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## DETERMINANTS OF AIR PASSENGER DEMAND IN POLAND

## DETERMINANTY POPYTU NA PASAŻERSKIE PRZEWOZY LOTNICZE W POLSCE

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**Streszczenie.** Popyt na usługi przewozów pasażerskich w transporcie lotniczym od wielu lat charakteryzuje się tendencją rosnącą. Badacze, którzy zajmują się ekonomiką transportu, bezustannie poszukują ekonomicznych i pozaekonomicznych czynników determinujących popyt na usługi transportowe. W związku z tym jako cel opracowania przyjęto analizę zależności pomiędzy liczbą pasażerów korzystających z transportu lotniczego w Polsce i w wybranych województwach a warunkami życia ludności oraz wybranymi wielkościami z zakresu demografii i koniunktury. Przeprowadzona analiza pozwoliła na wskazanie determinant popytu na przewozy pasażerskie transportem lotniczym. Do badania wykorzystano dane roczne z lat 2010–2016 publikowane przez Główny Urząd Statystyczny.

**Key words:** air transport, determinants of demand, Pearson linear correlation coefficient.

**Słowa kluczowe:** determinanty popytu, transport lotniczy, współczynnik korelacji liniowej Pearsona.

## INTRODUCTION

The transport services market shows continuous increase in demand for air transport services. Demand for air passenger transport is generated by (Porty lotnicze wobec... 2008):

- individual and group passengers,
- companies and organizations,
- tour operators offering holiday and tour packages (i.a. travel offices, tourism agencies).

Many academics in the field of economics of transportation seek to identify economic and non-economic determinants of demand for passenger transport in various transportation sectors (e.g. Hawlena 2000, 2005; Śleszyński 2004, 2007; Gądek-Hawlena 2008). There is a general agreement between researchers that the primary determinant of passenger transport demand, including air transport, is the price factor. However, when we analyze the relationship between change in price and change in demand, economists assume that „customer preferences and income and prices of other transport services remain are fixed” (Tłoczyński 2016). And yet, economic practice demonstrates clearly that prices of transport services, including all kinds of transportation, vary enormously and fluctuate seasonally. Therefore the above variables were not taken account in the analysis which was conducted based on annual macroeconomic indicators for the years 2010–2016 published by the Polish National Statistical Office. This paper seeks to investigate the links that exist between air passenger volume in Poland in general, and some selected provinces in particular and:

- the living standard,
- selected demographic factors,
- selected market condition factors.

Such approach will allow to identify determinants of air passenger demand in Poland and its provinces.

The present research is based on data gathered by the National Statistical Office for the years 2010–2016. In view of the seasonality of the study subject, only annual data were used.

## **MATERIAL**

After consideration of potential determinants of air passenger transport demand, 24 variables were selected and classified in 3 categories:

### 1. Standard of living:

- x<sub>1</sub> – average monthly salary (in PLN),
- x<sub>2</sub> – average monthly gross salary in in the state sector,
- x<sub>3</sub> – average number of pensioners and disability pensioners benefiting from the non-agricultural social security system (in thous. persons),
- x<sub>4</sub> – average monthly nominal pension and disability pension gross paid from the non-agricultural social security fund (in PLN),
- x<sub>5</sub> – average monthly real pension and disability pension gross paid from the non-agricultural social security fund,
- x<sub>6</sub> – average number of pensioners and disability pensioners benefiting from the individual farmers' pension fund (in thous. persons),
- x<sub>7</sub> – average monthly nominal pension and disability pension of individual farmers gross (in PLN),
- x<sub>8</sub> – average monthly real pension and disability pension of individual farmers gross,
- x<sub>9</sub> – registered unemployment rate (in%),
- x<sub>10</sub> – average monthly disposable income per person (in PLN).

### 2. Demographics:

- x<sub>11</sub> – total population,
- x<sub>12</sub> – total male population,
- x<sub>13</sub> – total female population,
- x<sub>14</sub> – pre-working age population / population total
- x<sub>15</sub> – working age population / population total,
- x<sub>16</sub> – post-working age population / population total,
- x<sub>17</sub> – total population growth,
- x<sub>18</sub> – total fertility rate,
- x<sub>19</sub> – international migration balance.

