.87	0.33	-0.38	1.00	
12	Net Migration	**-0.25**	**-0.22**	0.05	-0.30	-0.21	0.08	0.33	0.23	-0.22	0.13	-0.34	1.00
WROCLAW		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1	**LCC traffic**	**1.00**											
2	LCC AM index	1.00	1.00										
3	City budget revenue, mln	**0.92**	**0.93**	1.00									
4	Employed in the transportation sector, total	**0.03**	**0.02**	-0.10	1.00								
5	Employed in the hotel and catering sector, total	**0.91**	**0.91**	0.85	-0.03	1.00							
6	No of hotels	**0.85**	**0.85**	0.96	-0.21	0.76	1.00						
7	No. of foreign tourists (FT) accommodated	**0.82**	**0.82**	0.89	0.17	0.80	0.84	1.00					
8	No. of overnight stays (FT.)	**0.76**	**0.75**	0.85	0.22	0.75	0.80	0.99	1.00				
9	Airport revenue	**0.34**	**0.34**	0.36	-0.39	0.35	0.42	0.39	0.34	1.00			
10	Transport Tax	**-0.23**	**-0.22**	-0.44	-0.30	-0.05	-0.47	-0.61	-0.66	-0.01	1.00		
11	Students	**-0.76**	**-0.76**	-0.91	0.04	-0.68	-0.89	-0.94	-0.93	-0.39	0.70	1.00	
12	Net Migration	**0.52**	**0.52**	0.63	-0.16	0.61	0.63	0.62	0.64	-0.02	-0.35	-0.69	1.00

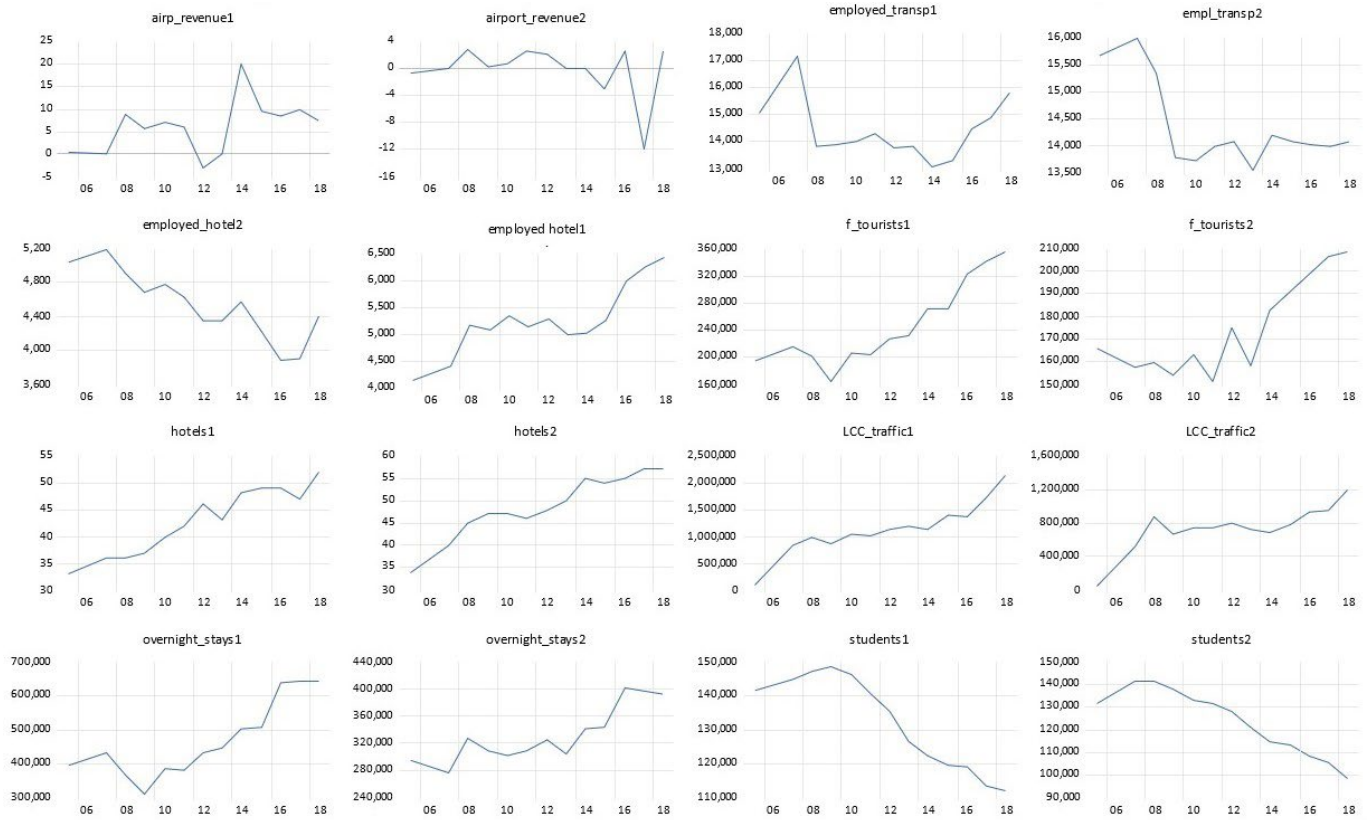
Note: the colours indicate the strength of the relationship, according to the correlation coefficient number. Numbers from 0,7 to 1 are highlighted in green, from 0,4 to 0,7 – in orange.
Source: Own Elaboration

