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An Estimation of the Number of Lost Airport Passenger Services as a Result of the Covid-19 Pandemic in Poland

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Abstract:

Purpose: *The main aim of the research is to present the scale of the number of lost passenger transport as a result of limiting the activity of the aviation industry in Poland in the cross-section of the most important civil airports.*
Design/Methodology/Approach: *An analysis of passenger traffic in the most important airports in Poland was carried out. The methods of regression analysis and forecasting[4] were applied for the analyzes. In order to estimate the impact of restrictions on the operation of the aviation industry on passenger traffic in Poland across individual airports, the parameters of trends in 2011-2019 were estimated. Then, the models for 2020 (March-December) were predicted. As a result, the volume of lost traffic (in thousands of passengers) was obtained and the scale of changes in percent was determined. Linear and nonlinear regression models with index variables were used for the research.*
Findings: *The cause of severe losses is not only the pandemic itself, but it may be the lack of a coherent management system in the COVID-19 crisis. Taking into account the history of the development of passenger air services and the importance they have played for economic development in the most important economies, it should be stated that the crisis of 2020 may be a predictor of significant changes in the management system in the long term.*
Practical Implications: *The introduced restrictions and limitations were poorly coordinated at the national and international levels, which resulted in chaos and a feeling of uncertainty as to the development of the situation, which in turn prevents rational actions by aviation market participants, including airlines.*
Originality/Value: *This article is an original contribution in the study of the impact of pandemic restrictions on passenger air transport in Poland, using regression analysis and forecasting methods.*

Keywords: *Passenger air traffic, pandemic COVID-19, prediction and forecasting.*

JEL classification: *L91, L93, R40, R41.*
Paper Type: *Research Paper*

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1. Introduction

At the beginning of 2020, scientific publishers, institutions and global mass media published information about the spread of the coronavirus pandemic among people (Liu *et al.*, 2020; European Center for Disease Prevention and Control, 2020; World Health Organization, 2019). In Poland, the Act on preventing, counteracting and combating COVID-19 was adopted on March 2, 2020 and entered into force on March 8, 2020 (Journal of Laws of 2020, item 374). Air traffic bans were introduced by the Regulation of the Council of Ministers of the Republic of Poland of March 13, 2020, which entered into force on March 29, 2020 (Journal of Laws of 2020, item 436). As part of the research, the results of which are presented in this paper, an analysis of passenger traffic in the most important airports in Poland was carried out, in particular, a quantitative assessment of the direct effects of the introduction of air traffic restrictions justified by the outbreak of the COVID-19 pandemic, i.e., from March to December 2020.

The research assumed the hypothesis that the introduction of restrictions on the operation of the air transport industry motivated by the SARS-CoV-2 pandemic had a significant impact on the scale of the depreciation of passenger air transport in 2020, which may herald financial problems in the functioning of the aviation industry. The main aim of the research is to present the scale of the number of lost passenger transport as a result of limiting the activity of the aviation industry in Poland in the cross-section of the most important civil airports.

2. Literature Review

The role of air transport in creating economic development and the mobility of the inhabitants of many countries seems to be obvious, and many studies emphasize the importance of air transport for economic growth (Aguirre *et al.*, 2018; Baker *et al.*, 2015; Hu *et al.*, 2015). The aviation industry is an important element of the transport and research and development policy of almost every region, state or international economic association (Lehmkuhl, 2011). The relationship between the economic growth measured by the Gross Domestic Product and the development of the air transport industry, and thus also the technology for the production of aircraft, means of communication and telecommunications, are the subject of numerous studies (Dziedzic, 2017; Pijet-Migoń, 2012; Holloway, 2008; Button and Taylor, 2000). In the past, breakdowns in air traffic were associated with the occurrence of crisis phenomena. In the years 1974-1975 there was the first oil crisis, and in 1981 there was the second oil crisis (Świdzińska, 2017). In the years 2001-2002 there was an ”Internet speculative bubble” (Mazur, 2020; Piech, 2003) and an attack on the WTC (Gillen and Lall, 2009).