### 3. Economic situation:

- x<sub>20</sub> – business climate indicator for construction industry,
- x<sub>21</sub> – business climate indicator for production industry,
- x<sub>22</sub> – business climate indicator for trade,
- x<sub>23</sub> – GDP fixed prices,
- x<sub>24</sub> – consumer goods and services price indicator.

Table 1 presents basic statistical measures of variables selected for the analysis of demand.

Table 1. Statistical measures of variables

Variable \ Measure	X <sub>1</sub>	X <sub>2</sub>	X <sub>3</sub>	X <sub>4</sub>	X <sub>5</sub>	X <sub>6</sub>	X <sub>7</sub>
Mean	3709.55	102.54	7737.54	1891.33	102.72	1263.12	1089.24
Range	829.75	4.35	210.00	443.37	4.00	180.25	228.06
Coefficient of variation	7.83%	1.66%	0.95%	8.83%	1.42%	5.43%	8.46%
Variable \ Measure	X <sub>8</sub>	X <sub>9</sub>	X <sub>10</sub>		X <sub>11</sub>	X <sub>12</sub>	
Mean	102.14	11.72	1314.06		38 492 301	18 628 220	
Range	6.55	4.68	281.74		105 455	61 411	
Coefficient of variation	2.06%	13.82%	7.31%		0.12%	0.14%	
Variable \ Measure	X <sub>13</sub>	X <sub>14</sub>	X <sub>15</sub>	X <sub>16</sub>	X <sub>18</sub>	X <sub>23</sub>	X <sub>24</sub>
Mean	19 864 081	18.24	63.3	18.44	1.31	103.06	101.42
Range	44 717	0.90	2.60	3.40	0.12	3.60	5.20
Coefficient of variation	0.10%	1.76%	1.52%	6.70%	3.21%	1.23%	2.08%

Source: own compilation based on data from the Polish National Statistical Office.

To analyze the correlations between subject phenomena in Poland and its provinces, numerical data were compiled in data series (por. Statystyka 1998). Since all attributes are quantitative, whereas relationships between them and the air transport passenger volume are linear, Pearson's linear correlation coefficient was used to evaluate how data sets are related to one another.

The strength of association was determined based on the following ranges (Sobczyk 2006):  
 |0 – 0.2| – very weak correlation,  
 |0.2 – 0.4| – weak correlation,  
 |0.4 – 0.6| – moderate correlation,  
 |0.6 – 0.8| – strong correlation,  
 |0.8 – 1.0| – very strong correlation.

## DETERMINANTS OF DEMAND IN POLAND

Figures 1–3 present Pearson's linear correlation coefficients for all-Poland data broken down into three categories: standard of living, demographic and business climate factors.

A very strong positive correlation is observed for  $x_1$ ,  $x_2$ ,  $x_4$ ,  $x_7$  and  $x_{10}$  variables (Fig. 1), and the correlation coefficients indicate that in 95.84%, 67.26%, 89.15%, 83.48% and 99.32% respectively the changes in passenger volume are determined by changes in the variables of interest. Variables  $x_5$  and  $x_8$  show very weak positive correlation, whereas  $x_3$ ,  $x_6$  and  $x_9$  demonstrate strong and very strong negative correlation. In the case of  $x_3$  correlation coefficient reveals that in 50.48% changes in passenger volume are related to changes in  $x_3$ , whereas in case of  $x_6$  and  $x_9$  it is respectively 81.52% and 67.27% (Fig. 1).

