METHODS USED IN THE SEASONAL VARIATIONS ANALYSIS OF TIME SERIES

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Abstract

Statistical data established in dynamic or time series differ from other data sets being ordered according to the time variable. Herein lies the importance of studying the time series. You can determine the important role of the time factor in socio-economic phenomena as well as in other areas. In fact, in the economic and social life, a great part of the data subject to research are provided as time series.

An important component of time series together with *trend*, *cyclical and random oscillations* are s*easonal fluctuations*.

The paper presents methods through which seasonal fluctuations can be analyzed.

Keywords: oscillations, series, model index (ratio) of seasonality, mass phenomena, interferences, frequency.

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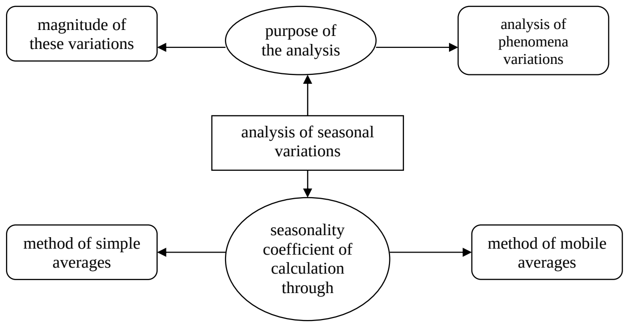
Seasonal fluctuations are periodical series that are repeated on a more or less regular basis in each period, or every year. Periodic series really exist only in theory, but seasonal variations are quite close to this model. The assumption underlying the model construction is that the regular series are caused due to systematic and not accidental causes.

One can cite many examples of seasonal variations: car sales as well as soft drink', temperatures or rainfall volume recorded over a year, etc. Systematic causes that produce such variations are repeated periodically, although some deviations may occur.

The analysis of the seasonal variations has, in our opinion, an obvious practical interest. The analysis allows, for example, to determine when it is time to change seasons stock up. It allows to explain the variations that are found in some areas of production, movement of goods, etc.

Note that similar to seasonal variations, i.e periodic variations can be found in some areas of economic life, for example in the production and consumption of energy, and during a week or during the day.

Scheme of components for seasonality analysis



First, it is useful to recognize the magnitude of the change, finding ways to measure them and calculate an index of seasonality, valid for a whole series of annual periods. *Secondly*, it may be useful to know the evolution of mass phenomena by eliminating seasonal variations.

The idea behind the calculation of seasonal variations consists in the possibility and usefulness of determining that part of the annual total that is due to each of the twelve months of the year. The random factor that can arise in a given year is considered independently of what might occur next year. Whether in a year there is a rainy July, this random factor is considered independent of any factor that might happen in July of the following year, or in any other July. If they are added for July from a number of years, the perturbations caused by casual factors will compensate each other. If we eliminate the trend, what will remain will be seasonal variation which can be expressed by an index or coefficient of seasonality.

To calculate the **index (coefficient) of seasonality,** there are several *methods.* It first presents the method of simple averages because it helps to explain the idea behind the other methods in an elementary form. It should be noted that in practice the simple average method is used less.

If there is a series of monthly data (on two years, but the number of monthly data can be extended, the core of calculation procedures remain the same), **Table 1**.

Column 03 contains the sum of the lines of the two years, and column 04 the arithmetic average of these months. Column 04 can be interpreted as data from which it has been deleted the influence of random phenomena, and of course, this assumption will have a more solid basis as the number of years taken into consideration would be higher. Given that by calculating the averages in 04 column, random influences were eliminated, we believe that these figures include only components of monthly seasonality trend.

To find out the effect of seasonality, therefore will eliminate the trend. It is employed the *Method of the smallest squares.*

Monthly averages are needed over several years. Example is shown in Table 2.

Monthly data series – over two years for calculations by simple average Method.

Table no.1.

	01	02	03	04	05	06	07
months	year 1	year 2	1+2	$\frac{1+2}{2}$	Trend	Average $\frac{1+2}{2}$ Trend	Seasonality
Jan.	560	780	1340	670	0	670	97,5
Feb.	500	720	1220	610	5	605	88,1
Mar.	450	670	1120	560	10	550	80,1
Apr.	420	660	1080	540	15	525	76,4
May	420	630	1050	525	20	505	73,5
Jun.	480	660	1140	570	25	545	79,3
Jul.	590	730	1320	660	30	630	91,7
Aug.	750	860	1610	805	35	770	112,1
Sept.	860	970	1830	915	40	875	127,4
Oct.	900	980	1880	940	45	895	130,3
Nov.	900	950	1850	925	50	875	127,4
Dec.	850	870	1720	860	55	805	117,2
Total	7680	9480	x	x	x	8250	1200
Average	640	790	x	x	x	687	100

Series of monthly data – over many years

Table no.2.

Year	*x*	*y*	*xy*	x^2
I	-2	520	-1040	4
II	-1	580	-580	1
III	0	540	0	0
IV	1	640	640	1
V	2	790	1580	4
Total	$\sum x = 0$	$\sum y = 3070$	$\sum xy = 600$	$\sum x^2 = 10$

According to the known formulas, it results:

$$a = \frac{\sum y}{n} = \frac{3070}{5} = 614$$

$$b = \frac{\sum xy}{\sum x^2} = \frac{600}{10} = 60$$

$$y' = 614 + 60x$$

b = 60 indicates the annual rise of trend, on average of the 12 months. The rise on a single month will be:

$$\frac{b}{12} = \frac{60}{12} = 5$$

There is an increasing in the trend equivalent with 5 per month (column 05). If the data in column 05 are substracted from the data in column 04 which represent the trend plus seasonality, it results data representing exclusively seasonality (column 06). To calculate the index (coefficient seasonality) each monthly data in column 06 are divided at the respective average (687). Data are obtained from column 07 on seasonality.