Unlike in Wroclaw with 55% growth and stronger statistical correlation with the LCC traffic, the number of people employed in the hotel and catering sector had decreased over the same period in Poznan (-13%), as well as the number of hostels (-43%). That type of budget accommodation can be considered as primary accommodation option for the LCC passengers.

Wroclaw is also a place of temporal or permanent residence to a growing number of foreigners, many of whom come from Eastern Europe, including Ukraine. In 2019 there were 21370 officially registered Ukrainians in Greater Poland Voivodeship and 16285 – in the Lower Silesia (the Italians were in the 3rd place, which can explain the LCC connections to Italy (migracje.gov.pl, 2020). Besides, the negative correlation dependency between the LCC traffic and the number of students and the positive correlation with net migration is higher in Wroclaw, which may result in an assumption that the migration (general and educational, as far as students prefer the LCC over the traditional carriers for economic reasons) has a stronger connection with the LCC traffic there.

The impact on migration processes results in significant flows of labor pass through the primary regional airports, which offer a network of regular international connections to meet the demand (and to adjust to its geographic patterns), i.e., in the case of Greater Poland, mainly via the Poznan Airport, in case of Lower Silesia – via Wroclaw. The existing research on the impact of the migration processes on the LCC routes (Pancer-Cybulska et al., 2011) states that the creation of the demand for fast and cheap connections between Poland and the destinations of the economic migration resulted in the LCC network (in case of Poznan and Wroclaw that is seen via the LCC networks to the UK, Ireland, Norway, and Italy). After 2014 the analogical situation was with the impact of Ukraine's migration flows on developing the LCC routes to Kyiv (2 airports), Odesa, and Kharkiv (the airport officials admit increase in passenger numbers from Ukraine in Poznan). That increase can also be partly explained by the visa liberalization agreement between Ukraine and the EU. It came into force in 2017, and introduced the visa-free regime for short trips (like visiting friends or touristic purposes) for the Ukrainians into the EU. Based on the results of the correlation analysis, 8 indicators have had a strong statistical relationship (as presented in fig. 7), and 2 of them (LCC traffic and number of foreign tourists) had been selected for Johansen cointegration test.