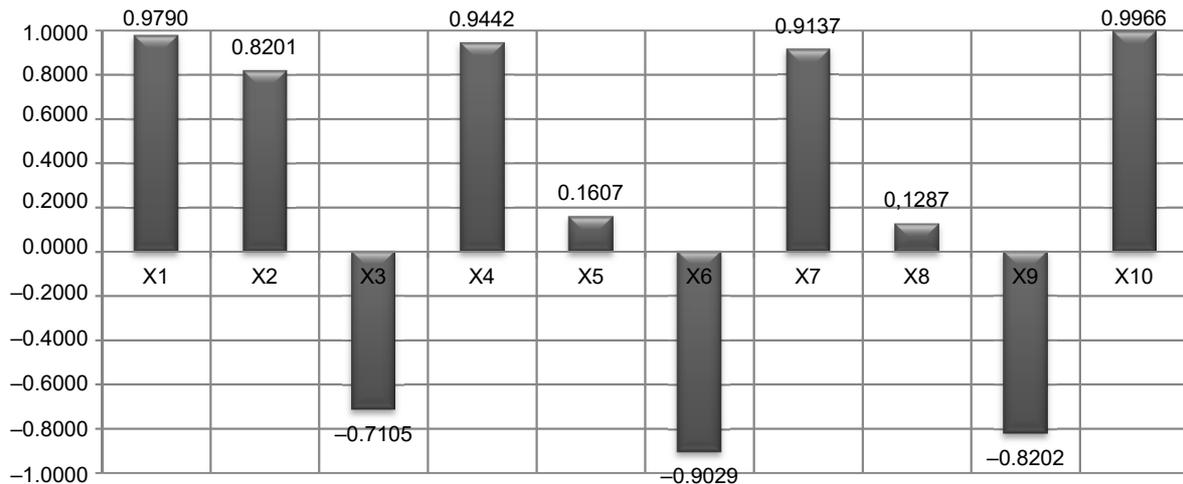


Fig. 1. Pearson's correlation coefficient for air transport passenger volume in Poland (standard of living)  
Source: own compilation based on data from the Polish National Statistical Office.

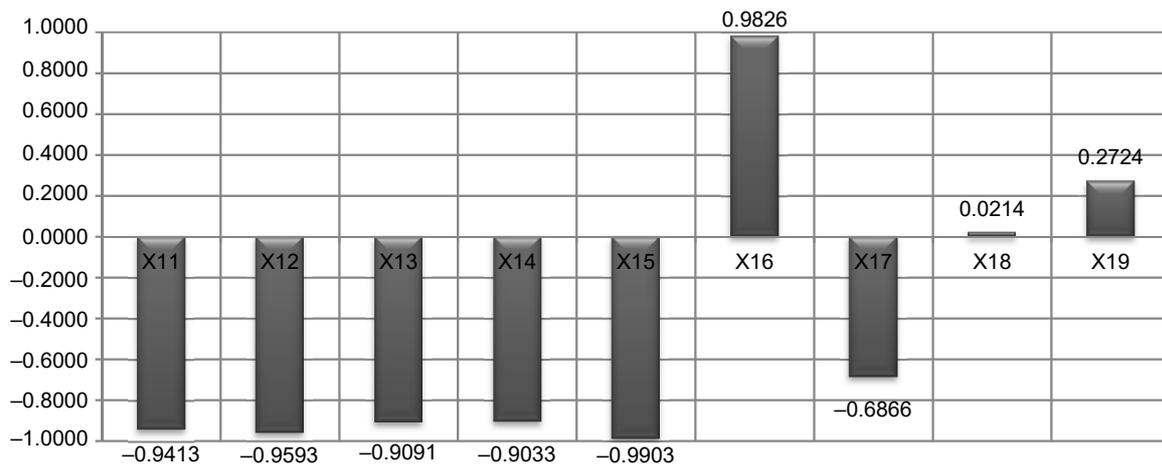


Fig. 2. Pearson's correlation coefficient for air transport passenger volume in Poland (demographics)  
Source: own compilation based on data from the National Statistical Office.

As it transpires from Fig. 2, only one variable  $x_{16}$  shows very strong positive correlation, which means that in 96.55% a change in passenger volume is conditioned by changes in post-working age population to population total. Variables  $x_{18}$  and  $x_{19}$  show very weak and weak positive correlation. Most of the studied variables show very strong negative correlation. The highest value of the coefficient was determined for working age population to population total – 98.07% and male population to population total – 92.03%. Moderate negative correlation was observed for  $x_{17}$ .

Among the group of variables displayed in Fig. 3 very strong correlation was identified for only one variable, that is  $x_{24}$ . This indicates that in 67.82% a change in passenger volume reflects a change in the consumer goods and services price indicator. Other variables show very weak correlation, apart  $x_{22}$  demonstrating moderate correlation.

