Slovak international scientific journal

№39, 2020
Slovak international scientific journal
VOL.2

The journal has a certificate of registration at the International Centre in Paris – ISSN 5782-5319.
The frequency of publication – 12 times per year.
Reception of articles in the journal – on the daily basis.
The output of journal is monthly scheduled.
Languages: all articles are published in the language of writing by the author.
The format of the journal is A4, coated paper, matte laminated cover.
Articles published in the journal have the status of international publication.

1000 copies
Slovak international scientific journal
Partizanska, 1248/2
Bratislava, Slovakia 811 03
email: info@sis-journal.com
site: http://sis-journal.com

CONTENT

ECONOMY

POLITICAL SCIENCES

https://yur-gazeta.com/publications/practice/inshe/bagatorivneva-sistema-komplaens.html

9. Коляда І. В. Поняття та сутність комплаєнс-контролю у вітчизняній економічній науці та суспільному дискурсі / І. В. Коляда // Молодий вчений. - 2016. - № 12.1. - С. 791-794.

10. Комплаєнс –контроль URL:http://gryphongroup.com.ua/ru/compliance/

11. Положення про організацію внутрішнього контролю в банках України: Постанова Правління Національного банку України № 867 від 29.12.2014 року URL:https://zakon.rada.gov.ua/laws/show/v0867500-14

12. Сарахман О. М. Функціонування комплаєнс-контролю у вітчизняній банківській справі / О. М. Сарахман, В. Козьол // Бухгалтерський облік, аналіз і аудит. – 2015. – Випуск 2 (112). – С. 87–90.

13. Стандарт з автоматичного обміну податковою інформацією Організації економічного співробітництва і розвитку від 21 липня 2014 р URL: https://fbs-tax.com/uk/legal-practice/automatic-exchange-of-tax-information/

14. Шарамко М. М., Гарипов И. Р. Институциональный комплаенс-контроль: монография. – Москва: РУСАЙНС, 2016. – 138 с.

FINANCIAL STABILITY OF THE ENTERPRISE. FORECAST AND ADEQUACY OF THE MATHEMATICAL MODEL

Shevchuk O.
Candidate of Economic Sciences, Associate Professor
Vinnytsia National Agrarian University

Abstract

Forecasting the development of economic phenomena is always an important point in the strategic management of the enterprise. Creating predictive models can be done by different methods, which raises the question of selecting the best model. These issues in this paper are addressed.

In the article the dynamics series values of financial stability integral index is analyzed as for the availability of abnormal levels and trend. The predictive model of the financial stability integral index of the test enterprise is developed and its adequacy is checked.

Keywords: financial stability, balance of development, economic and mathematical modeling, integrated method for financial stability diagnosing, model for assessing the financial stability level, predisting the level of financial stability.

Introduction. Many researchers the definition and substance of financial sustainability have addressed. However, as shown in [1], the proposed methods for determining the level of financial stability of enterprises gave quite different and even radically opposite results. This leads to the development of a common methodology that takes into account both the specifics of the industry and the real results of functioning agricultural enterprises. In our previous work [2, 3] this was done.

Forecasting the development of economic phenomena is always an important point in the strategic management of the enterprise. Creating predictive models can be done by different methods, which raises the question of selecting the best model. These issues in this paper are addressed.

Formulation of the problem. One of the main tasks of economic and mathematical modeling is to make a forecast of economic phenomena. Such information is extremely important and necessary for effective management of the enterprise. Predicted values are, for the most part, obtained using a correlation-regression model of the dynamic series.

However, it should be noted that before conducting correlation-regression analysis it is necessary to check the values of a dynamic series for the presence of anomalous levels and the presence of a trend. Unfortunately, these steps are often overlooked by analysts, leading to the loss of some of the important information that was observed in the past, and as a result, possible erroneous predictive values of the model.

Therefore, one of the tasks of this paper is the popular advanced analysis of a dynamic series of the values of the financial stability integral index for the presence of abnormal levels and trend.

Growth curve models are often used to identify the direction of economic development. Development of a forecast using growth curves involves the following steps: choosing a curve which shape corresponds to the dynamics of the time series; estimation of the parameters of the selected curve; verification of the adequacy of the selected process forecast curve and the final selection of the curve; calculation of point and interval forecasts.

Therefore, the study of the financial stability integral index of the test enterprise [2] in terms of obtaining a reliable forecast is another of the tasks of this work.

The main results.

We consider a dynamic series of values of the financial stability integral index of the test enterprise for the last 10 years. Its calculation was performed according to the method proposed in [2], but according to a simplified model obtained after elimination of multicollinearity [3]. By test company we mean a really functioning successful agricultural enterprise, which by the method of scoring as the best in terms of financial performance was determined.