Figure 7. Time-series data dynamics for the selected socio-economic indicators, 2005-2019



Note: indicators ending with 1 – Wroclaw; with 2 – Poznan; see indicators changes and correlation in tables 3-4.
Source: ULC, GUS

The results of Johansen cointegration test are presented in the table 5. They show that there is a statistical cointegration (when Trace and Max-Eigen statistics values are higher than critical value, and probability is less than 0,05) between the 2 variables (LCC traffic and the number of foreign tourists) in Poznan and Wroclaw. It is interesting, though, that hypothetical assumptions (based on lags interval) indicated two cointegrating equations at the 0,05 level for Poznan, and only one cointegrating equation in Wroclaw.

Table 5. Johansen cointegration test for Wroclaw and Poznan

POZNAN				
Unrestricted Cointegration Rank Test (Trace)				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.** Critical Value
None *	0.894	27.075	18.398	0.0024
At most 1 *	0.368	4.593	3.841	0.0321
Unrestricted Cointegration Rank Test (Max-eigenvalue)				
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.** Critical Value
None *	0.894	22.481	17.147	0.0076
At most 1 *	0.368	4.594	3.841	0.0321
Max-Eigen and Trace tests indicate 2 cointegrating equation(s) at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) *p*-values				
WROCLAW				
Unrestricted Cointegration Rank Test (Trace)				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.** Critical Value
None *	0.957	35.362	18.397	0.0001
At most 1	0.311	3.732	3.841	0.05336
Unrestricted Cointegration Rank Test (Max-eigenvalue)				
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.** Critical Value
None *	0.957	31.630	17.147	0.0002
At most 1	0.311	3.732	3.841	0.0533
Max-Eigen and Trace tests indicate 1 cointegrating equation(s) at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) *p*-values				

Source: Own Elaboration

However, Johansen cointegration test results (as well as measurements of pairwise correlations) should be interpreted cautiously. Like many mathematical data-analysis tools, they may show some statistical relationship, but not provide the detailed insight into the true causal relationship between the selected variables. More complex theoretical models behind the time-series data are, probably, preferable for further in-depth analysis.

5. Conclusion

Liberalization of the air transportation market in the European Union had a significant impact on passenger mobility, airport's connectivity, tourism and other related areas. The accession of Poland into the EU in 2004 and the entrance of the LCC in 2005 had led to the increase in connectivity, growth of the LCC traffic, direct and indirect socio-economic impact on airports and cities, including the studied cities of Poznan and Wroclaw.

This study confirms the common in the *academic literature* investigations, that market deregulation and liberalization attracts the LCC. It contributes the existing scientific discourse with a comparative case study of 2 Polish airports. Deregulation results in rapid network development and passenger traffic growth (Gabor, 2010; Dobruszkes, 2013). The research shows that the similar processes occurred in Poznan (496% total passenger traffic growth) and Wroclaw (681% growth) – right after the first LCC, namely Ryanair and Wizz Air, initiated their operations in 2005 (the time-frame of this research covers the period until 2019). The results of this investigation enrich the existing geographic and other literature, related to the network development, traffic analysis at POZ and WRO airports, delivering an update on connections (last geographic works date 2011) and analyzing the changes of the development and contemporary structure of spatial interaction links with European destinations and countries. The results prove that there is still a strong demand for connections between Poznan and Wroclaw and the UK and Italy (defined by migration flows, as demonstrated by Pancer-Cybulska et al. (2011)), but the recent spatial changes indicate the "shift to the East" caused by the increased number of connections with Ukraine for the similar reasons.

Once the research was conducted in 2020-2021, an important update on the situation in Ukraine is essential here, as far as it was an essential LCC destination from Poznan and even more - from Wroclaw. The war of Russia against Ukraine, started in February 2022, had a devastating effect on the civil aviation sector in the country. All airlines had ceased their operations, cut off all connections, some of the fleet based at the airports was grounded (Wizz Air performed some fleet evacuations in 2023), and the martial law in Ukraine had significantly reduced the cross-border mobility of male population. The further research, though, can be held on how the war had changed traffic patterns and connectivity in the Polish airports near the Ukrainian border (Rzeszow, Lublin).