The method of mobile averages is the most used method for measuring seasonal variations. Since the variations have, by definition, a periodicity of 12 months, we use the 12-month mobile averages. Mobile average method consists essentially in calculating seasonal component time series trend by dividing the total number of successive values in the series; further on the term factor will still be deleted.

A certain complication in applying the method, occurs because in the calculation of mobile averages there is a periodicity of 12 months (if you are working with data that are quarterly with a periodicity of 4 quarters). We will discuss the first results obtained by calculating centered mobile averages (of mobile provisional averages) to reach the centered mobile averages.

Mobile averages to calculate the seasonal component, the index (coefficient) seasonality (for example)

Table no.3.

Year	Month	Time series	Provisional mobile average on 12 months	Provisional mobile average on 24 months	Centered mobile average on 12 months	Index (seasonal+ random)	Year	Month	Time series	Provisional mobile average on 12 months	Provisional mobile average on 24 months	Centered mobile average on 12 months	Index (seasonal+ random)
I	I	280	-	-	-	-	III	I	382	4756	9581	399	1,37
	F	271	-	-	-	-		F	344	4823	9758	407	0,96
	M	290	-	-	-	-		M	365	4933	10028	418	0,94
	A	411	-	-	-	-		A	512	5095	10369	432	0,87
	M	281	-	-	-	-		M	393	5274	10740	448	1,18
	I	308	-	-	-	-		I	394	5466	10078	462	0,88
	I	284	4867	9990	416	0,68		I	361	5612	11322	472	0,85
	A	384	5123	104440	435	0,88		A	466	5710	11528	480	0,76
	S	449	5317	10790	450	0,99		S	540	5818	11704	488	0,97
	O	518	5473	11108	463	1,12		O	571	5886	11812	492	1,10
	N	590	5635	11354	473	1,25		N	599	5926	11811	492	1,18
	D	801	5719	11481	478	1,68		D	685	5885	11694	487	1,22
II	I	536	5762	11532	481	1,11	IV	I	480	5809		480	
	F	456	5770	11514	580	0,97		F	452	5711		470	
	M	446	5774	11417	476	0,94		M	433	5563	11520	455	
	A	573	5673	11222	468	1,22		A	552	5356	11274	437	1,41
	M	365	5549	10913	455	0,80		M	352	5127	10919	414	1,00
	I	351	5364	10466	436	0,81		I	318	4822	10483	39	0,96
	I	292	5102	10050	419	0,68		I	263		9949	-	0,95
	A	358	4948	9785	407	0,88		A	318	-	9361	-	1,26
	S	378	4827	9573	399	0,95		S	333	-		-	0,85
	O	394	4746	9431	393	1,00		O	342	-	-	-	
	N	405	4685	9398	392	1,03		N	294	-		-	
	D	539	4713	9469	394	1,02		D	402	-		-	

Calculations / Results:

The first 12-month mobile average falls between June and July and can be used on 1 July. The second interim 12-month mobile average is the sum of terms of the second term of the original series to the thirteenth inclusively (falls on 1 August). Next, do the same, to obtain other provisional mobile averages. To center the provisional mobile averages, we calculate the average of 27 successive terms of mobile averages obtaining mobile averages centered on 12 months. The first mobile average centered on 12-month will fall in mid-July. It is noted that six months after the start of the series and six months after their end, we do not take into account mobile averages. Averages process involves an important loss of information. With a mobile average of 12 months, there is a loss of information on 12 months. Therefore, the application of the process requires consideration of longer series, it is preferable that the application be made on monthly data series and only on the quarterly data series.

As it has been obtained the mobile averages centered on 12 months (it is preferably to be calculated not by dividing the temporary mobile averages on 24 months at 24, but by multiplying with the inverse of 24 respectively with 1/24 = 0.041667), which is the trend. Latter values are reported in terms of the original series, obtaining seasonal factors. + monthly factors.

If all the data are collected and the average of that amount is calculated on each month, we believe that the accidental factor is deleted. The 12 averages can be considered to represent estimates of seasonal adjustment factor, and all must give 12. If not, you can apply a correction factor consisting of the quotient of 12 and the actual amount of averages. Multiplying by 100 the seasonal adjusted factors, we obtain seasonal indices. The 12 indices must be 1200.

There were 48 original observations, and consequently (48-12), 36 seasonal factors + casual factors. For each month are gathered three such factors that make the average multiplied by 100 to get the seasonal indices. Seasonal influence can be eliminated by dividing the original data on each month by seasonal index on that month.

Determination of seasonal indices

	I	F	M	A	M	I	I	A	S	O	N	D
	-	-	-	-	-	-	68	88	99	112	125	168
	111	97	94	122	80	81	69	88	95	100	103	137
	96	94	87	118	88	85	76	97	110	116	122	141
	100	96	95	126	85	82	-	-	-	-	-	-
Total	307	287	276	366	253	248	213	273	304	328	350	446
Averages	102	95	92	122	84	82	71	91	101	109	116	148

Total of averages = 1213

Seasonal indices 101 94 91 120 83 81 70 90 100 108 115 147

Total of indices = 1200, after applying a correction coefficient = 1200/1213=0,989 with which the averages were multiplied.

Conclusions

The study of socio-economic phenomena and processes in terms of their evolution over time is a necessity for businesses, an important condition for economic decision making. In our opinion, it should be a special emphasis on the statistical analysis of the evolution of phenomena, while processing the data time series showing the final evolution of a phenomenon over a period of time.

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