It is clear that the levels of this series are not deterministic but random. Therefore, anomalous values may appear among them. Such values may be due to technical or first-order errors. On the other hand, anomalous values may reflect real processes, such as the rapid growth of inflationary processes and the like; such anomalous values refer to second-order errors.

We will use the Irwin method to detect anomalous levels in the dynamic series $\Im_1, \Im_2, \ldots, \Im_n$. According to this method according by the formula

$$\lambda_i = \frac{|\Im_i - \Im_{i-1}|}{\sigma_\Im}, \qquad i = 1,\ 2,\ \ldots,\ n, \quad (1)$$

where - $\sigma_\Im$ is the mean square deviation of the series, calculating values $\lambda_2, \lambda_3, \ldots,$ that are compared with the table value λ_α of the Irwin criterion; if any of the values λ_i is larger than the table value, then the corresponding value $\Im_i$ of the level of a dynamic series is considered anomalous. The values of Irwin criterion for the significance level $\alpha = 0{,}05$ in Table. 1 are given

Table 1

n	2	3	10	20	30	50	100
λ_α	2,8	2,3	1,5	1,3	1,2	1,1	1,0

Note that when the anomalous level of a dynamic series is caused by a technical order error, it is replaced either by the corresponding value of the approximating curve or by the arithmetic mean of two adjacent values of the series.

Therefore, when anomalous levels are detected, the cause of these abnormalities should be determined.

Check for abnormal values, the value of the financial stability integral index of the test company. The calculated values in table 2 are entered.

Let's calculate the mean value of the integral index and its standard deviation over the last 10 years:

$$\overline{\Im} = \frac{\sum \Im_i}{n} = \frac{6{,}365}{10} = 0{,}6365;$$

$$\sigma_\Im = \sqrt{\frac{\sum(\Im_i - \overline{\Im})^2}{n-1}} = \sqrt{\frac{0{,}107287}{9}} = 0{,}109.$$

Table 2

Checking for abnormal values

Number of the year	$\Im_i$	$\Im_i - \overline{\Im}$	$(\Im_i - \overline{\Im})^2$	λ_i
1	0,456	-0,1805	0,03258	–
2	0,482	-0,1545	0,02387	0,239
3	0,578	-0,0585	0,003422	0,881
4	0,614	-0,0225	0,000506	0,330
5	0,692	0,0555	0,00308	0,716
6	0,758	0,1215	0,014762	0,606
7	0,592	-0,0445	0,00198	1,523
8	0,724	0,0875	0,007656	1,211
9	0,745	0,1085	0,011772	0,193
10	0,724	0,0875	0,007656	0,193

Comparing the values obtained λ_i with the table value of the Irwin criterion $\lambda(10;\ 0{,}05) = 1{,}5$, we can conclude that there was an anomalous value of the financial stability integral index, which in year №7 was observed.

Having conducted a detailed analysis of the work of the test enterprise for this year, it was found that such anomalous value is caused by the fact that this year the enterprise made capital investments in the form of expansion of the livestock of its main herd of cattle, which is connected with the specialization of the farm - breeding cattle.

As we can see, in the financial analysis of the following periods (years) the financial stability of the enterprise increases, which is convincing evidence of the appropriateness of such a strategic management decision.

If a dynamic series shows a long-term trend of the economic index change, then in this case they say that there is a trend. Therefore, a trend means a change that determines the general direction of development or the main trend of a dynamic series. The trend is a systematic (not random) component of long-term action.

The presence of a trend in the dynamic series is checked by special methods. One of these is the sign series method, which is implemented using the following algorithm:

1. For the time series under study, we determine the sequence of signs based on the condition

$$\delta_i = \begin{cases} +, & when \quad y_{i+1} - y_i > 0, \\ -, & when \quad y_{i+1} - y_i < 0. \end{cases} \quad (2)$$

however, if the neighboring values are the same in the time series, then one of them is taken.

2. We calculate the number of series $\upsilon(n)$. A series means a series of consecutive pluses or minuses; one plus or one minus as a series being considered.

3. Determine the length $l_{\max}(n)$ of the longest series.

4. Find the number $l(n)$ that is determined by the following table

The length of the series n	$n<26$	$26<n<153$	$153<n<170$
the value $l(n)$	5	6	7

5. If at least one of the following two inequalities is not fulfilled, then the hypothesis of no trend is rejected with a confidence probability 0,95:

$$\begin{cases} \upsilon(n) > \left[\frac{1}{3}\cdot(2n-1)-1{,}96\cdot\sqrt{\frac{16n-29}{90}}\right]; \\ l_{\max}(n)\le l(n). \end{cases} \quad (3)$$

(The symbol $[a]$ denotes the integer part a).