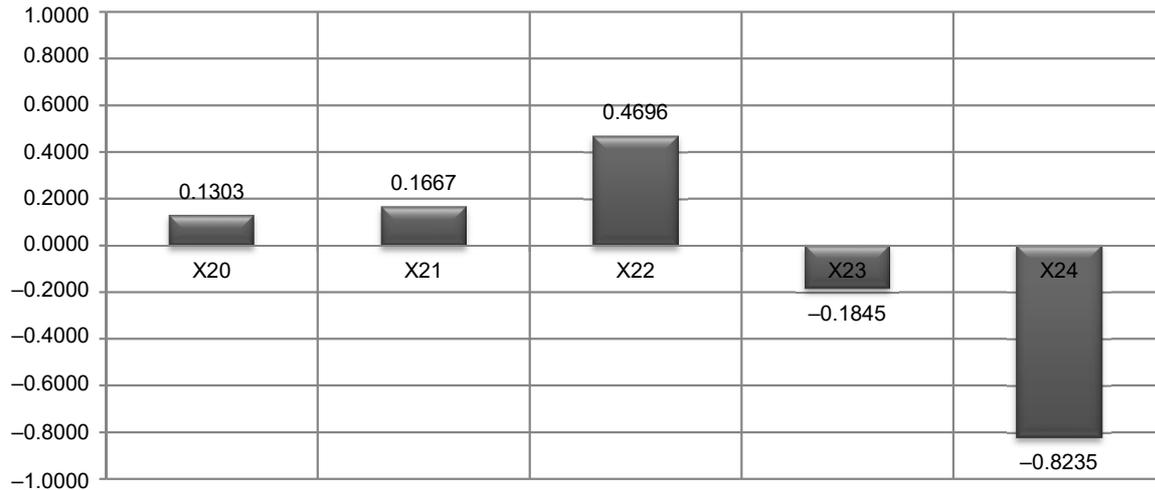


Fig. 3. Pearson's correlation coefficient for air transport passenger volume in Poland (business climate)  
Source: own compilation based on data from the Polish National Statistical Office.

## DETERMINANTS OF DEMAND BY PROVINCES

Figure 4 presents total Polish air passenger traffic by all provinces which have airports. These are:

- Masovia province: Chopin Airport in Warsaw, Warsaw Modlin Airport, Radom Airport,
- Lesser Poland province: Krakow Balice Airport,
- Pomeranian province: Gdansk Airport,
- Silesian province: Katowice Pyrzowice Airport,
- Lower Silesian province: Wroclaw Starachowice Airport,
- Greater Poland province: Poznan Lawica Airport,
- Subcarpathian province: Rzeszów Jasionka Airport,
- West-Pomeranian province: Szczecin Goleniow Airport,
- Lublin province: Lublin Airport,
- Kuyavian-Pomeranian province: Bydgoszcz Airport,
- Lodz province: Lodz Airport,
- Warmia-Masuria province: Olsztyn Mazury Airport,
- Lubusz province: Zielona Gora Babimost Airport.

As indicated in Fig. 4, air transport services in the Warmia-Masuria province were launched in 2016 (the construction of Mazury Airport was completed towards the end of 2015). For this reason, the province was excluded from further analysis.

Due to high passenger mobility connections between passenger traffic in individual provinces and lack of relevant numerical data, there is no way to analyze the links between them. Therefore, all-Poland statistical data were used to determine Pearson's correlation coefficient (Tables 2–4).

Analysis of the above coefficients reveals that very weak, weak and moderate correlation exists between air passenger volume in particular provinces and the variables  $x_5$ ,  $x_8$  (excluding the Kuyavian-Pomeranian and Lubusz provinces),  $x_{18}$  (excluding the Lubusz province),  $x_{19}$  (excluding the Greater Poland),  $x_{20}$ ,  $x_{21}$ ,  $x_{22}$  (excluding the Lodz and Silesia provinces) and  $x_{23}$ .

