"Methodological approach to the evaluation of the financial system stability in the conditions of economic transformation"

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# Methodological approach to the evaluation of the financial system stability in the conditions of economic transformation

## Abstract

The article studies the issues of qualitative and quantitative mathematical evaluation of the financial system's stability. It conducts the formalization of phases for the assessment process in general. It also carries out the identification of the relevant performance characteristics of the financial system in the conditions of economic transformation.

**Keywords:** stability, financial system, transformation of the economy, financial instability, Pareto optimality principle, binary indicators.
**JEL Classification:** G10.

## Introduction

**Problem statement.** Considering the significant cyclicity in the functioning of the global financial system and periodic destabilization of its equilibrium the deepening of scientific achievements in the development of the crisis monitoring system is becoming increasingly relevant. It is important not only to expand the range of state measures to support businesses, but also to improve the efficiency of instruments to counteract the destructive factors, including the efficiency assessment of the implemented measures and the formation of financial instability early warning systems. This makes it important to find an integral indicator for the assessment of the financial system stability, the quantitative value of which would allow to determine the level of destabilization of financial processes in the country and to analyze the efficiency of management decisions made by the state authorities.

**Main results of the study.** Quantitative assessment of the stability of any system is related to the adequate formation of an array of input information, i.e. a set of indicators that would characterize the peculiarities of organization and functioning of the financial system. The vast majority of indicators for different countries will be similar, but some indicators are not relevant for certain conditions and forms of organization of financial systems.

We will consider several approaches to the choice of indicators that can accurately characterize the stability of Ukraine's financial system: the methodology of the International Monetary Fund [3], the Maastricht criteria [4], the works of the Institute for Economies in Transition (Russia) [1], the system of indicators of Eichengreen and Rose [2], the methodology of the Ministry of Economic Development and Trade of Ukraine [7] and the National Institute of International Security Problems [6].

During the analysis of indicators it was discovered that their main drawback is the duplication of the selected indicators' values. It is also necessary to take into account the peculiarities of the national economy and its financial system. Furthermore, in the conditions of economic transformation and activation of globalization processes the consideration of both internal and external factors of influence within the result indicator is becoming increasingly important.

Considering the analyzed methods it was determined that for the assessment of the financial system's stability in relation to the indicators of external influence we should take into account the following: the ratio of external debt to GDP, the current account balance to GDP, direct investments to GDP, the growth rate of the exchange rate of the Ukrainian hryvna to the U.S. dollar, the ratio of foreign exchange reserves to weekly imports, the share of capital of foreign banks in the national banking system and export/import ratio.

The system of indicators of internal influence on the financial system's stability should include the following indicators: the ratio of internal debt to GDP, the growth rate of per capita GDP, inflation rate, the ratio of the balance of state budget to GDP, the ratio of foreign exchange reserves to GDP, the ratio of commercial bank assets to GDP, the ratio of stock market capitalization to GDP, the growth rate of industrial production and house hold savings (see Table 1 in Appendix).

Along with the formation of a set of indicators for the stability of the financial system of Ukraine we should also determine the influence of these characteristics on the result indicator. Thus, the ratio of external debt to GDP should tend to decline because it is one of the main criteria characterizing the independence of the state from foreign creditors. The ratio of the current account balance to GDP should increase, because it shows a positive balance of payments and the activity on the international markets. The volume of direct investments in GDP

should grow, because this indicator shows the investment attractiveness of Ukraine, although it is necessary to consider the countries of origin of investments and exclude offshore zones. The growth rate of the exchange rate should maintain a minimal upward trend characterizing a stable monetary policy of the state. The ratio of foreign exchange reserves to weekly imports should increase. This tendency demonstrates the ability of the state to regulate monetary relations and to be less dependent on foreign currencies. The share of capital of foreign banks to ensure the financial stability should decrease, because the banking system of Ukraine occupies a prominent position in the financial relations of the state and its stability has a significant impact on the financial system as a whole. The export/import ratio should be balanced (the volume of export equal to the volume of import).

It should be noted that the ratio of internal debt to GDP should decrease demonstrating the availability of state funds to finance the state's activities. The growth rate of real per capita GDP should have a tendency to increase. It is necessary to emphasize that this indicator should increase with the growth of GDP, not through the decline of the population. The rate of inflation should be low and stable showing the optimal interaction of supply and demand on the market of goods and services as well as the financial solvency of the population. The ratio of the balance of state budget to GDP should be positive, reflecting the budget surplus. The amount of foreign exchange reserves to GDP should increase indicating the money market stability, the provision of the National Bank of Ukraine with funds to maintain a stable currency. The assets of commercial banks and stock market capitalization have to grow as it shows the development of these financial sectors. The growth rate of industrial production should have a positive trend. Household savings should increase indicating a sufficient income of the population not only for consumption but also for investment.

Developing the economic and mathematical model for determining the financial system's stability it is necessary to point out that it must take into account the method of criteria grouping (clusterization of the financial system's characteristics on the basis of their impact on the stability), normalization of indicators with the help of the relative approach (based on the ratio of the maximum possible value in the dynamics) and the Pareto optimality principle in calculating the binary estimates of the financial system's stability.

We shall designate $x_{it}^v$ as the value of the $i$-th internal indicator of the financial system's characteristic for the time period $t$ and $x_{jt}^z$ is the

corresponding value of the $j$-th external indicator in the time interval $t$. Therefore, based on the introduced symbols we write a set $I = \left\{ x_{it}^v ; x_{jt}^z \right\}$ of input data for the assessment of the system's stability.