According to the method described above, we check the trend of the financial stability integral index $\Im_i$ of the test company.

We define the sequence of signs.

Number of the year	1	2	3	4	5	6	7	8	9	10
$\Im_i$	0,456	0,482	0,578	0,614	0,692	0,758	0,592	0,724	0,745	0,724
δ_i		+	+	+	+	+	–	+	+	–

The number of series $\upsilon(n)=4$, the length of the longest series $l_{\max}(n)=5$, according to the table $l(n)=5$. Write the system of inequalities (3):

$$\begin{cases} 4 > \left[\frac{1}{3}\cdot(2\cdot 10-1)-1{,}96\cdot\sqrt{\frac{16\cdot 10-29}{90}}\right]; \\ 5\le 5. \end{cases} \Rightarrow \begin{cases} 4>4; \\ 5\le 5. \end{cases}$$

Since the first inequality is not satisfied, we can conclude that there is a trend of integral indicator of financial stability of the test enterprise with a confidence probability 0,95.

Dynamic series trend checking can also be done by other techniques, such as the mid-level difference test or the Foster-Stewart method. It should be noted at once that the second method. It should be noted at once that the second method, namely the Foster-Stuart method, is more efficient in terms of checking the presence of a trend, because it tests not only the mean value but also the variance.

The idea the mid-level difference test method is:

1. We divide the dynamic series $y_1,\ y_2,\ \ldots,\ y_n$ into two approximately equal parts in length n_1 and n_2 $(n_1+n_2=n)$;

2. For each of these parts we compute the mean values $\bar{y}_1,\ \bar{y}_2$, and the unbiased variances σ_1^2 and σ_2^2;

3. Using the Fisher test, we check the homogeneity of the variances of both parts of the series, where

$$F_\alpha = \begin{cases} \frac{\sigma_1^2}{\sigma_2^2}, \quad when \quad \sigma_1^2>\sigma_2^2; \\ \frac{\sigma_2^2}{\sigma_1^2}, \quad when \quad \sigma_2^2>\sigma_1^2. \end{cases} \quad (4)$$

The significance level is 0,1; 0,01 or 0,05. If the calculated value $F_\alpha^{(P)}$ is less than the table value $F_\alpha^{(T)}$, then the hypothesis of the equality of variances is accepted and we proceed to check the presence or absence of a trend. If $F_\alpha^{(P)} \ge F_\alpha^{(T)}$, then the hypothesis of equality of variances is rejected and we conclude that this method does not answer the question of the presence or absence of a trend;

4. The hypothesis of no trend is tested using the Student t-criterion. Here

$$t_p = \frac{|\bar{y}_1-\bar{y}_2|}{\sigma\sqrt{\frac{1}{n_1}+\frac{1}{n_2}}}, \quad (5)$$

where σ is the standard deviation of the mean differences:

$$\sigma=\sqrt{\frac{(n_1-1)\sigma_1^2+(n_2-1)\sigma_2^2}{n_1+n_2-2}}. \quad (6)$$

If at the level of significance α $t_p \le t_\alpha$ (t_α – tabular value), then the hypothesis about the absence of trend is accepted. If $t_p > t_\alpha$, then the hypothesis on the existence of a trend with probability $1-\alpha$ is accepted.

We use the method of checking the differences of mean levels for the financial stability integral index $\Im_i$ of the test enterprise. To do this, divide the time series into two equal parts: the first half – from the first to the fifth year, the second – from the sixth to the tenth year. We determine the mean values and variances of both halves. The calculated data in Table 3 are presented.

Table 3

The method of checking the differences of mean levels for the financial stability integral index of the test enterprise

Number of the year	$\Im_i$	$\overline{\Im}$	$\Im_i - \overline{\Im}$	$\left(\Im_i - \overline{\Im}\right)^2$	σ^2
1	0,456		-0,108	0,011664	
2	0,482		-0,082	0,006724	
3	0,578	0,564	0,014	0,000196	0,0094
4	0,614		0,05	0,0025	
5	0,692		0,128	0,016384	
6	0,758		0,049	0,002401	
7	0,592		-0,117	0,013689	
8	0,724	0,709	0,015	0,000225	0,0045
9	0,745		0,036	0,001296	
10	0,724		0,015	0,000225	

Therefore, by the formula (4) we have:

$$F_\alpha^{(P)} = \frac{\sigma_1^2}{\sigma_2^2} = \frac{0{,}0094}{0{,}0045} = 2{,}09.$$

