Using Time-Series Analysis of Economic and Financial Phenomenon

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Abstract

In the business of forecasting the evolution of financial-economic phenomena with the help of models of time series based on statistical and econometric methods, starts from the assumption that the phenomenon will continue to have in a foreseeable period of time the same behavior as in the past.

Key words: chronological series, time series, evolution of financial – economic phenomena

1. General notions regarding the chronological series

Analysis and forecasting of economic phenomena in general, and financial transactions, in particular, requires a precise knowledge of their history and identification of regularities of their past, which forecasts can be carried out with a high degree of reliance on the evolution of the studied phenomena in a slightly anticipabilă period of time.

„The database is based on analysis of the evolution of the phenomena in time consists of time series (or chronological series)”. „Often, the measurements of the variable are made at equal intervals of time, chronological series being presented in the form of”:

\[ Y = \begin{pmatrix} 1 & 2 & \ldots & t & \ldots & T \\ Y_1 & Y_2 & \ldots & Y_t & \ldots & Y_T \end{pmatrix} \]
Analysis of chronological series ensures the understanding and modelling of the evolution of the terms of the series, as well as in the definition of specific patterns such developments. Based on these models it is possible to achieve effective predictions about the future evolution of the phenomenon under analysis.

The results obtained on the basis of analysis of chronological series to be one correct and usable in forecasting the phenomena investigated the observed period length is long enough to make it possible to estimate a suitable qualitative model outsells the real mechanism of generation of the phenomenon, so as to identify some components of long-term evolution.

When Latin chronosticon indicates the presence of some anomalous values, corresponding to strikes, natural disasters or other specific events, they will be replaced with mean values that would have been recorded in normal circumstances.

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Used in time series analysis of economic phenomena, in general and financial transactions, in particular, can be classified as:

- Series of stock or series of moments (integral),
  These series of data characterizing the level of development of phenomena at certain moments of time. Their feature is the fact that the indicators show may not be of summed whereas the level at a certain point levels are cumulative all previous moments. As a result, these constraints summation values would lead to a situation in which same size would be taken into account by several times, which is meaningless. Because of this, terms of these series may call and sizes of stock.
- Series of intervals (differential)
  Series of intervals ensures faithful reflection of the development of a process or phenomenon for some time. Levels of indicators can highlight the years, months or other fractions of time. Feature a series of intervals refers to the ability of the sum of the quantities of successive of indicators. This feature has a particular importance both in the training series, in operations to optimize the operation of the grouping size ranges, as well as in the analysis in order to establish economic results on long intervals. In the literature these series are called and series cumulative.
As such, the description of the statistical series of time starts at analysis of factors causing their movement. In general, evolution of a phenomenon is generated by the action of certain groups of factors:

- essential factors, with the long-term action, phenomena that print trend of production; action by such factors tracing is depending on the units of time for which it has been measured the phenomenon analyzed;
- seasonal factors, with action on periods of more than one year, which causes deviations from the trend printed phenomenon essential factors;
- fully oxidized by this factors, with action on periods of more than one year, that print swinging evolution of this phenomenon in the case of series contruite for long periods of time;
- random factors, (with random action), whose action is compensated if the data recorded refer to a large number of periods of time.

2. Components of a time series
For the purpose of analysing and forecast area, on the basis of models statistico - econometric modeling, evolution of a economic phenomenon using series of time it is necessary to be known the main components of such a series of data. They can be obtained by operation of decomposition and can be summarised in such:

a) Most important trend or Trend
The trend of a chronological series is a key component of it, what caracterizeauă evolvement over the long term. On the basis of the trend forecasts, analyses of oscillating components depending on the frequency and amplitude, as well as processing of stationary series, unaffected by the trend.

b) Seasonal time series
From the analysis of chronological series, particularly economic and financial transactions, results that there are indicators which can be considered cyclical evolution. For example, the main macroeconomic indicators of outcomes are significantly better reuse during the winter months, while the prices of the main categories of goods are in the same range considered.
Econometric analysis, in order to eliminate these seasonal developments and highlight just the impact it has on a given variable over another, time series are seasonally adjusted, this being defined by specific methods, which have been implemented in software and specialized statistical analysis-economic.
c) **Ciclicity of time series**

Time-series analysis, in particular those in the economic field, has led, in the case of many evolutionary processes over time, identify their cyclical developments. Similarly seasonal deviation ciclicitatea affects the quality of the information provided by the subject of the analysis, by the emergence of similar variations from the series at regular intervals.

