ANALYTICAL METHODS FOR SEASONAL TRENDS OF ROMANIAN FOREIGN TRADE

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Abstract. The statistical mathematical functions offer a variety of options for analyzing economic trends. The practical method of selecting one or the other of these functions is a question whose solution presupposes the prior study of the chronological series being analyzed, followed by the elucidation of these aspects: the element of randomness in trends; components of a trend (the trend itself, the seasonality, the cyclicity, the autoregression, and the residual tendency); the trend in the context of the interdependencies between multiple factors.

We will study whether or not the trend in foreign trade are characterized by a marked seasonal aspect. For the phenomena and processes whose development is related to the season of the year or to some other period, complex statistical mathematical functions that, as a rule, treat all of the above-mentioned aspects are used.

Keyword: foreign trade, exports, imports, statistical-mathematical functions

1. The trend itself

The data for the theoretical and practical methods of representing the separate components of seasonal tendencies will be taken from Table 1, which gives the quarterly value of Romanian imports and exports [6] during 2002-2005.

Quarter	Year	Total	Exports	Imports	Year	Quarter	Total	Exports	Imports
1	2002	6559	2897	3662	2004	1	9674	4329	5345
2		7635	3320	4315		2	11314	4685	6629
3		8458	3757	4701		3	11591	4952	6639
4		9074	3895	5179		4	12637	4969	7668
1	2003	8899	4039	4860	2005	1	11734	5092	6642
2		8406	3458	4948		2	13537	5440	8097
3		9396	4077	5319		3	14252	5932	8320
4		10014	3940	6074		4	15302	5792	9510
Source: Data prepared by from the Romanian National Institute of Statistics (www)									

Table 1. The dynamics of Romanian exports and imports during 2002-2005 (euro million)

In this analysis, the components of the evolving tendencies will first be isolated, and then integrated by means of a more complex function.

In order to separate the trend itself from other factors, we must first eliminate the seasonal aspects, which can accomplished by several methods [7][8]. One of the best-known methods utilized for the quantification of the trend apart from its seasonal components is based on the **seasonal index** determined by calculating the ratio between the mean values of the 2^{nd}, 3^{rd}, and 4^{th} quarters taken in chronological order and the means of the 1^{st} quarter (Table 2).

Specification	Year / Quarter	Exports (euro million)				Imports (euro million)			
		1	2	3	4	1	2	3	4
Initial Values y_x	**2002**	2897	3320	3757	3895	3662	4315	4701	5179
	2003	4039	3458	4077	3940	4860	4948	5319	6074
	2004	4329	4685	4952	4969	5345	6629	6639	7668
	2005	5092	5440	5932	5792	6642	8097	8320	9510
Quarterly values	**Total:**	16357	16903	18718	18596	20509	23989	24979	28431
	AVG:	4089	4226	4680	4649	5127	5997	6245	7108
Seasonal index	*	**1.00**	**1.03**	**1.14**	**1.14**	**1.00**	**1.17**	**1.22**	**1.39**
Unseasoned values y_x^T	**2002**	2897	3223	3296	3417	3662	3688	3853	3726
	2003	4039	3357	3576	3456	4860	4229	4360	4370
	2004	4329	4549	4344	4359	5345	5666	5442	5517
	2005	5092	5282	5204	5081	6642	6921	6820	6842
Source: Data prepared by the Romanian National Institute of Statistics (www)									

Table 2. Data needed to isolate the trend itself

Table 2 also contains data representing exports and imports (y_x), as well as the aseasonal adjusted values y_x^T, which are determined by taking the ratio of the initial y_x values and the corresponding seasonal indices of the respective quarters. [We will use term "aseasonal" to mean values or trends that have been adjusted so as to remove the seasonal component, and the term "deseasonalize" to describe this adjustment.]

The data used for the analysis of the adjusted values (y_x^T), when evaluated by the various statistical mathematical functions -- linear, parabolic, hyperbolic and exponential [2][3]-- indicates that the second-order parabolic function yields the lowest value for the least-squares expression, both for the value of exports and that of imports. From the analysis of the adjusted values (y_x^T) it can be observed that the trend is of the parabolic type, which means that the second-order parabolic function can be used to isolate the trend itself.

2. Seasonal trend

The determination and separation of the seasonal component from the empirical trend can be accomplished with the help of a method [9] consisting of the following steps:

a) The determination of the deviation of the intial values (y_x) from the theoretical values y_x^T, calculated with the aid of the function used to isolate the trend itself (in the given example, the second-order parabolic function);

b) The calculation of the average standard deviations for the 2nd, 3rd, and 4th quarters;

c) The determination of the method by which the standard deviations will be used to calculate the seasonal trend; for this purpose the values of the **indicator** variables (Q_1, Q_2, Q_3, Q_4) shall be defined as:

- for the first quarter of each year $Q_1 = 0$ because the values of that quarter are being used as a basis for comparison; $Q_1 = 0$ for the other quarters as well;
- for the second quarter $Q_2 = 1$ when calculating the values of the Y_x^{TS} complex function for this quarter; for the other quarters $Q_2 = 0$; similarly, $Q_3 = 1$ for the values of the third quarter

of each year and $Q_3 = 0$ for the other quarters; $Q_4 = 1$ for the values of the forth quarter of each year and $Q_4 = 0$ for the other quarters.