Tabular value of Fisher criterion $F_\alpha^{(T)} = 5{,}05$ at significance level $\alpha = 0{,}05$ [4]. Since $F_\alpha^{(P)} < F_\alpha^{(T)}$, then by (5) and (6) we find:

$$\sigma = \sqrt{\frac{(5-1)0{,}0094 + (5-1)0{,}0045}{5+5-2}} = 0{,}083; \; t_p = \frac{|0{,}564 - 0{,}709|}{0{,}083\sqrt{\frac{1}{5}+\frac{1}{5}}} = 2{,}76.$$

Then the theoretical value of the Student criterion for the level of significance $\alpha = 0{,}05$ is equal to $t_\alpha = 2{,}31$. Since $t_p > t_\alpha$, then the hypothesis that there is no trend in the mean values is rejected, that is, the hypothesis that the series tends to develop.

Since two different ways of investigating the trend of a financial stability integral index the same result have yielded, there is no need to use the Foster-Stewart method.

Based on the fact that the dynamics of a series of financial stability integral index of the test company, both visually and logically, tends first to increase and then to saturation, analytical curvature smoothing was performed. An exponential smoothing method for this purpose was chosen (Fig. 1).

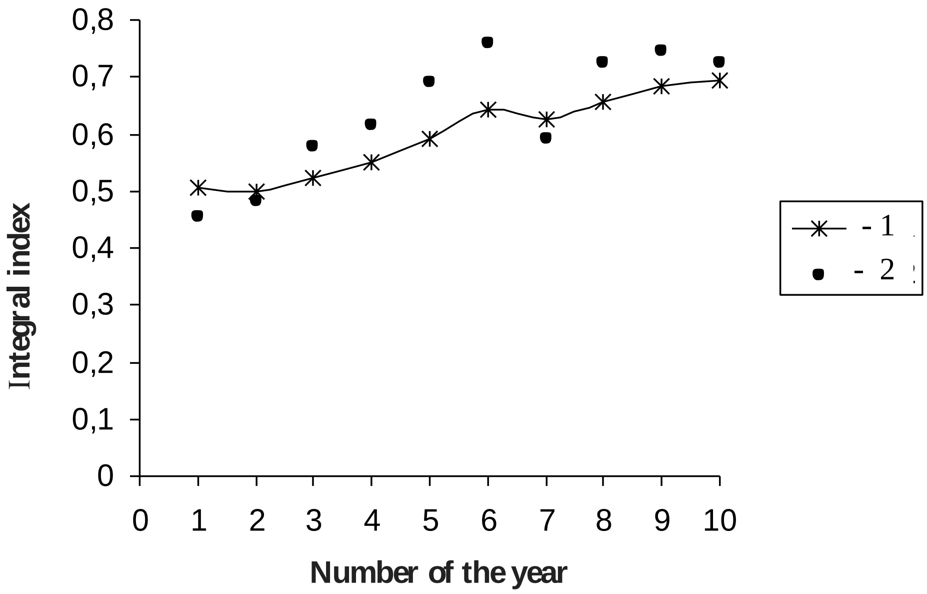

Fig.1. Exponential smoothing of the financial stability integral index $\Im_i$ of the test enterprise; the series 1 - smoothed levels; the series 2 - starting data.

Growth curve models for economic forecasting are often used. Since the financial stability integral index tends to saturate in its content, the growth curve of this indicator can be taken as a Homperz function curve, a Pearl-Reid function logistic curve, or a modified exponent.

We find the model growth curve of a financial stability index of the test company. We will look for it as a function:

$$\Im = \frac{1}{1 + a \cdot b^t}, \; a > 0, \; 0 < b < 1. \qquad (7)$$

The least squares method to find the parameters a and b was used. As a result, we obtain the equation:

$$\tilde{\Im} = \frac{1}{1 + 1{,}143 \cdot (0{,}877)^t}.$$

The graph of the growth curve and the forecast for the next two years in Fig. 2 are presented.