The effects of terrorist attacks and the financial crisis on civil aviation could be observed primarily in the American continents and Europe. Epidemic crises were the cause of the decline in air traffic. The process of rebuilding the level of air traffic in

China before the SARS pandemic of 2003 took nine months (Sipiński, 2020). At that time, 5,328 people fell ill in China and 349 people died, and there were a total of 8,096 cases worldwide, including 774 fatal (Pancer, 2018). In 2008-2009 there was a financial crisis caused by the situation on the subprime market in the USA (Macario and Van de Voorde, 2009). During the economic crisis of 2008-2009, a visible decline in revenues from exclusively aviation activities was observed. Most of the operating result (income before tax) came from other diversified activities, e.g. commission on booking accommodation or cars (Rydzkowski, 2010). This example shows the evaluation of air transport to new business models.

The crisis that broke out as a result of the COVID-19 pandemic in 2020 is global (Business Insider, 2020) and also affects Poland. The temporary suspension of international (from March 15, 2020) and domestic (from March 16, 2020) air connections in the territory of the country caused a drastic decrease in air traffic (GAT IFR traffic without taking into account OAT and General Aviation traffic) compared to the corresponding period in previous years. The year 2020 is a decrease in the number of air operations by 56.4 percent compared to 2019 (Sas, 2021). The negative consequences of the global crisis are felt much more than ever in history. Willie Walsh, former IAG CEO and IATA CEO, said: ”We always compare a current crisis to historical events but by any measure, this is more difficult. International aviation has been shut down for 12 months. It is off the scale” (Irish Examiner, 2021). The problem is extremely important because the current crisis has a ”double power”, due to the reduction of demand for passenger air transport, but also due to the global economic crisis, thus affecting the aviation industry.

The introduced restrictions on supply (including the number of seats on the plane and the number of connections) with their gradual elimination do not result in an increase in demand return. The budget deficits of countries will also cause a decrease in purchasing power among potential customers, but also a potential permanent change in the model of using this industry on the demand side (Janczuk and Czapski, 2020).

3. Matherials and Methods

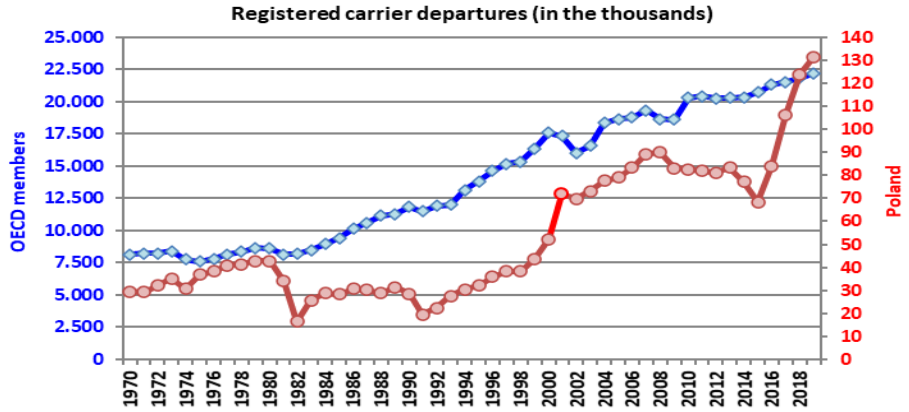
The methods of regression analysis and forecasting were applied for the analysss. In order to estimate the impact of restrictions on the operation of the aviation industry on passenger traffic in Poland across individual airports, the parameters of trends in 2011-2019 were estimated. Then, the models for 2020 (March-December) were predicted. As a result, the volume of lost traffic (in thousands of passengers) was obtained and the scale of changes in percent was determined.

Linear and nonlinear regression models with index variables were used for the research (Rabiej, 2018; Bedyńska and Książek, 2012). The data for analysis was downloaded from the Eurostat database (https://ec.europa.eu/eurostat) and OECD (https://www.oecd-ilibrary.org/) and verified on the websites of Polish airports.

4. Study Results

From 1970 to 2019 global air transport recorded a dynamic increase in passenger and cargo transport. The sharp declines year to year took place in the years 1974-1975; (-7.3%), 1981; (-5.4%), 2001-2002; (-7.7%), 2008-2009; (-3.4%) - calculations based on OECD data. Compared to OECD countries, Poland is characterized by analogous trends in changes in passenger traffic in the long term, with the proviso that deep declines were recorded in the 1980s and early 1990s, and in 2010-2016 (Figure 1).