We will now use the three steps of the algorithm above to analyze the seasonal trends of Romania's exports and imports between 2002 and 2005.

Table 3 presents the data to be used in the calculation of the standard deviations as well as the corresponding values of the **indicator** variables Q_1, Q_2, Q_3 and Q4.

Year	Quarter	Exports		Imports		Q_1	Q_2	Q_3	Q_4
		$y_x - Y_x^T$	$\left(y_x - Y_x^T\right)^2$	$y_x - Y_x^T$	$\left(y_x - Y_x^T\right)^2$				
2002	1	*	*	*	*	0	0	0	0
	2	171	29399	585	341862	0	1	0	0
	3	499	248726	836	699197	0	0	1	0
	4	522	272211	1166	1360372	0	0	0	1
2003	5	*	*	*	*	0	0	0	0
	6	-161	25913	600	359676	0	1	0	0
	7	327	107123	783	612995	0	0	1	0
	8	54	2951	1337	1787114	0	0	0	1
2004	9	*	*	*	*	0	0	0	0
	10	360	129531	1209	1460666	0	1	0	0
	11	470	220841	964	929662	0	0	1	0
	12	325	105444	1725	2977281	0	0	0	1
2005	13	*	*	*	*	0	0	0	0
	14	456	207524	1579	2493557	0	1	0	0
	15	770	592268	1494	2233321	0	0	1	0
	16	446	199258	2363	5585849	0	0	0	1
Source: Data prepared by the Romanian National Institute of Statistics (www)									

Table 3. Data for the calculation of the standard deviations for the seasonal analysis

The results of the of the standard deviation calculations:

- for the 2nd quarter: $\sigma_{2e} = 147.27$ for exports; $\sigma_{2i} = 53.48$ for imports;
- for the 3rd quarter : $\sigma_{3e} = 74.79$ for exports; $\sigma_{3i} = 42.89$ for imports;
- for the 4th quarter : $\sigma_{4e} = 38.20$ for exports ; $\sigma_{4i} = 13.26$ for imports;

Table 4 presents the Y_x^{TS} values as well as the $y_x - Y_x^{TS}$ deviations, which represent the component of the Y_x^R residual tendency.

The Y_x^R values presented in table 4 can be used to determine the provisional intervals used in the estimate calculation [3][8]. In this situation the standard deviation is determined by the following equation:

$$\sigma_R = \sqrt{\frac{\sum\left(y_x - Y_x^{TS}\right)}{n}} \qquad (1)$$

Year	Quarter x	Exports			Imports		
		Y_x^{TS}	Y_x^R	$\left(Y_x^R\right)^2$	Y_x^{TS}	Y_x^R	$\left(Y_x^R\right)^2$
2002	1	3044	-147	21623	3609	53	2796
	2	3296	24	585	3784	531	282182
	3	3333	424	179720	3908	793	629317
	4	3411	484	233812	4026	1153	1329626
2003	5	3493	546	297577	4174	686	470870
	6	3766	-308	95013	4402	546	298387
	7	3824	253	63760	4579	740	547681
	8	3924	16	260	4750	1324	1751849
2004	9	4173	156	24219	5179	166	27440
	10	4472	213	45215	5474	1155	1334252
	11	4557	395	156142	5718	921	848803
	12	4682	287	82096	5956	1712	2931712
2005	13	4812	280	78545	6224	418	175100
	14	5132	308	95037	6571	1526	2327511
	15	5237	695	482747	6868	1452	2106982
	16	5384	408	166615	7160	2350	5523366
*	*	**Total**		**2022965**	**Total**		**20587876**
Source: Data prepared by the Romanian National Institute of Statistics (www)							

Table 4. The Y_x^{TS} and Y_x^R values for the seasonal analysis

Using the data from Table 4, the Y_x^R index level is:

$$\sigma_{\text{Re}} = \sqrt{\frac{2022965}{16}} = 356 \quad \text{for exports ; } \sigma_{Ri} = \sqrt{\frac{2022965}{16}} = 356 \quad \text{for imports} \qquad (2)$$

For the given analysis, the limits of the interval of the trend are determined by the following expression:

$$Y_x^{TSR} = Y_x^T + Y_x^S \pm \sigma_R = \begin{cases} Y_x^{TS} + \sigma_R \rightarrow \text{upper limit} \\ Y_x^{TS} - \sigma_R \rightarrow \text{lower limit} \end{cases} \qquad (3)$$

For the values of the parabolic function parameters and those of the standard deviations, the complex function which elucidates both the trend itself and the seasonal trend for exports and imports has the following form:

$$Y_{xe}^{TS} = a_e + b_e x + c_e x^2 + \sigma_{2e} Q_2 + \sigma_{3e} Q_3 + \sigma_{4e} Q_4 \qquad (4)$$

$$Y_{xi}^{TS} = a_i + b_i x + c_i x^2 + \sigma_{2i} Q_2 + \sigma_{3i} Q_3 + \sigma_{4i} Q_4$$

Where: $a + bx + cx^2 = Y_x^T$ (the trend itself)

$$\sigma_2 Q_2 + \sigma_3 Q_3 + \sigma_4 Q_4 = Y_x^S \quad \text{(the seasonal trend)}$$

using the corresponding specific values for the exports and imports of our case.