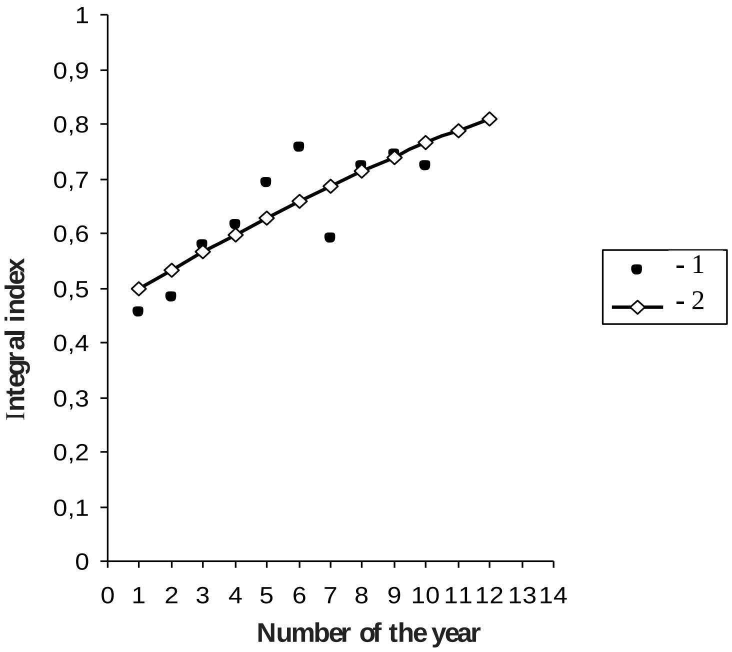

Fig.2. Model curve of growth of a financial stability integral index of the test enterprise; the series 1- theoretical values; the series 2 - actual values.

Let us evaluate the found trend model for adequacy. In other words, let's find out how well it reflects the economic process under study. This requirement is equivalent to the fact that sequence of residues

$$u_i = \Im_i - \tilde{\Im}_i \qquad (8)$$

should have random fluctuations with normal distribution law, zero mathematical expectation, and independence of their levels.

Checking the randomness of fluctuations in the residuals sequence is conducted to confirm the hypothesis that the chosen trend type is correct.

To investigate the randomness of deviations from the trend, we use one of the methods, such as the series method. This method uses the concept of median sampling and in such stages is conducted.

We place a residuals series u_i in the order of increasing or decreasing and find a median $u_{me} = u_{(n+1)/2}$ when n – odd number or $u_{me} = \frac{u_{n/2} + u_{(n/2)+1}}{2}$ when n – even number.

Then we compare a members u_i of the obtained residuals series and the median u_{me}. If $u_i > u_{me}$, then we put the sign "+"; if $u_i < u_{me}$, then we put the sign "–"; if $u_i = u_{me}$, then the value u_i into account is not taken.

The sequence of pluses or minuses that follow in succession is called as a series. If V – the total number of series, and $k_{\max}$ – the number of members of the longest series, then for the 5% significance level we check the simultaneous fulfillment of two such inequalities:

$$k_{\max} < \left[3{,}3 \cdot (\lg n + 1)\right]; \qquad (9)$$

$$V > \left[\frac{1}{2} \cdot \left(n + 1 - 1{,}96 \cdot \sqrt{n-1}\right)\right], \qquad (10)$$

If at least one of the inequalities is not fulfilled, then the hypothesis about the randomness of the residuals of the time series is rejected, therefore, the trend model is not adequate.

In our case, the median is sought for the ranked series of residues (Table 4) by the formula:

$$u_{me} = \frac{0{,}005 + 0{,}01}{2} = \frac{0{,}015}{2} = 0{,}0075.$$

Table 4

Ranked series of residues

i	1	2	3	4	5	6	7	8	9	10
u_i	-0,095	-0,05	-0,043	-0,041	0,005	0,01	0,013	0,017	0,064	0,1

We compare the initial series of residuals and the median:

Number of the year	1	2	3	4	5	6	7	8	9	10
u_i	0,043	-0,05	0,013	0,017	0,064	0,1	-0,095	0,01	0,005	-0,041
sign	–	–	+	+	+	+	–	+	–	–

Therefore, the total number of series is $V=5$, and the number of members of the longest series $k_{\max}=4$ Check the inequalities (3) and (4):

$$\begin{cases} 4<\left[3{,}3\cdot(\lg 10+1)\right]; \\ 5>\left[\frac{1}{2}\cdot\left(10+1-1{,}96\cdot\sqrt{10-1}\right)\right]; \end{cases} \Rightarrow \begin{cases} 4<\left[6{,}6\right]; \\ 5>\left[2{,}56\right]. \end{cases}$$

As both inequalities are fulfilled, we conclude that the proposed trend model is adequate.

This result is also confirmed by the turning point method. A point is called a turning point if $u_{i-1}<u_i>u_{i+1}$ or $u_{i-1}>u_i<u_{i+1}$.

If Π – the total number of turning points, $\overline{\Pi}$ – their mathematical expectation, σ_{Π}^2 – their variance, where by randomness of the sampling of residues

$$\overline{\Pi}=\frac{2}{3}(n-2), \tag{11}$$

$$\sigma_{\Pi}^2=\frac{(16n-29)}{90}, \tag{12}$$

then at the 5% level of significance the implementation of inequality

$$\Pi>\left[\overline{\Pi}-1{,}96\sqrt{\sigma_{\Pi}^2}\right], \tag{13}$$

means that the trend model is adequate.

