

Regression in Personal Air Transport of Passengers Evolution at Selected Airport Time Series Method

Regresija u osobnom zračnom prijevozu putnika - razvoj metode vremenskih serija u odabranoj zračnoj luci

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Summary

The content of the paper is supported by programme environment MATLAB, where algorithms can be identified and consequently simulate seasonal (time) elements of personal air transport in which the period of time series equals standard time length or its multiple. The main aim of the paper is to show the mutuality of previous calendar constants of time series with highlighting the estimation of prognosis of personal air transport effectiveness prognosis.

Sažetak

U ovom radu koristi se program zaštite okoliša MATLAB, kojim se algoritmi mogu identificirati i time simulirati sezonski (vremenski) elementi osobnog zračnog prijevoza, u kojima je razdoblje vremenskih serija jednako standardnoj duljini vremena ili njenom višekratniku. Glavni cilj rada je pokazati uzajamnu povezanost prethodnih kalendarskih konstanti vremenskih serija s naglaskom na procjenu učinkovitosti prognoze osobnog zračnog prometa.

KEY WORDS

passenger in air transport
regional air transport provider
square matrix
monthly variations
periods
deterministic system
statistic model
regression model

KLJUČNE RIJEČI

putnik u zračnom prijevozu
regionalni zračni prijevoznik
kvadratna matrica
mjesečne varijacije
razdoblja
deterministički sustav
statički model
regresijski model

INTRODUCTION

The significance of air transport is based on its speed, operation ability, comfort and possibility to cross big distances as well as quick technical development. Air transport has to react to the development of production force, development of aircraft technology, ground security systems by the modernisation of airport equipment within an appropriate timeframe.

The problem of number transported passengers, their diversity, as well as following their customs is a problem which has been solved in academic and scientific communities along with being solved in practice itself. Air transport providers and airports follow the numbers of transported passengers; define their predictions, which are necessary in the creation of long-term intentions of the development of the transport and airports. This indicator is one of the most important factors for air transport providers to decide about the number and frequency of lines among different destinations as well

as about the fact, if those lines would stay in the flight plan or be cancelled. Equally important, this indicator plays a role in making code-share contracts among different providers. These contracts serve the providers as means to enlarge the line networks or they are enabled to use the network of contracting partners and sell tickets to them as if they were their own, increasing the number of transported passengers. Based on these types of contracts and understanding their benefits, there were several attempts to create multilateral partnerships, known as world flight alliances, in the period of 1989-2002. Historically it can be stated that only those world alliances, which have had wide participation in north-Atlantic market, Europe and recently also in Asia have become successful. It has been north-Atlantic region which has prevailed in the transport of passengers in intercontinental and intracontinental connections in long term.[6]

The most important indicator which influences further strategic control and development is the number of interested people in air transport as well as the prediction of its decrease or increase for the airports. One example could be M. R. Stefanik airport in Bratislava, when the intentions to build a new terminal got its realistic shape around 2003, when air traffic provider Sky Europe Airlines PLC established itself on Slovak market. This fact was at the same time one of the impulses of the development of air transport in Slovakia when the number of passengers grew in jumps annually.[10] In 2002 the airport recorded 371 631 a year, in 2003 it was 493 917 passengers, in 2004 their number increased to 893 614 passengers (yearly growth 1,86), in 2005 it was 1 326 493 passengers (yearly growth 1,48) and in 2006 it was almost 2 million of passengers – exactly 1 937 642 (yearly growth 1,41), of which 47,52% of transported passengers of this airport used the services of SkyEurope Airlines. It can be said that the number of passengers has become the existential question according to the experience of other international and regional airports in Slovakia, therefore the application of the below mentioned method can significantly speed up and ease their decision-making process in the area of their development or direction. This method clearly shows the fact that management of airlines, as well as airports, does not rely on blind trust or probable expectation of the number of transported passengers and they could support their intentions by a clear mathematical method in future [9].

Time causality and cyclic changes in the number of air transported passengers in each calendar year is the rule, which is based on yearly (seasonal) periods. Accidental manifestations, which have importance of non-stationary influences, have supported the motivation to devote attention to mathematically describable expressions of such periodical changes on the air transport effectiveness. In most cases it is possible to create mathematical models which can existing changes to approximate on the bearable values. This is the reason why existing methods based on the theories of time series enable to predict the following state at the beginning [3]. Problems of investigate to reflect basic notions of time series in connection with their practical use in the area of identification of personal air transport quality and its model. Time functions, which are basic analytical tools, enable us to substitute numeric form by which the number of passengers is expressed by successiveness of time impulses. It means that impulses ordered in time into a series shifted in time increase enable to create a function of their peaks. Programme MATLAB: *Title Time Series Regression of Airline Passenger* [1] has been used in the following procedures [2],[3].