As has been pointed out in the case of the chronological series sezonalității, to increase the quality of the information and forecasts made using time-series, it is necessary to eliminate the effect of rotation in order to specify a statistical model-one of the series of econometric data found. This adjustment of the operation, is performed, most of the time, with the help of specific functions implemented as software specialized for such analyses.

d) **Random variation of time series**

At any time series observations that may occur to vary significantly from the general trend of the population considered, in particular as a result of the action of random factors. To enable modeling of econometric data considered necessary the action of these factors to be eliminated by adjusting the series considered.

The four components mentioned above may be combined, thus obtaining the value of the variable $Y$ in this, two main models are recognized with the help of which the components can be combined to a chronological series, namely:

- the additive model of the chronological series:
  \[ y_t = Y_t + S + C + R \]
  where:
  $Y_t$ = the trend series;
  $S$ = reproduction (seasonal variation);
  $C$ = ciclicity;
  $R$ = random variation.

- The multiplicative model of the chronological series:
  \[ y_t = Y_t \times S \times C \times R \]

In statistics and econometrics paper works were defined a number of specific methods by which to ensure the adjustment of data series, replacing the terms empiricists of the series affected by errors with theoretical terms, determine the optimum conditions for evolutionary process, thus ensuring the removal from among them those with character periodically or by chance.
Among these methods, include: method method reproductive rate mobile environment, environmental index method, analytical method for adjusting function using linear, analytical method for adjusting reflector shell using the second degree, analytical method for adjusting function using Expo, spice nentiaite, Analytical method for adjusting using the exponential function, spice glowing Spaceship as amended, analytical method for adjusting curve using Gompertz or analytical method for adjusting using logistic curve.

To be able to analyze in terms of chronological series statistically it is necessary to define a series of elements that make this kind of data namely:

a) Frequency of the time series represents the frequency with which it is observed variable. Depending on the specific subject of analysis time series, frequency can be:
   a. daily (as is the case in financial asset prices-prices, interest rates, exchange rate);
   b. on a monthly basis (for example, the rate of inflation, the average salary in economy, unemployment rate);
   c. quarterly;
   d. annual.

b) Population represents the whole observations carried out and reported with respect to the time course of a variable.

c) The sample is a small subset of observations of random variable, extracted on the basis of a well-established mechanism, so that it may be considered to be representative for the whole population which has been analyzed.

d) The moments of the time series
In the literature are identified and submitted four moments of a time series namely:
   o Chronological series Media
   o Standard deviation of the series, which is a measure of dispersion observations.

Formula for calculating the Scattering (s) for a sample of observations is:

\[ s = \sqrt{\frac{\sum_{i=1}^{N}(y_i - \bar{y})^2}{N - 1}} \]

where:
\( N \) – the number of observations from the sample;
\( y_i \) – the observations included in the sample. \( i = 1, N \)
The coefficient of asymmetry - is a measure of two-tone distribution of the average. The calculation formula of the asymmetry coefficient (S) for a series of time is:

\[ S = \frac{1}{N} \sum_{i=1}^{N} \left( \frac{y_i - \overline{y}}{\hat{\sigma}} \right)^3 \]

where:
- \( N \) – number of observations in the sample;
- \( y_i \) – their observations included in the sample;
- \( \overline{y} \) – average value of the sample
- \( \hat{\sigma} \) – an estimator for the standard deviation of the series
- \( s \) – the time series variation.

Kurtosis - is an indicator measure the height distribution series, which can be determined based on the following calculation relationships:

\[ K = \frac{1}{N} \sum_{i=1}^{N} \left( \frac{y_i - \overline{y}}{\hat{\sigma}} \right)^4 \]

It is important to note that, for a normal distribution, calculated value of this indicator is 3. In the event that, The value of kurtosis has exceeded the reference level shall be considered as distribution is leptokurtic (and has a height greater than a normal distribution), While values lower than the reference level referred to above may lead to a distribution platykurtic (he has a height of more than the normal distribution).