Figure 1. *Changes in air transport in OECD and Poland in 1970-2019*



Source: *Own study based on OECD data.*

In the case of Poland, the volume of passenger growth and forecasts showed favorable prospects for the development of the aviation market. Forecasts of the Civil Aviation Authority of the Republic of Poland (concerning the number of passengers using air transport and the number of commercial operations at Polish airports) indicated that, while maintaining the dynamics of the time, the number of passengers would double by 2035 and reach almost 95 million passengers per year (Civil Aviation Office, 2017). The number of airport passengers in Poland in the period March-December 2020 is presented in relation to the corresponding period of 2019 (Table 1). The months of January and February were not included in the analysis, because at that time air transport functioned normally and taking these months into account would weaken the assessment of the crisis affected by air transport.

An index of the dynamics of passenger traffic at Polish airports was determined in the period of 2020 compared to 2019. The scale of the depreciation is significant - passenger traffic decreased by an average of 80 percent. A relatively small decrease was recorded at Lublin airport, but it was caused by unusually low traffic in 2019. In order to illustrate the scale of changes in passenger traffic for Polish airports in 2020, dynamics indices were determined for the corresponding months of 2019 (Table 2).

Table 1. *Ranking of Polish airports according to the relative declines in passenger traffic in 2020 compared to the results for 2019.*

Airport name	Location	No. of passengers in thousands (III-XII)		Dynamics (2019 = 100)
		2019	2020	
Lublin Airport	Świdnik	307	74	24.3
Solidarity Szczecin-Goleniów Airport	Goleniów	499	109	21.8
Gdańsk Lech Wałęsa Airport	Rębiechowo	4723	969	20.5
Rzeszów International Airport	Jasionka	667	136	20.5
Katowice Airport	Pyrzowice	4386	890	20.3
Bydgoszcz Ignacy Jan Paderewski Airport	Szwederowo	370	67	18.2
Wrocław Copernicus Airport	Starachowice	3101	559	18.0
John Paul II International Airport Kraków-Balice	Balice	7378	1309	17.7
Poznań-Ławica Henryk Wieniawski Airport	Ławica	2127	376	17.7
Warsaw Chopin Airport	Okęcie	16495	2877	17.4
Warsaw Modlin Airport	Modlin	2641	451	17.1
	TOTAL	42909	7828	18.2

Source: *Own study based on the data obtained from the websites of Eurostat and Polish airports.*

Table 2. *Percentage changes in passenger traffic at Polish airports in individual months of 2020 (the highest result in the holiday season for each airport is marked in green)*

Airport	Dynamics of the number of passengers in 2020 (corresponding month of 2019 = 100)									
	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Bydgoszcz	38.7	0.0	0.0	0.3	18.7	37.9	38.0	23.2	6.0	9.9
Gdańsk	40.4	0.3	0.3	3.4	27.3	41.6	33.7	24.6	14.0	17.0
Kraków	41.6	0.0	0.0	1.9	26.2	37.5	30.5	18.4	8.8	10.7
Katowice	38.6	0.0	0.0	1.4	25.0	39.4	34.7	25.9	8.5	16.0
Lublin	36.4	0.0	0.1	3.2	42.5	55.3	44.8	23.8	8.9	16.5
Warszawa/Modlin	27.1	0.0	0.0	0.8	22.2	35.4	35.2	24.6	13.0	15.3
Poznań	37.1	0.4	0.1	1.5	23.4	37.5	27.6	19.3	7.2	12.5
Rzeszów	30.2	0.2	0.0	4.2	27.2	38.6	37.4	26.3	12.8	16.6
Szczecin	36.8	0.0	0.1	11.9	36.9	44.7	34.0	19.5	12.0	15.1
Warszawa/Okęcie	38.3	0.9	0.4	2.6	23.0	33.7	25.7	19.1	12.0	16.2
Wrocław	32.3	0.3	0.4	1.4	25.5	38.4	30.3	21.7	9.2	13.1
TOTAL	37.6	0.4	0.2	2.3	24.6	36.7	29.7	20.8	10.9	14.6

Source: *Own study based on the data obtained from the websites of Eurostat and Polish airports.*

Based on monthly data for 2011-2020, a forecast of the level of traffic for each airport in the months from March to December 2020 was formulated (Table 3). The forecast was developed using regression models with a linear or quadratic trend with index variables (illustrating the effects of seasonality, which is very strong in air transport). In order to quantify the losses incurred by the aviation sector, the actual results should be compared to the traffic forecast in 2020, assuming the continuation of trends initiated in previous years. The formulated forecasts of the number of passengers at airports for 2020 are characterized by a determination factor of 74-98

percent. Therefore, the high quality of fitting the models to the data should be recognized.