TIME SERIES METHOD IN THE EVOLUTION OF PASSENGER AIR TRANSPORTATION

In the observed case, time series are created by values, the set of which is the result of observation in the following direction: calendar past – present. In the following description of the evolution of air transport it is supposed that time interval between measurements is the same while discretion with

equidistant step is accepted. The main task of the performed analytical – synthetic research is to show the possibility of actual use of time series to predict future values [2]. Seasonal element of time series, the period of which equals standard element of calendar time (hour, day, week, month, year) or its constant multiple is important to solve the task. Operations with time series has been thoroughly described [8]. The method of time series in the synthesis of the model of transported passengers by air effectiveness accepts concrete knowledge of the number of passengers in months and years. It is supposed that a regional airline provider transported in the period 2000, 2001 to 2011 in different months the numbers of passengers which create a square matrix. The data has been adapted from the statistic records of Kosice airport [4][1].

```
y = [785 846 847 584 528 445 846 232 797 820 294 186 Jan
236 367 235 254 257 256 367 325 840 408 248 245 Feb
325 409 540 455 425 562 409 402 891 308 330 286 Mar
235 316 325 328 321 327 316 235 119 396 383 356 Apr
369 454 359 325 256 267 454 526 137 394 465 389 May
841 860 987 635 654 632 860 785 141 473 470 478 Jun
956 462 452 396 332 325 462 425 535 401 503 458 Jul
374 388 358 564 458 457 388 405 321 799 345 258 Aug
369 749 425 214 215 215 479 425 860 472 801 658 Sept
125 512 421 385 325 325 512 524 648 946 413 452 Oct
396 602 568 425 235 248 602 254 312 282 395 354 Nov
941 569 417 415 125 147 569 521 446 465 268 247] Dec
```

The method of transfer of depicted set into time series has been performed in programme environment MATLAB according to the following methodology [1]:

Matrix columns are matched with years:

```
yr= repmat((2000:2011),12,1)
```

Sequence (time) of calendar months in years is determined by command:

```
mo= repmat((1:12);1,12)
```

Time series (calendar) of transported passengers is then:

```
time = datestr(datenum(yr(:),mo(:),1))
```

Numbers of passengers are discrete values of time series (sequence) expressed by the command:

```
ts = timeseries(y(:),time,'name','AirlinePassengers')
```

By standardisation of time series (ts-time series) into normative calendar form is used for formal calendar form:

dd-mmm-yyyy (days - months - years) and command is sent:

```
ts.TimeInfo.Format = 'dd-mmm-yyyy'
```

time series creates a collection which can be used as a command:

```
tscol = tscollection(ts); Shows:
```

plot(ts), with the use of Tools in the figure Matlab, straight line is found and its equation Basic Fitting is formed:

a straight line is the output of the solution:

```
y= - 0.16*x+480
```

The difference of input (x=0) and output numbers of passengers show the decrease (degradation) of transported people.

Fig. 1 draws attention to the beginning of the series ('0') which is presented by calendar year 2000.