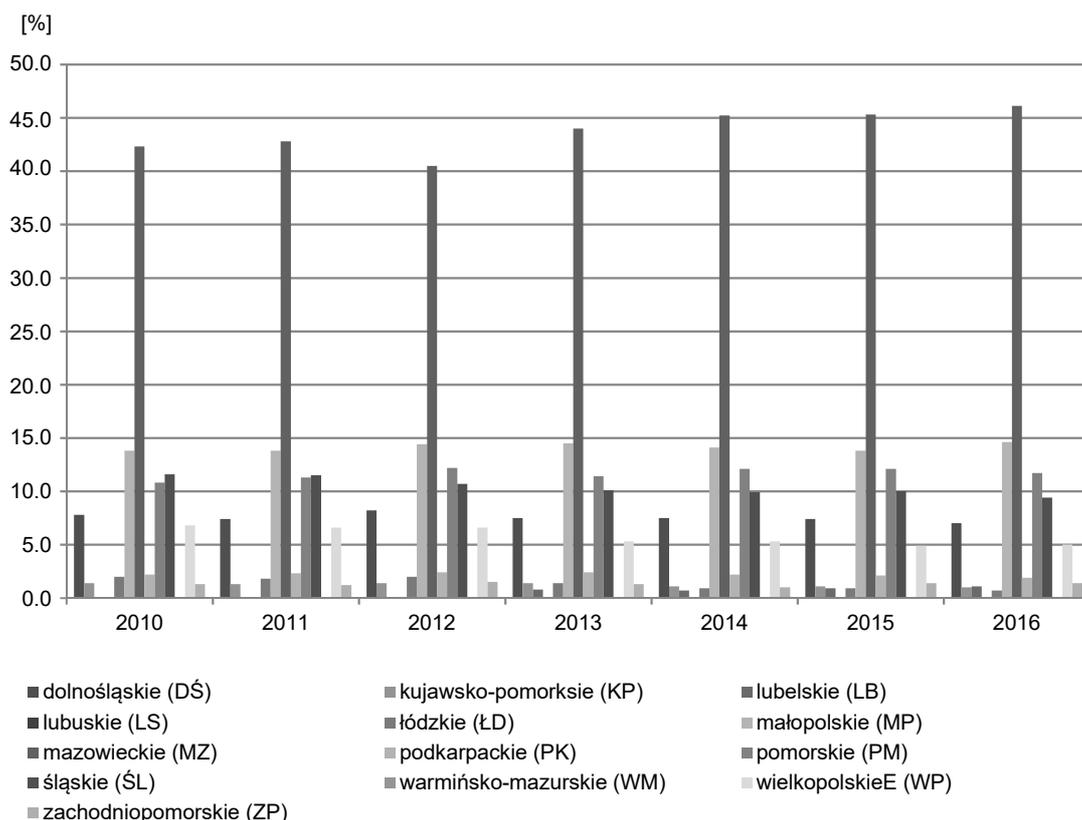


Fig. 4. Province-wise percentage share in total air passenger traffic in Poland in 2010–2016 (Poland = 100%)  
Source: own compilation based on data from the Polish National Statistical Office.

Table 2. Pearson's correlation coefficient for air passenger volume by provinces (standard of living)

Province	Correlation coefficient for variables									
	X <sub>1</sub>	X <sub>2</sub>	X <sub>3</sub>	X <sub>4</sub>	X <sub>5</sub>	X <sub>6</sub>	X <sub>7</sub>	X <sub>8</sub>	X <sub>9</sub>	X <sub>10</sub>
DŚ	0.9630	0.7693	-0.7616	0.9456	0.2033	-0.9136	0.9296	0.2535	-0.7507	0.9693
KP	0.6142	0.2747	-0.5607	0.6317	0.1804	-0.6206	0.6704	0.6272	-0.2401	0.6070
LB	0.9426	0.9227	-0.6893	0.9285	0.3962	-0.8848	0.9125	0.2306	-0.7407	0.9445
LS	0.6212	0.3749	-0.8156	0.6901	0.2313	-0.7240	0.7340	0.6054	-0.1208	0.5194
ŁD	-0.8401	-0.9484	0.6628	-0.8335	-0.3773	0.8083	-0.8010	0.0009	0.6861	-0.8178
MP	0.9725	0.8078	-0.6922	0.9364	0.1764	-0.8945	0.9073	0.1383	-0.7985	0.9967
MZ	0.9721	0.8963	-0.6922	0.9395	0.2313	-0.8944	0.9068	0.0980	-0.8350	0.9839
PK	0.9780	0.7501	-0.8795	0.9862	0.2541	-0.9781	0.9844	0.3539	-0.5943	0.9503
PM	0.9849	0.8064	-0.7720	0.9605	0.1525	-0.9303	0.9333	0.1489	-0.7830	0.9872
ŚL	0.9189	0.8196	-0.5790	0.8619	0.0539	-0.8032	0.8153	-0.0234	-0.9168	0.9476
WP	0.5772	0.2498	-0.2045	0.4710	-0.4458	-0.4203	0.4024	-0.3213	-0.7475	0.6817
ZP	0.7788	0.5683	-0.4107	0.7189	0.0369	-0.6485	0.6971	0.1942	-0.7823	0.8416