In Table 5, these values are presented for each quarter of the 4 years analyzed, as well as the extrapolations for the quarters of the year 2006.

Year	Quarter	Export			Import		
		$Y_x^{TS} - \sigma_R$	Y_x^{TS}	$Y_x^{TS} + \sigma_R$	$Y_x^{TS} - \sigma_R$	Y_x^{TS}	$Y_x^{TS} + \sigma_R$
2002	1	2688	3044	3400	1757	3609	5462
	2	2940	3296	3651	1931	3784	5636
	3	2977	3333	3689	2055	3908	5760
	4	3056	3411	3767	2174	4026	5878
2003	5	3138	3493	3849	2321	4174	6026
	6	3411	3766	4122	2549	4402	6254
	7	3469	3824	4180	2727	4579	6431
	8	3568	3924	4279	2898	4750	6603
2004	9	3818	4173	4529	3327	5179	7032
	10	4117	4472	4828	3622	5474	7326
	11	4201	4557	4912	3865	5718	7570
	12	4327	4682	5038	4103	5956	7808
2005	13	4456	4812	5167	4371	6224	8076
	14	4776	5132	5487	4719	6571	8424
	15	4882	5237	5593	5016	6868	8721
	16	5028	5384	5739	5307	3609	9012
2006	17	5178	5534	5890	5628	7481	9333
	18	5519	5875	6231	6030	7882	9734
	19	5646	6002	6357	6380	8232	10085
	20	5814	6169	6525	6725	8577	10429
Source: Data prepared by the Romanian National Institute of Statistics (www)							

Table 5. The calculated limits of the intervals of the trend

The graph in Fig. 1 represents the seasonal (Y_x^S) trend for exports and imports.

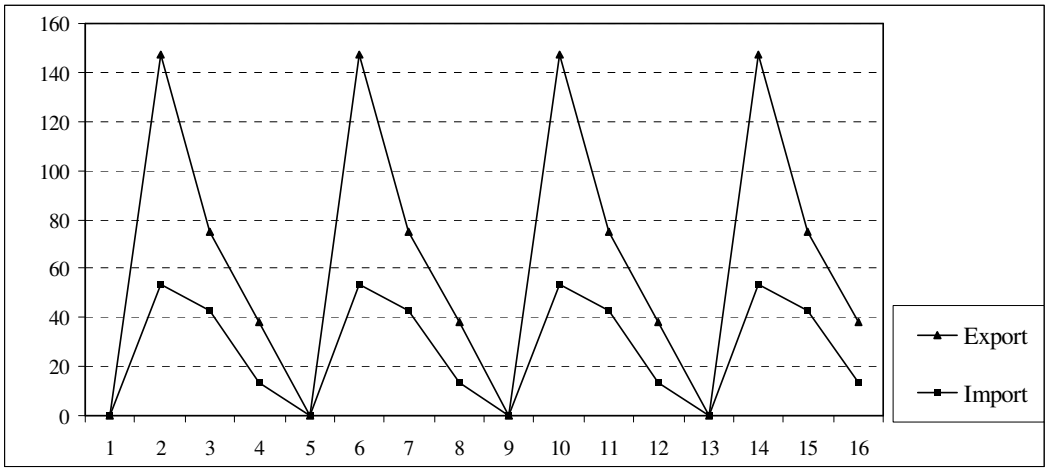

Fig. 1 Seasonal trend (Y_x^S)

3. Conclusions

From the statistical analysis of the data presented in the tables and graphs, we draw the conclusion that generally, in the third quarter of each year, the value of exports and imports is much lower than in the other quarters. This points to the seasonal nature of certain exported or imported goods, for which demand is much higher in 1st, 2nd, and 4th quarters; whereas, since the 3rd quarter is the vacation season, the value and volume of commercial transactions during that period[5] is substantially reduced.

Likewise, we can observe that in the 4th quarter of each year, the value of imports and exports attains much higher levels in comparison with the levels of the preceding quarters, as a result of the fact that in this period of the year the income of the population reaches its maximum levels.

If we thoroughly analyze the values of the Y_x^R residual trend component, it can be observed that these oscillate strongly both for exports and imports, which means that the unexplained residual variation caused by the influence of other factors has a strong significance in proportion to the variations accounted for by the components of the complex function described in this article.

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