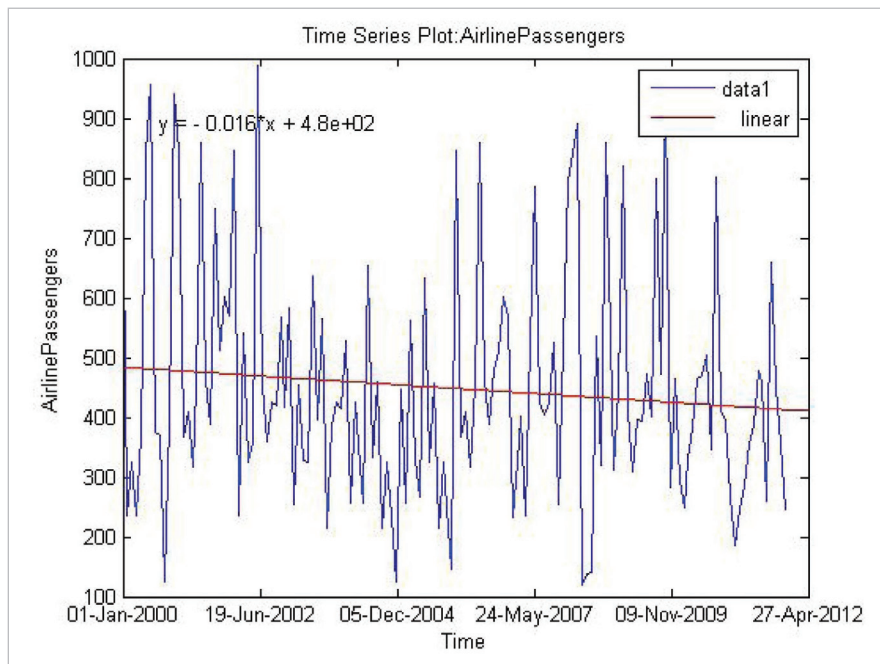


Figure 1 Graphic ordering of passenger transport set into time series

TRANSPORT TRENDS

Transport trend can have gradation or degradation character which can be expressed by a straight line, exponent line or other function. Monthly magnitudes of transported passengers are variable and differ in size considerably. Because the equation of the straight line requires work with large numbers, it is suitable to differ between magnitudes with the help of logarithms [7].

Logarithmic coordinates are adjusted by a scale to the number of passengers by the following command:

```
set(gca,'YScale','log')
```

The set is matched to the time series as constants which accept the collection in established logarithms:

```
tscol = addts(tscol, log(ts.data), 'logAirlinePassengers')
```

Next, monthly variations of transported passengers are considered in observed years. Calendar time is dated backwards by the following command:

```
t = reshape(datumum(time),12,12)
```

Command 'reshape' enables the user to transform the matrix of 'calendar' years according to selected month, which shows the required number of passengers. In the given case the selected month is July. July is comparative month for numeric evaluation of effectiveness.

Meaning of matrix 't' elements: first element 730486 : 7 - July,30 – calendar day of July, 486 – number of days from the beginning of coordinate system (year 2000) towards the past, i.e. end of August, year 1998. Total: 730486+31=730517,...

Columns 't_i' (i – serial column of matrix) expressing growing time. After filling the year with calendar days the beginning of the following year is obtained: 731003, which is in the second column ('t_i' where i=2).

Differences of days in lines present growing years. Example: 730486 – 730852 = 366 days.

Meaning: command 't' present actual calendar time which can be divided into periods.

In the following step, matrix 'y' is taking a logarithm due to more suitable graphic description:

$\log y = \log(y)$, Result is the decrease of time series constants.

Its mean values are:

```
ymean = repmat(mean(logy),12,1)
```

Differences between logy and ymean are defined where defined mean values are:

```
ydifff = logy - ymean
```

Value expression of the difference in monthly coordinates is:

```
x = yr + (mo-1)/12
```

```
plot(x,ymean,'b-';x,ymean+ydifff,'r-')
```

```
title('The monthly variations in the years','FontSize',15)
```

```
xlabel('Years','FontSize',13)
```

```
ylabel('Medium differential value','FontSize',13)
```

Knowledge of daily number of passengers is necessary for the model synthesis, e.g. monthly effectiveness, see Fig. 2. In the observed case, there are yearly data available, which differ in data in periods:

0.period (2001-2000):6.249-6.031 = 0.218;

I.period:2002÷2001:6.127-6.031 = 0.122;

II.period:2003÷2002:5.981-6.127 = 0.146;

III.....= 0.227;

.....= 0.027;

.....= 0.431;

.....= 0.23;

.....= 0.017;

.....= 0.171;

X.period:2010-2009:5.965-6.17 = 0.205;

XI.period:2011-2010:5.838-5.96 = 0.127;

A table highlights the idea of cyclic demonstration of numbers of participants of transport:

```
x=0:1:10;ye=[0.218 -0.122 -0.146 -0.227 0.027 0.431 -0.23 0.017  
0.171 -0.205 -0.127];
```

```
[x,ye]; Record:
```

```
plot(x,ye,
```

```
title('Medium values (log) AirlinePassengers in periods','FontSize',15),
```

```
ylabel('Values after period of difference','FontSize',13),xlabel('Periods','FontSize',13),[1]
```