This research *methodology* incorporated general (comparative, logico-structural, statistical analyses) and particular geographic (network and connectivity analysis, GIS modelling, cartographic visualization) research methods. That multidisciplinary approach helped to emphasise the complexity of interactions between dimensions of socio-economic development and LCC presence and impact. The comparative analysis was useful to distinguish, describe and explain similarities and variances between LCC network development, performance and socio-economic impact in Wroclaw and Poznan.

The existing *limitations* on the methodology, besides the ones, mentioned in the chapter 3, expand the horizons for further research on the topic. The important part of discussion here is the selection of methods and instruments for better assessment of the LCC socio-economic impact. The previous research on the subject used mostly econometric approach towards the evaluation of the economic impact (i.e., by using a cost-benefit analysis, as in Almeida & Costa (2015, 2018), or descriptive case study analysis as Lassen et al. (2015)). The spatial aspect is missing there, and this study aims to partially fill that gap, incorporating primarily geographical, but also a multidisciplinary approach. However, more time-series data is useful for better evaluation and further testing of the existing econometric, as well as spatial models.

The analysis of the *spatial impact* of the LCC in Poznan and Wroclaw confirmed the importance of the budget carriers for the growth of transport connectivity, in particular, in 2009-2019 (105% increase in Poznan and 115% - in Wroclaw). The increase in the number of destination countries was 128% and 113%, respectively. The LCC accounted for approximately 80% of the network in both airports, significantly defining the spatial patterns of access to the international and domestic (in Wroclaw) destinations. The overall spatial picture was similar for both airports, with the most frequent destination countries being the UK, Ireland, and Italy, with the significant increase of the Ukrainian destinations in 2014-2022. That increase can also be explained by the visa liberalization agreement between Ukraine and the EU in 2017, what introduced visa-free regime for short visits (like visiting friends or touristic purposes).

The increase in passenger traffic was observed at both airports. However, the LCC share and the total LCC traffic numbers were higher in Wroclaw due to slightly higher demographic potential, better tourist attractiveness, and airport policies (i.e., lower airport charges).

The results of correlation analysis altogether with Johansen cointegration test on data from Poznan and Wroclaw data highlighted probable statistical associations between the LCC traffic and the indicators of tourism development, and cointegration between LCC traffic and number of foreign tourists. That corresponds with the existing research on the topic about statistical relationship between LCC and tourism. The LCC have had an impact on Poznan's and Wroclaw's tourism sector, which is observed from several in-

dicators' growth. In 2005-2019 the number of tourists per capita (in the city) had grown by 124% in Poznan and 199% in Wroclaw, number of foreign tourists accommodated – 26% and 79% accordingly, number of hotels – 68% and 58%.

The figures of investments of the major budget carriers at POZ and WRO (as their operational bases) reveal that Wroclaw received better financial and employment benefits than Poznan. Additionally, the Wizz Air operational base's closure in Poznan in 2018 resulted in network cuts, financial and employment losses (due to fleet and staff relocation). More research on the LCC-airport-city interaction is needed to see a broader picture of the impact on local communities, which can be valuable for both researchers and practitioners (city administration, airport authorities, tourism offices, etc.). Further research on conditions and terms of public subsidies or financial support can contribute towards better understanding of stakeholders' socio-economic interactions. For example, it is a common practice for the local governing authorities to pay the airlines to promote the place. In 2015 Lublin airport paid EUR 550 thousand to Wizz Air to promote connections from the airport. Ryanair received PLN 17 mln from Subcarpathian Voivodeship for three years of promotion of the region. After Wizz Air closed its base and removed four connections from the Poznan airport network in 2018, the city of Poznan and the Greater Poland Voivodeship had announced that they are willing to spend 26 million PLN on new connections from the airport (Fly4free, 2018). Within this implication, the further methodology development and analysis of airports and airlines competition (and its impact on urban or regional positioning and competitiveness) can be useful for both researchers and stakeholders, involved in air transportation and related activities.

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