In practical activity, it was found that financial data series have a distribution leptokurtic. A basic feature of this distribution is the fact that the probability of occurrence of extreme events is higher than in the case of a normal distribution.

e) Stationarity of time series

Conditions to be met in order for a series of time to be stationary are:
- average time series to be constant (the value of all observations should fluctuate around series average considered).
- Variance series to be constant.
In economic analyzes - financial is necessary, most of the times, to ensure stationarizarea series of data. In this respect, recourse, in the vast majority of cases, to stationarizarea through differentiation. Thus, the order of integration of the series is the number of successive differentiation required for obtaining a series parking (or the number of the roots of uniform series). In the economy, the most common series nestationare are integrated approximately I (requires only a single differentiation have a root unit).

In the literature have been identified and time series trend - stationary, i.e. those series of data nestationare, which can be turned into series stationary by eliminating (decrease) trend (deterministic) of a series.

Most series of economic data are non - stationary, showing trends of increase or decrease, in such a way that their environments and the variations are time-dependent.

Testing non - stationary series can be done using a variety of specific statistical tests, as well as:

- Test Bartlett, by which verify that in the case of a series stationary, the coefficients of autocorrelation $r_k$ are approximately normally distributed, media 0 and constant dispersion equal with $\sigma^2 = \frac{1}{n}$. In the case for $r_1, r_2, \ldots, r_k$, $k$ is the threshold, it can be established that they belong within the range $-1.96\sigma \leq r_k \leq 1.96\sigma$, for a profitability of 95%, Then hypothesis zero is acceptable, meaning $\rho_k = 0$ and the series is stationary. If this is not the case, the autocorrelation coefficients are significant and series is nontationary.

- Test Q on Box-Pierce, for checking simultaneity nesemnificatiei for all the coefficients of autocorelatie $r_k$; being ipeteza zero $H_0$. Box-Pierce statistics is $Q = n \sum_{k=1}^{m} r_k^2$. $Q$ is higher than the reference level time series is considered nestationara. The value thus obtained will be compared to a reference level concerned test $\chi^2$. In the case where the value test $Q$ is higher than the reference level time $\chi^2$ the time series is considered non-stationary.

- Test Ljung-Box defines a specific variable LB, to be determined according to the following relationship of calculation:
\[ LB = n(n+2) \sum_{j=1}^{k} \left( \frac{r_j^2}{n-j} \right) \]

Test value Ljung-box should be compared with the theoretical and, in the case in which the value \( \chi^2 \), LB is more recent than the reference level is to be considered as the data which has been analyzed is one non-stationary.

3. Specific aspects financial time series

Chronological series analysis and identification of legitati/models that describe the evolution of duly phenomena subject to research, followed by carrying out forecasts on the basis of the results of this research constitutes a challenge for specialists in this field. This statement is most valid for series of data within the financial field as they are a series of specific characteristics, which may make them more difficult modelable of econometric point of view.

Econometrics modeling of financial variables is aimed at obtaining models, which previzioneze as well the values of their future, tanand into account the nature of inertia of process analyzed and relatively predictable nature of their development in response to some deviations from the past noticed.

Econometrics modeling financial variables shall take account of the characteristics, that:

- specific form of distribution of financial series, a concept which means that these series of data has the following special features:
  - do not follow a normal distribution, these series of data being, most of the times, leptocurtice, which implies a deviation of wide front extreme values from the average population considered.
  
  In this case you will notice that the value of Kurtosis for financial chronological series take values higher than the level of reference 3;
  - financial series tend to be asymmetrical, leading to aparită values of Skewness, non-zero index.
- serial residue correlation;
- heteroschedasticity.

A variable X is called homoscedastic if it shows values recorded a constant dispersion. Financial specialist literature, in most cases, the problem arises in connection with homoscedasticității terms of a residual regression functions. Compliance with the homoscedasticității residual
terms is necessary for the estimation of the regression function to be relevant. One of the implicit assumptions of the models mentioned above says the stability over time of return dispersion (homoscedasticity).

Own practice-activity itself confirmed that hypothesis has not been adopted homoscedasticității only for sake of simplification of econometric modelling. In general, it appears that the hypothesis is not homoscedasticității checks only incidentally and for short periods of time, it shall not be used in case of time-series, which are usually used in specific analyses of the capital market.

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