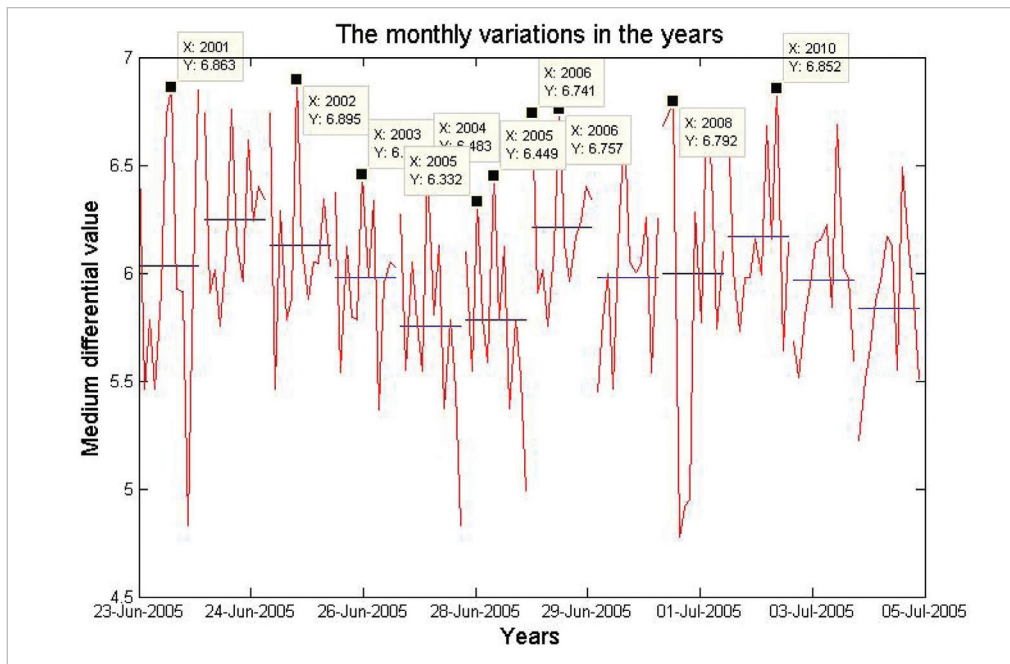


Figure 2 Distribution of mean value of number of passengers in selected years, months

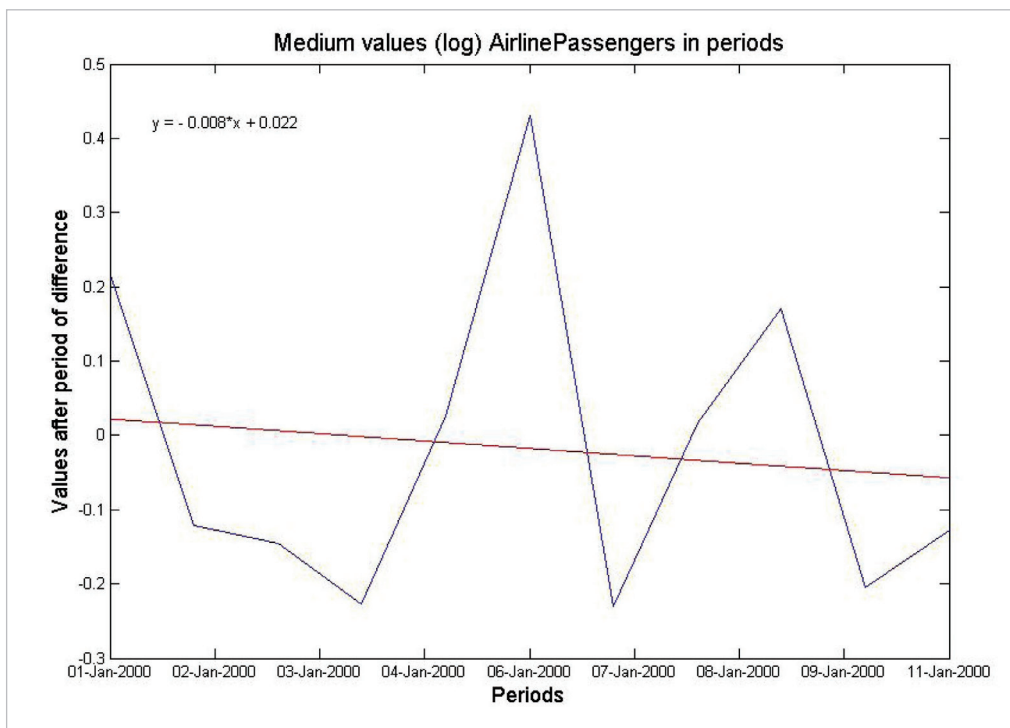


Figure 3 Distribution of passenger numbers in the days of January in calendar year 2000