Explanations see Fig. 4.

Source: own compilation based on data from the National Statistical Office.

Table 3. Pearson's correlation coefficient for air passenger volume by provinces (demographics)

Pro- vince	Correlation coefficient for variables								
	X <sub>11</sub>	X <sub>12</sub>	X <sub>13</sub>	X <sub>14</sub>	X <sub>15</sub>	X <sub>16</sub>	X <sub>17</sub>	X <sub>18</sub>	X <sub>19</sub>
DŚ	-0.9160	-0.9363	-0.8810	-0.9121	-0.9600	0.9647	-0.7293	-0.0407	0.2357
KP	-0.5098	-0.5425	-0.4614	-0.6119	-0.5716	0.5941	-0.7889	-0.3463	-0.0223
LB	-0.9664	-0.9727	-0.9500	-0.8551	-0.9724	0.9574	-0.6887	-0.0228	0.1004
LS	-0.5310	-0.5560	-0.4930	-0.7066	-0.5309	0.6003	-0.9201	-0.6808	-0.1612
ŁD	0.8853	0.8825	0.8818	0.7820	0.8671	-0.8608	0.5037	0.0017	-0.0298
MP	-0.9264	-0.9466	-0.8915	-0.8950	-0.9854	0.9753	-0.6718	0.0320	0.2268
MZ	-0.9710	-0.9813	-0.9491	-0.8838	-0.9968	0.9827	-0.6614	0.0369	0.2492
PK	-0.8871	-0.9160	-0.8409	-0.9735	-0.9421	0.9695	-0.8605	-0.2785	0.0040
PM	-0.9317	-0.9523	-0.8963	-0.9335	-0.9807	0.9853	-0.7220	-0.0502	0.2383
ŚL	-0.9289	-0.9361	-0.9115	-0.8040	-0.9543	0.9288	-0.6034	0.1276	0.4751
WP	-0.4545	-0.4849	-0.4097	-0.4875	-0.5944	0.5644	-0.1596	0.4120	0.6186
ZP	-0.7701	-0.7839	-0.7451	-0.6492	-0.8180	0.7825	-0.5807	0.1695	0.4970

Explanations see Fig. 4.

Source: own compilation based on data from the Polish National Statistical Office.

Table 4. Pearson's correlation coefficient for air passenger volume by provinces (business climate)

Pro- vince	Correlation coefficient for variables				
	X <sub>20</sub>	X <sub>21</sub>	X <sub>22</sub>	X <sub>23</sub>	X <sub>24</sub>
DŚ	0.0276	0.1060	0.3957	-0.2732	-0.8163
KP	-0.5681	-0.5158	-0.2871	-0.7029	-0.4271
LB	0.1523	0.2261	0.4736	-0.1813	-0.9204
LS	-0.3925	-0.3400	-0.1561	-0.3313	-0.5011
ŁD	-0.4006	-0.4678	-0.6503	-0.1334	0.8858
MP	0.0858	0.1248	0.4265	-0.2446	-0.8156
MZ	0.2307	0.2687	0.5508	-0.0911	-0.8746
PK	-0.1399	-0.0733	0.2173	-0.3612	-0.8157
PM	0.1060	0.1482	0.4498	-0.1734	-0.8200
ŚL	0.3331	0.3130	0.6138	0.0359	-0.7683
WP	0.1376	0.0550	0.3411	-0.1236	-0.2178
ZP	0.0185	0.0213	0.3119	-0.3080	-0.5942

Explanations see Fig. 4.