For the data in the previous table, the number of turning points $\Pi=4$. By formulas (5) and (6) we find their mathematical expectations and variance:

$$\overline{\Pi}=\frac{2}{3}(10-2)=\frac{16}{3}\approx 5{,}33;$$

$$\sigma_{\Pi}^2=\frac{(16\cdot 10-29)}{90}=\frac{131}{90}\approx 1{,}46.$$

Check the inequality (7):

$$4>\left[5{,}33-1{,}96\cdot\sqrt{1{,}46}\right],\ 4>\left[2{,}96\right].$$

Consequently, the implementation of this inequality makes it possible to assert with probability 0,95 that the trend model is adequate.

In practice, it is not always possible to immediately build a sufficiently high-quality model of forecasting, so the stages of constructing trend models of economic dynamics repeatedly can be performed.

We will check the correspondence of the distribution of a random variable $u_i=\Im_i-\tilde{\Im}_i$ to the normal law by examining the asymmetry index and the excess index. It is well known that for normal distribution, these indexes in the parent population are equal to zero.

We assume that the deviation from the trend is a sample of the parent population. We calculate the sample values of asymmetry, excess and their corresponding mean square deviations.

For the asymmetry coefficient:

$$A_c=\frac{\frac{1}{n}\sum_{i=1}^{n}u_i^3}{\sqrt{\left(\frac{1}{n}\sum_{i=1}^{n}u_i^2\right)^3}}, \tag{14}$$

mean quadratic deviation

$$\sigma_{Ac}=\sqrt{\frac{6(n-2)}{(n+1)(n+3)}}. \tag{15}$$

Excess index of the sample

$$E_x=\frac{\frac{1}{n}\sum_{i=1}^{n}u_i^4}{\sqrt{\left(\frac{1}{n}\sum_{i=1}^{n}u_i^2\right)^4}}-3, \tag{16}$$

and its standard deviation:

$$\sigma_{Ex}=\sqrt{\frac{24n(n-2)(n-3)}{(n+1)^2(n+3)(n+5)}}. \tag{17}$$

If two inequalities that are analogous to the “three sigma rule” are satisfied simultaneously

$$|A_c|<1{,}5\cdot\sigma_{Ac}; \tag{18}$$

$$\left| E_x + \frac{6}{n+1} \right| < 1,5 \cdot \sigma_{Ex}, \qquad (19)$$

then the hypothesis of the normal distribution of the random variable u_i is accepted and the model is considered adequate.

Perform the calculations for the residuals of the financial stability integral index of the test enterprise according to the formulas (8−11): $A_c = 0,086$; $\sigma_{Ac} = 0,58$; $E_x = -0,615$; $\sigma_{Ex} = 0,755$.

Check the inequalities (12) and (13):

$$\begin{cases} |0,086| < 1,5 \cdot 0,58; \\ \left| -0,615 + \frac{6}{10+1} \right| < 1,5 \cdot 0,755; \end{cases} \Rightarrow \begin{cases} 0,086 < 0,87; \\ 0,0695 < 1,1325. \end{cases}$$

Since both inequalities are fulfilled simultaneously, the hypothesis about the normal distribution of random residues is accepted and the model proposed by us is considered adequate.

We check the equality of zero mathematical expectation of a random component u_i normally distributed proceed as follows. Calculate the value of the normalized random variable t_p by the formula:

$$t_p = \frac{\bar{u} - 0}{\sigma_u} \cdot \sqrt{n}, \qquad (20)$$

where $\bar{u}$ is the mean value of residuals levels; σ_u is the mean quadratic deviation of the residual levels.

If the calculated value t_p is less than the table value t_α at the level of significance α and at degrees of freedom $n-1$, that is $t_p < t_\alpha$, then the hypothesis that the mathematical expectation of a random component u_i is equal to zero is accepted; otherwise, it is rejected.

We calculate the value t_p for residues by (14):

$$t_p = \frac{-0,002}{0,054} \cdot \sqrt{10} = -0,117,$$

where

$$\bar{u} = \frac{1}{n} \cdot \sum u_i = \frac{1}{10} \cdot (-0,02) = -0,002, \quad \sigma_u = \sqrt{\frac{1}{n} \cdot \sum u_i^2 - \bar{u}^2} = \sqrt{\frac{1}{10} \cdot 0,0297 - (-0,002)^2} = 0,054.$$

We find the tabulated value t_α for the level of significance $\alpha = 0,05$ and degrees of freedom $(n-1) = 9$: $t_\alpha = 1,833$ (see [4]). Since $t_p < t_\alpha$, then the hypothesis that the mathematical expectation of a random component u_i is equal to zero is accepted.