Table 3. *Passenger traffic forecasts at Polish airports for March-December 2020*

Airport	Forecasted number of passengers in 2020 (in thousands)										R^2
	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Bydgoszcz	30	36	38	43	48	47	46	38	32	34	73,7%[1)]
Gdańsk	438	484	523	552	598	589	559	518	457	461	96.8%[1)]
Kraków	727	785	833	845	881	887	879	858	798	808	98.4%[1)]
Katowice	383	415	487	599	671	677	620	486	417	418	91.8%[1)]
Lublin	36	40	43	43	47	48	46	44	37	39	61.1%[2)]
Warszawa/Modlin	279	307	322	316	324	318	303	300	286	286	74.2%[2)]
Poznań	194	210	244	298	321	319	301	239	213	213	90.7%[1)]
Rzeszów	61	65	71	75	84	84	78	71	57	58	94.9%[2)]
Szczecin	48	52	59	61	65	64	60	57	49	49	84.3%[2)]
Warszawa/Okęcie	1642	1736	1910	2059	2179	2165	2133	1940	1755	1731	96.3%[1)]
Wrocław	289	317	345	381	407	402	389	345	309	309	95.6%[1)]
TOTAL	4128	4447	4874	5271	5625	5601	5412	4896	4409	4405	×

Note: *R^2 – determination coefficient (the quality of the model fit to the data from 2011-2019). 1) Linear trend model with seasonal dummy variables 2) Quadratic model with seasonal dummy variables.*

Source: *Own study based on the data obtained from the websites of Eurostat and Polish airports.*

The decrease in the level of transport in individual months of 2020, as well as in the entire period, was assessed. Table 4 shows the dynamics indexes calculated in relation to the corresponding months of 2019 (or the entire period). It is worth comparing these values with the results presented in tables 2 and 3. It turns out that taking into account the current trends, the drops in air traffic for most airports are even more severe than in relation to the values from 2019. For instance, in Krakow during the summer months (July-August), the level of air traffic in 2020 was 26.2 and 37.5%, respectively, compared to 2019, but only 23.3 and 34.8% compared to the forecast result. for 2020. As shown in Table 1, the traffic at all Polish airports in March-December accounted for only 18.2% of the traffic in 2019 in the corresponding period and only 15.9% of the values forecasted for 2020 (Table 4).

Estimates of the number of passengers at the most important airports in Poland in 2020, presented in Table 5, indicate that the number of passengers decreased in March - December 2020 by over 41 million passengers. The dramatic decrease in passenger transport carried out by Polish airports is expressed by an over 6-fold decrease in relation to the expectations that would be achieved in a situation where the pandemic did not occur. Figure 2 shows number of lost passengers to relative lost in Polish Airports in 2020.

The largest airports lost the most passengers. Nevertheless, taking into account the scale of the percentage decrease, a tendency can be noticed that smaller airports recorded a relatively higher percentage loss in the number of passengers (Spearman's correlation coefficient: r_S = -0.42 p = 0.19).

Table 4. *Passenger traffic forecasts at Polish airports for March-December 2020*

Airport	The actual number of passengers in 2020 in relation to the forecasted volumes (forecasts for the relevant periods of 2020 = 100)										
	III	**IV**	**V**	**VI**	**VII**	**VIII**	**IX**	**X**	**XI**	**XII**	**III-XII**
Bydgoszcz	38.3	0.0	0.0	0.3	18.7	38.4	34.5	21.6	5.3	8.4	17.2
Gdańsk	33.1	0..2	0.2	3.3	25.8	39.6	31.8	22.7	11.8	14.5	18.7
Kraków	34.5	0.0	0.0	1.7	23.3	34.8	28.1	16.9	7.5	9.5	15.8
Katowice	25.2	0.0	0.0	1.4	24.6	38.5	31.9	19.1	5.9	10.7	17.2
Lublin	26.1	0.0	0.0	2.2	31.1	40.0	33.4	17.7	6.1	12.1	17.6
Warszawa/Modlin	24.8	0.0	0.0	0.7	20.4	33.8	28.6	19.5	9.8	11.9	14.9
Poznań	26.3	0.3	0.1	1.3	21.3	34.5	25.7	15.6	5.0	8.2	14.8
Rzeszów	29.7	0.2	0.0	4.1	26.9	39.3	36.0	23.9	11.3	14.5	19.5
Szczecin	31.6	0.0	0.1	10.	31.5	39.6	31.2	19.2	10.9	14.2	19.3
Warszawa/Okęcie	31.2	0.7	0.3	2.2	20.4	30.2	22.6	16.7	9.9	12.9	14.9
Wrocław	27.4	0.2	0.4	1.4	24.4	36.7	28.5	18.4	7.0	10.1	16.0
TOTAL	30.5	0.4	0.2	2.1	22.6	34.2	26.9	18.0	8.8	11.7	15.9