Fig. 3 shows favourable values (above the red line) and unfavourable values, which influence the effectiveness of relevant destination in one month. Positive values are (distance of relevant point: $a_i = (p_i - p_{0i})$, $a_1 = 0.195$; $a_2 = 0.045$; $a_3 = 0.446$; $a_4 = 0.0532$; $a_5 = 0.2127$;

Table 2 is drawn:
 $i = 1:5$;
 $a = [a_1 \ a_2 \ a_3 \ a_4 \ a_5]$;
 $[i; a]$;
 $plot(i, a)$

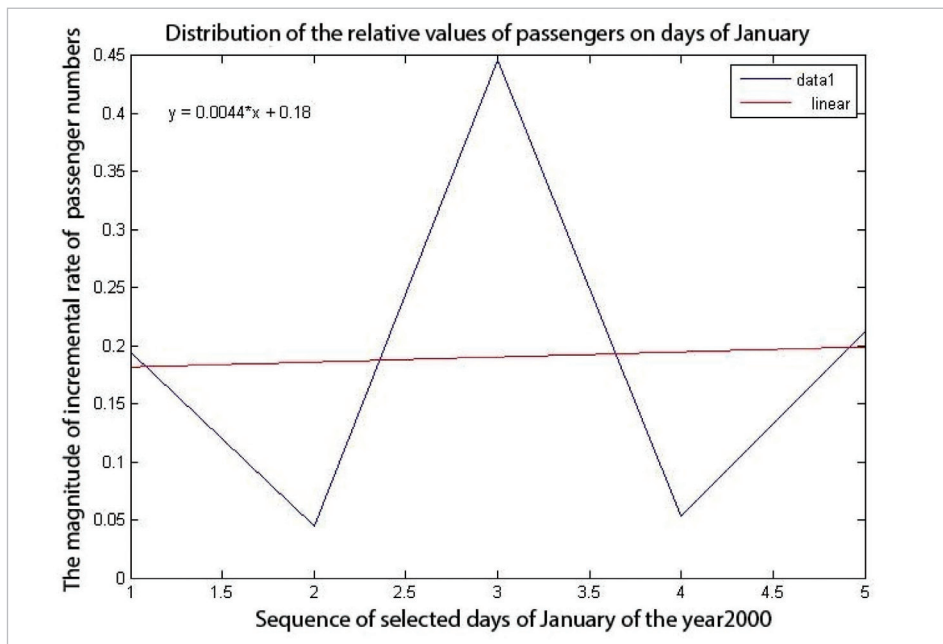


Figure 4 Incremental rate of passenger number in the period of 7 days in January 2000

title(' Distribution of the relative values of passengers on days of January','FontSize',15),
ylabel(' The magnitude of incremental rate of passenger numbers','FontSize',13),
xlabel('Sequence of selected days of January of the year2000','FontSize',13),

Equation $Y=0.0044*x + 0.18$ is the model of the average of the increase of passenger growth average in the given month and calendar year. It can be seen that in the month of January there exists progress of the increase of air transport. This problem can be expanded by further considerations in which it is possible to prognoses the development of air transport from the wider angle of view, in complex range of the use by its users.[1]

CONCLUSION

On the basis of above mentioned method, after its practical application on an actual set of transported passengers at selected regional airport, it is possible to show that the change of the number of transported passengers, its decrease or increase is the phenomenon, which is influenced by accident and has impact on all area of air transport. A mathematical model which has been obtained by the analysis of the reason of the decrease does not research it, it only statistically evaluates the existing state, however, it is necessary to search for other concrete reason or actual event which has caused this state. From the viewpoint of the evaluation of outputs of the used method it can be confirmed that with correct interpretation

and its possibilities, the programme MATLAB enables the ability to create mathematical models of such a complex system [3] as passenger air transport is. Obtained outputs, which are presented by mathematical models, can be used in the creation of the strategies of management of air transport providers and also enable the transfer to a posterior evaluation of the quality of passenger air transport. This problem is the subject of further detailed investigation of continuing research, when obtained results and used method can open new dimension of looking into this problem in scientific and academic communities.

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