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Modeling the dynamics stability of Ukrainian banking system

Liberalization of economic relations and expansion of globalization caused the rapid development of consumer and financial markets. At the same time, mentioned factors adversely affected the financial market and its segments, especially the banking system, because banks play the most important role in the financial market and are major financial intermediaries in our country. Besides, the fluctuation in banking sector can also be the reason of economic circumstances instability in the country. Therefore, it raises the question of necessity to carry out research and develop economical mathematical model, which could make possible to identify the factors of banking system stable development and find out the mechanism of its regulation on the basis of regression and decomposition analysis.

Stability of banking system is proposed to consider as the ability of the system to maintain stable basic characteristics in time in condition of insignificant market fluctuation, to accept and resist the influence of external factors adequately, and to maintain the condition of a long-term dynamic equilibrium.

Modeling the dynamics stability of the banking system is suggested to perform on the basis of stationary time series verification by adaptation of the Forster-Stewart method to the peculiarities of the research subject. Therefore, the stationary time series is a process, which is characterized by constant mathematical expectation and variance (without trends), autocorrelation function depends on two subsequent periods of time, but not from a specific time period. It is recommended to analyze the stages of the proposed approach practical implementation in more details with consideration of the mentioned definition.

1 stage. Creation the research information base by collecting statistical data in the context of the relevant indicators dynamics of quantitative estimation of the stability of Ukrainian banking system; comprehensive analysis of their basic regularities. Such indicators are: the rate of growth of net profit/loss; the capital adequacy of banks; interest margin; ROA (return on assets); ROE (return on equity) (figure 1).
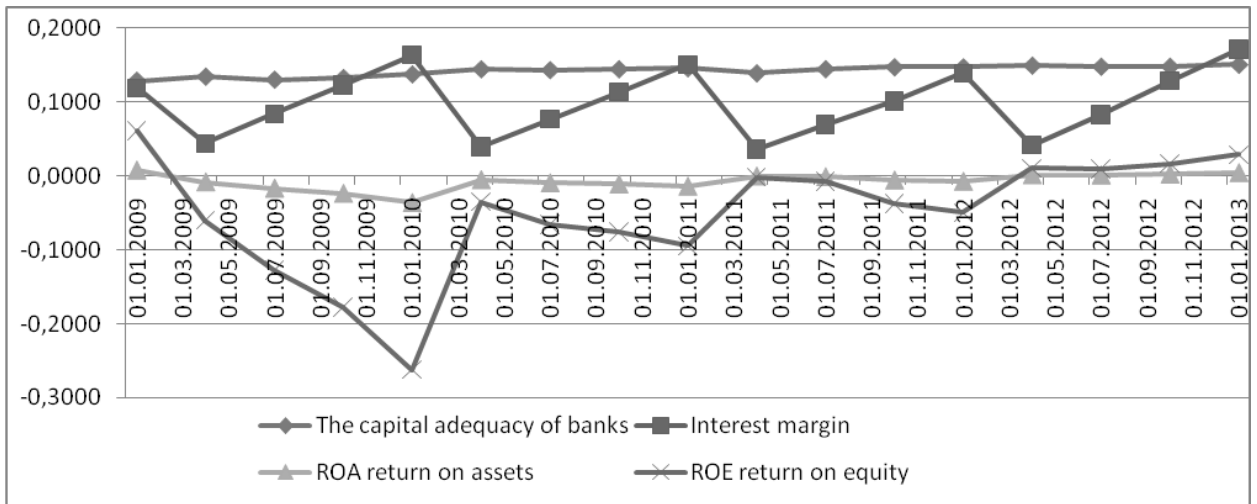
Figure 1 - Diagram of the relevant indicators dynamics of quantitative estimation of the stability of Ukrainian banking system

The comprehensive analysis of time series, presented in figure 1, allows to determine the main tendencies in change of the national banking system index stability. Therefore, clear linear trend of development is observed in the context of capital adequacy and the return on assets of banking institutions, while the seasonal variations are typical for such indices as interest margin and return on capital. The above-indicated variations of the mentioned indicators cause the oscillation trends in the dynamics of the banking system stability indicator.