Source: own compilation based on data from the Polish National Statistical Office.

Changes in province-wise passenger volume depend on the following variables:

- Lower Silesia:  $x_1$  – 92.74%,  $x_4$  – 89.42%,  $x_{10}$  – 93.95%,  $x_{15}$  – 92.16%,  $x_{16}$  – 93.06%;
- Kuyavia-Pomerania:  $x_{17}$  – 62.24%;
- Lublin province:  $x_{11}$  – 93.39%,  $x_{12}$  – 94.61%,  $x_{15}$  – 94.56%;
- Lubusz province:  $x_3$  – 66.52% i  $x_{17}$  – 84.66%;
- Lodz province:  $x_2$  – 89.95%,  $x_{11}$  – 78.38%,  $x_{12}$  – 77.88%,  $x_{13}$  – 77.76%;

- Lesser Poland:  $x_1 - 94.58\%$ ,  $x_{10} - 99.34\%$ ,  $x_{15} - 97.10\%$  and  $x_{16} - 95.12\%$ ;
- mazowieckie:  $x_1 - 94.50\%$ ,  $x_{10} - 96.81\%$ ,  $x_{11} - 94.28\%$ ,  $x_{12} - 96.29\%$ ,  $x_{15} - 99.36\%$ ,  $x_{16} - 96.57\%$ ;
- Subcarpathian province:  $x_1 - 95.65\%$ ,  $x_4 - 97.26\%$ ,  $x_6 - 95.67\%$ ,  $x_7 - 96.90\%$ ,  $x_{14} - 94.77\%$ ,  $x_{16} - 93.99\%$ ;
- Pomerania:  $x_1 - 97.00\%$ ,  $x_4 - 92.26\%$ ,  $x_{10} - 97.46\%$ ,  $x_{15} - 96.18\%$ ,  $x_{16} - 97.08\%$ ;
- Silesia:  $x_{10} - 89.79\%$ ,  $x_{12} - 87.63\%$ ,  $x_{15} - 91.07\%$ ;
- Greater Poland:  $x_9 - 55.86\%$ ;
- West-Pomerania:  $x_{10} - 70.83\%$ ,  $x_{15} - 66.91\%$ .

## CONCLUSIONS

Analysis of relationships between the volume of passengers using air transport services in individual airports indicates that the strongest correlations occur in the category relating to the standard of living: with very strong correlation – 42.50%, strong – 25.83%. As it comes to demographic indicators, a very strong correlation was observed in 41.67% of cases, and strong in 15.00%. The weakest correlations occurred in the category of business climate indicators – 5.83% showing very strong and 2.50% strong correlation. Similar correlations exist for the all-Poland data.

The findings indicate that both country-wise and province-wise, the following variables show very weak, weak or moderate correlation: average monthly real pension and disability pension gross paid from the non-agricultural social security fund, average monthly nominal pension and disability pension of individual farmers gross (strong correlation for the Kuyavian-Pomeranian and Lubusz provinces), fertility rate (strong correlation for the Lubusz province), international migration balance (strong correlation for the Greater Poland province), business climate indicator for construction industry, business climate indicator for production industry, business climate indicator for trade (strong correlation in case of the Lodz and Silesian provinces) and GDP fixed prices.

This line of research will be taken further to investigate the mechanisms underlying the correlations between factors indicated in the study, which are expressed as regression functions. The research will be based on variables showing strong and very strong positive and negative correlations for the all-Poland and province-wise model.

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**Summary.** For many years now, demand for air passenger services has continually shown an increasing trend. Researchers specializing in transport economics tirelessly seek to identify economic and non-economic determinants of demand for transport services. Therefore, this paper aims to analyze dependencies between air passenger volume in Poland and in selected provinces specifically, and the standard of living, and other demographic and economic situation variables. The findings allowed to identify determinants of air passenger transport demand. The research data for the years 2010–2016 were retrieved from the Polish National Statistical Office.