If the look of the trend function is not successful, then the sequence of values of the residual series $u_1, u_2, ..., u_i$ may not have the properties of independence. In this case, say that there is an autocorrelation of errors.

The most common technique for checking the autocorrelation of residuals is the Darbin-Watson (*DW*) test:

$$d = DW = \sum_{i=2}^{n} (u_i - u_{i-1})^2 \Big/ \sum_{i=1}^{n} u_i^2, \qquad (21)$$

which can acquire values from the interval $[0; 4]$. (This criterion is sometimes called d-statistics).

If the residuals u_i are random variables, normally distributed, not autocorrelated, then *DW* values are close to 2. With positive autocorrelation $DW < 2$ and negative $DW > 2$. For a given level of significance α, number of observations n, and number of independent variables m, according to the table we find the lower limit of the DW_1 criterion and the upper limit of the DW_2.

If the $DW_{real} < DW_1$, then the residuals have a positive autocorrelation. When $DW_{real} > DW_2$, then we accept the hypothesis of no autocorrelation.

When $DW_1 < DW < DW_2$, no specific conclusions can be drawn and further research is needed to increase the aggregate of observations. It is worth noting that the *DW*-criterion is intended for small samples, which is important because the time series of the dynamics of economic phenomena are usually short.

You can show the relationship of the autocorrelation coefficient ρ between adjacent residual members of the series and the *DW*- criterion. Namely: if $\rho = 1$, then $DW = 0$; if $\rho = 0$, then $DW = 2$; if $\rho = -1$, then $DW = 4$. These ratios indicate that there are regions in which the Darbin-Watson test does not give a specific autocorrelation answer. The upper and lower bounds of the *DW*-criterion define the boundaries of this area for different sample sizes, a given significance level, and a given number of explanatory variables.

Note that when $DW_{real} > 2$, it is a negative autocorrelation (ρ <0). Since the critical values of the DW-criterion are tabulated only for the case of positive autocorrelation, in order to make a correct conclusion regarding the negative autocorrelation, it is necessary to compare the critical value of the DW-criterion with no calculated DW_{real}, and the number $4 - DW_{real}$.

For our financial stability index $DW \approx 1{,}98$.

Therefore, we conclude that there is no autocorrelation of residuals.

The magnitude of the deviations of the values of the time series along the growth curve from the actual level characterizes the accuracy of the trend model. For this purpose, we use such statistics as the mean quadratic deviation σ, the mean relative error of approximation δ, the coefficient of convergence φ^2, the coefficient of determination R^2, and others. They are calculated by the formulas:

$$\sigma = \sqrt{\frac{1}{n-m}\sum_{i=1}^{n}\left(\Im_i - \tilde{\Im}_i\right)^2} = \sqrt{\frac{1}{10-2}\cdot 0{,}0297} = 0{,}061; \quad (22)$$

where n is the number of levels of the series; m is the number of parameters that has a function of growth; $\Im_i$ − actual values of the financial stability integral index; $\tilde{\Im}_i$ – the value of the integral index according to the trend model.

$$\delta = \frac{1}{n}\cdot\sum_{i=1}^{n}\frac{\left|\Im_i - \tilde{\Im}_i\right|}{\left|\Im_i\right|}\cdot 100\% = \frac{1}{10}\cdot 0{,}71\cdot 100\% = 7{,}1\%; \quad (23)$$

$$\varphi^2 = \frac{\sum_{i=1}^{n}\left(\Im_i - \tilde{\Im}_i\right)^2}{\sum_{i=1}^{n}\left(\Im_i - \overline{\Im}\right)^2} = \frac{0{,}0297}{0{,}1073} = 0{,}277, \quad (24)$$

where $\overline{\Im}$ is the mean value of the financial stability integral index.

$$R^2 = 1 - \varphi^2 = 1 - 0{,}277 = 0{,}723. \quad (25)$$

In the case of a straight-line trend, the confidence interval $\Im_{np}$ is:

$$y_{sl} = \left(\tilde{y}_{n+\tau} - S_{\tilde{y}}\cdot K;\ \tilde{y}_{n+\tau} - S_{\tilde{y}}\cdot K\right), \quad (27)$$

where τ is the bias period; $\tilde{y}_{n+\tau}$ – point forecast on a linear model for the $(n+\tau)$th period of time; $S_{\tilde{y}}$ – standard error in which $m = 2$;

$$K = t_\alpha \cdot \sqrt{1 + \frac{1}{n} + \frac{3\cdot(n + 2\tau - 1)^2}{n\left(n^2 - 1\right)}};$$

t_α is the tabulated value of the Student criterion at the level of significance α.