Source: *Own study based on the data obtained from the websites of Eurostat and Polish airports.*

Table 5. *Number of lost passengers at individual airports in Poland in 2020 (in thousands)*

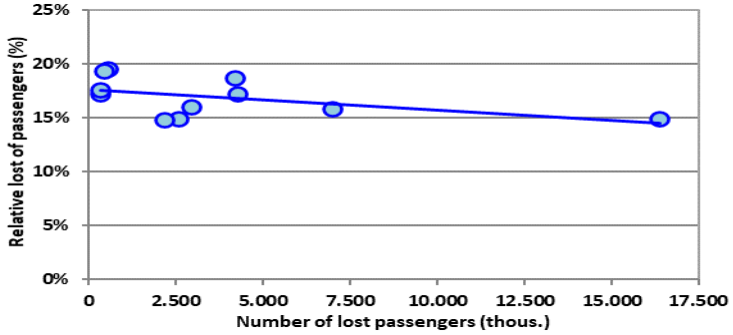
Months	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**IX**	**X**	**XI**	**XII**	**III-XII**
Bydgoszcz	19	36	38	43	39	29	30	30	31	31	324
Gdańsk	293	483	521	533	444	356	382	400	404	395	4210
Kraków	476	785	833	831	675	578	632	713	738	731	6992
Katowice	287	415	487	591	507	416	422	393	393	373	4284
Lublin	27	40	43	42	33	29	31	36	34	34	349
Warszawa/Modlin	210	307	322	314	258	211	216	242	258	252	2588
Poznań	143	210	244	294	253	209	223	202	202	195	2176
Rzeszów	43	64	71	72	62	51	50	54	50	50	566
Szczecin	33	52	59	55	45	38	41	46	44	42	455
Warszawa/Okęcie	1129	1723	1904	2013	1735	1512	1651	1617	1582	1507	16373
Wrocław	210	317	344	376	308	255	278	282	287	277	2932
TOTAL	2869	4431	4864	5163	4356	3684	3955	4014	4022	3888	41247

Source: *Own study based on the data obtained from the websites of Eurostat and Polish airports.*

5. Conclusions

As a result of the pandemic, the entire aviation industry is going through the most difficult period in its history, but not only it, because the pandemic caused a global crisis. This is probably the first time the pandemic involving air transport has spread, causing a crisis in more than two hundred countries. The pandemic has led to a diversification in the global air transport system. Aviation is one of the industries most affected by the consequences of the pandemic (Dube *et al.*, 2021; Sun *et al.*, 2020; Dabachine *et al.*, 2020).

Figure 2. *Number of lost passengers vs relative lost in Polish Airports in 2020*



Source: *Own study based on the data obtained from the websites of Eurostat and Polish airports.*

The cause of severe losses is not only the pandemic itself, but it may be the lack of a coherent management system in the COVID-19 crisis. The introduced restrictions and limitations were poorly coordinated at the national and international levels, which resulted in chaos and a feeling of uncertainty as to the development of the situation, which in turn prevents rational actions by aviation market participants, including airlines.

A separate issue is the degree of adequacy in limiting the functioning of the aviation industry by individual governments to the level of real pandemic threats. Airports operate thanks to passengers, and the decline in air traffic and demand has obviously left its mark on the financial situation of airports. It is also worth emphasizing that the pandemic will primarily hit regional airports, which are usually unprofitable. The vast majority of Polish airports suffer losses and only the largest operators earn.

Only five Polish airports were profitable in 2017 (Forsal.pl, 2017). The losses and costs of deficits are borne by the owners of regional airports, which are largely self-governmental. Taking into account the history of the development of passenger air services and the importance they have played for economic development in the most important economies, it should be stated that the crisis of 2020 may be a predictor of significant changes in the management system in the long term. Nevertheless, the impact of the crisis in the aviation industry on technological and economic development should be the subject of continuation of the research undertaken.

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