Formalization and quantification of the revealed laws is proposed to realize with the use of mathematical methods by decomposition of the considered time series filtering trend ($F(t)$), seasonal (cyclic) (S) and random components:

- return on capital is described by the trend-seasonal multiplicative model:

$$ROE_t = F(t) \cdot S = (0.01t - 0.16)(-0.25)^{d_1} 0.86^{d_2} 1.31^{d_3} 2.07^{d_4} \qquad (1)$$

where ROE_t - the return on equity at time t; d_1 (d_2, d_3, d_4) − the indicator of the first (second, third, fourth, and so on) quarter, which takes the values: «1», if time moment of calculations corresponds to the first (second, third, fourth, and so on) quarter, «0» - otherwise:

- interest margin is characterized by a trend-seasonal additive model:

$$PM_t = (-0.01t + 0.10) + 0.41d_1 + 0.81d_2 + 1.18d_3 + 1.51d_4 \qquad (2)$$

where PM_t - interest margin at time t.

2 stage. Determination of two numerical sequences k and l basing on the comparison of each input time series value (consistently one of a whole array selected indicators) with the previous one according to the following principle: in the context of the numerical sequence k - a single value, if the time series level (except the first one) is greater than all the previous ones, and a non-zero value

otherwise, within the sequence l - a single value, if the time series level (except the first one) is less than all the previous ones, and a non-zero value otherwise.

3 stage. Calculation of the monotonicity characteristics (variables c and d), fading or slacking off each time series of relevant indicators of quantitative estimation of the Ukrainian banking system stability:

$$c = \sum_{t=2}^{n}(k_t + l_t), \quad d = \sum_{t=2}^{n}(k_t - l_t)$$ (3)

where k_t (l_t) - the value of the numerical sequence k (respectively, l) at time moment t.

4 stage. The comparison of t-relations actual values with a critical one and making conclusions regarding confirmation (if the calculated value exceeds the critical one) or reject the hypothesis about trends in average and in the dispersion of the corresponding time series. Formulas take the form of:

$$t_c = \frac{|c - \mu|}{\sigma_1}, \sigma_1 = \sqrt{2\ln n - 3,43}, \quad t_d = \frac{|d - 0|}{\sigma_2}, \sigma_2 = \sqrt{2\ln n - 0,85}$$ (4)

where μ – assessment of the mathematical expectations time series; σ_1 – assessment of the mean-square deviations for the value c; σ_2 – assessment of the mean-square deviations for the value d.

5 stage. Determination of the dynamics banking system stability indicator (R) as a time series, the elements of which are calculated as the amount of t-relations in the moment of time t.

The practical implementation of the above-mentioned approach allows to identify time intervals, during which Ukrainian banking system is characterized by insufficient level of stability. So, the stability indicator takes a value «1» (the fact of an unstable condition) in the second half of 2010, the second quarter of 2011 and during almost the whole year in 2012.

Stability of the banking system is determined by a lot of indicators and influences on the formation of the main banking sector indicators. In the research it is relevant to determine the direction and nature of the link between the effective sign and the size of equity capital, liabilities and assets for the banking system as a whole. Therefore, quantification of the impact factors on the stability indicator is proposed on the basis of an econometric approach, which presupposes the construction of the multiple non-linear regression equations in such a form:

$$R = -91783.33 - 44754.38\ln OC - 338405.64\ln E + 385645.31\ln A +$$ (5)

$$+1260.82\ln^2 OC + 8606.86\ln^2 E - 9744.91\ln^2 A$$

where R - the indicator of the banking system stability; OC - equity capital; E - liabilities; A - assets.

Analysis of the equation parameters (5) allows to make the following conclusions. With the increase of the banks equity capital to the amount 177,48 billion (18% of GDP) the level of banking system stability will gradually reduce. Increase of the equity capital above the specified value will cause the revive of Ukrainian banking system stability. A similar tendency is characterized by the liabilities (critical value of 196.59 billion – 19.94% of GDP), in contrast to assets, the influence of which on the effective sign is opposite. Therefore, as the relationships between the stability indicator and assets are presented in the form of polynomial second order branches down, the increase in the assets to the level of 197,87 billion (20.07% of GDP) is accompanied by increase of productive character. The excess of this factor of specified value gradually leads to the loss of the banking system stable state.

The accuracy and adequacy of revealed regularities are confirmed: by Fisher's test, the actual value of which 3,52 exceeds a critical permissible level of 3.41; by coefficient of determination at the level of 70,10%; by statistically significant parameters of the regression equation (t-criterion).

Thus, modeling the dynamics stability of the Ukrainian banking system allows to define the stability indicator, explore its dynamics as time series, identify the main factors of its formation, realize decomposition of a system-forming components of the effective indicator.