To calculate the confidence forecast interval in the case of a straight-line trend, you can also use the following formula:

$$y_{sl} = \tilde{y}_{n+\tau} \pm t_\alpha \cdot S_{\tilde{y}} \cdot \sqrt{1 + \frac{1}{n} + \frac{\left(t_\tau - \bar{t}\right)^2}{\sum\left(t_\tau - \bar{t}\right)^2}}, \quad (28)$$

where t – ordinal number of series level $(t = 1, 2, ..., n)$; summation is conducted on all observations; t_τ corresponds to the $(n+\tau)$th period of time for which we make the forecast; $\bar{t}$ – the time corresponding to the middle of the observation period for the outgoing series.

If the beginning of the countdown is moved to the middle of the observation period, that is $\bar{t} = 0$, then

$$y_{sl} = \tilde{y}_{n+\tau} \pm t_\alpha \cdot S_{\tilde{y}} \cdot \sqrt{1 + \frac{1}{n} + \frac{t_\tau^2}{\sum t^2}}, \quad (29)$$

Similarly, confidence intervals can be found in the case of other growth curves that have a horizontal asymptote.

After the logarithm, the equation of the logistic curve takes the form

$$\tilde{Y} = -0{,}131\cdot t + 0{,}134.$$

Find the confidence interval by the formula (21) in the case of a linear trend in the new coordinates, and then, after completing the inverted transformations, find the confidence interval for the logistic curve.

Standard error $S_{\tilde{y}} = 0{,}278;\ K = 2{,}25$.

For example, the following year, the interval prediction of an integral indicator of financial stability for a test economy with a confidence probability of 0,95 is $\tilde{\Im}_{sl} = \left(0{,}663;\ 0{,}874\right)$.

Thus, the obtained interval value of the predicted financial stability level indicates the existence in the test enterprise of the potential for increasing it (up to 0,875). However, there is also a likelihood of a slight decrease in the value of the integral index (up to 0,663).

The reasons for such deviations may be changes in the internal and external environment of the enterprise.

Conclusions. The conducted studies have revealed the anomalous value of the financial stability integral index over a ten-year period and established the nature of its occurrence. The analysis also showed that in the experimental time series there is a long trend of development, namely, there is a trend of development, namely, there is a trend. Therefore, this series can be used to build an economic-mathematical model and to determine predictive values.

We have also established the type of the most accurate trend model of the financial stability integral index of the test enterprise and its adequacy is proved with high probability.

Note that the algorithms presented in the paper are universal in nature and can be used in the study of other economic phenomena and categories.

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CONSISTENCY OF EXPERT OPINIONS DETERMINATION IN FINANCIAL ANALYSIS WITH USE SPECTRAL APPROACH

Ruzakova O.

Candidate of Economic Sciences, associate professor of the department of computer science and economic cybernetics,

Vinnytsia National Agrarian University, Vinnytsia, Ukraine

Abstract

The problem of determining the level of estimations consistency during is considered group examination. The objective of the study is to develop a method for determining the consistency of peer reviews, without the number of key weaknesses inherent in existing methods. To increase the level of consistency, an expert feedback procedure is proposed, provided that no pressure is exerted on the expert. Expert evaluation the significance of the parameters of the financial condition of the enterprise for consistency with the spectral approach is presented in this article. The feasibility of using the spectral approach in financial analysis to verify the consistency of peer reviews is substantiated. An enhanced aggregated set of expert assessments, which is a strong base for further calculations, is defined.

Keywords: expert evaluation, consistency, spectral approach, the financial condition of the enterprise, financial parameters.

In the current conditions of the country's development, there is an urgent need to take into account the powerful arrays of financial and statistical reporting in making adequate financial decisions. This necessitates the involvement of experts' number to process such a wealth of data. Today, there are approaches that allow you to evaluate the quality of expert opinions by determining their degree of consistency, but most of them analyze all criteria at the same time, not individually. In addition, they do not take into account the competence of experts at the stage of calculating the consistency coefficient. Solving this problem will improve the quality of the peer review process, which in turn will have a significant impact on final decisions.

Today, scientists have developed many methods of assessing the financial and economic activity of the enterprise. To improve the quality of the evaluation process, some of the scientists involve expert diagnostics methods. Significant contribution to the study of this problem has been made by such scientists as: Beshelev S., Gurvich F., Malyshev N., Vernstein L.,