In addition to the listed benefits of the existing information base, the mentioned criteria have a significant drawback – inability to compare them with each other and aggregating them to get a full assessment of the financial system's stability. Although all identified indicators have the same unit of measurement – percent, the direct execution of these operations will lead to in adequate results due to the different specific trends and oscillatory components of the time series data. Therefore, we propose to normalize them on the basis of the relative approach, which is based on the correlation of factor indicators with the biggest possible value in the dynamics (equation (1)). The expediency of this approach to indicator normalization is caused by the presence of both negative and positive absolute values of information criteria.

$$k_{it}^v = \frac{\max_t \left\{ x_{it}^v \right\} - x_{it}^v}{\max_t \left\{ x_{it}^v \right\}},$$

$$k_{jt}^z = \frac{\max_t \left\{ x_{jt}^z \right\} - x_{jt}^z}{\max_t \left\{ x_{jt}^z \right\}} \qquad (1)$$

where $k_{it}^v$ ($k_{jt}^z$) is anormalized value of the $i$-th internal (respectively, the $j$-th external) indicator for the financial system characteristics in the time period $t$; $\max_t \left\{ x_{it}^v \right\}$ ($\max_t \left\{ x_{jt}^z \right\}$) – the maximum values of a set of internal (respectively, external) indicators of the financial system characteristics for the considered time period.

The use of equation (1) makes it possible to obtain the following results of the normalized internal and external indicators describing the financial system's functioning (see Table 2 in Appendix). The values in Table 2 are positive and comparable with each other.

The normalization of the indicators of the financial system's functioning does not consider their impact on the level of stability. Therefore, the next stage of the proposed scientific and methodological approach is the grouping of criteria selected for the analysis. Thus, the use of the criteria grouping method (clusterization of the financial system's characteristics on the basis of their impact on the stability) makes it possible to split the input indicators into three subsets:

♦ the first subset includes indicators the values of which can be reduced compared to the values calculated in accordance with the Pareto-optimality principle. They include the internal debt to GDP and external debt to GDP;

♦ the second subset includes indicators the values of which should be increased compared to the optimal compromise values: the growth rate of per capita GDP, the balance of state budget to GDP, foreign exchange reserves to GDP, bank assets to GDP, the growth rate of industrial production, the growth rate of household savings, stock market capitalization to GDP, the current account balance to GDP, direct investments to GDP, foreign exchange reserves to weekly imports;

♦ the third subset includes indicators the values of which should not change (increase or decrease) compared to the values received according to the Pareto optimality principle. This group is formed by such indicators as the rate of inflation, the growth rate of the exchange rate of the Ukrainian hryvna to the U.S. dollar, the share of capital of foreign banks in the general capitalization of the banking system, export/import.

The defining feature of the proposed scientific and methodical approach is the use of the Pareto optimal planing dividing the array of input indicators into three groups. According to this plan the maximal and minimal possible normalized values of both internal and external indicators are taken into account with a different level of priority in the proportion of 80% and 20%. Different combinations of weighting coefficients for maximal and minimal values for all the studied period correspond to the lower and upper limits of Pareto optimal values:

$$Popt_{iv}^{\max} = 0.8 \cdot \max_{t} \left\{ k_{it}^{v} \right\} + 0.2 \cdot \min_{t} \left\{ k_{it}^{v} \right\},$$

$$Popt_{iv}^{\min} = 0.2 \cdot \max_{t} \left\{ k_{it}^{v} \right\} + 0.8 \cdot \min_{t} \left\{ k_{it}^{v} \right\},$$

$$Popt_{jz}^{\max} = 0.8 \cdot \max_{t} \left\{ k_{jt}^{z} \right\} + 0.2 \cdot \min_{t} \left\{ k_{jt}^{z} \right\},$$ (2)

$$Popt_{jz}^{\min} = 0.2 \cdot \max_{t} \left\{ k_{jt}^{z} \right\} + 0.8 \cdot \min_{t} \left\{ k_{jt}^{z} \right\},$$

where $Popt_{iv}^{\max}$ ($Popt_{jz}^{\max}$) is the upper limit of the Pareto set of optimal values for the $i$-th internal (respectively, $j$-th external) indicator of the financial system's characteristic for the considered time interval; $Popt_{iv}^{\min}$ ($Popt_{jz}^{\min}$) is the lower limit of the Pareto set of optimal values for the $i$-th internal (respectively, $j$-th external) indicator of the financial system's characteristic for the considered time interval.

Intermediate calculations (maximal and minimal values for all years of the studied period), the upper

and lower limits of the set of Pareto optimal values were determined on the basis of actual data presented in Table 3 (see Appendix).

Based on the above mentioned indicators of Pareto optimal values we will write the inequalities which hold in the case of stability of the financial system in the context of the studied aspects, and which do not hold in the opposite case. It is offered to formalize the proposed approach by using the binary assessments of the financial system's stability, which allows:

♦ to provide qualitative interpretation of the financial system's stability at any given time (0 – stable, 1 – unstable);

♦ to claim the execution (non-execution) of requirements to the characteristics of the system's stability calculated according to Pareto optimal values;

♦ to consider the specific character of each group of indicators in the formation of a system of constraints.

We will study the binary values of the characteristics of the financial system's stability level:

♦ the first subset includes indicators the values of which can be reduced in comparison with the values calculated according to the Pareto-optimality principle:

$$b_{it}^{Iv} = \begin{cases} 0, k_{it}^{Iv} \geq Popt_{iv}^{min} = 0.2 \cdot \max_{t} \left\{ k_{it}^{v} \right\} + 0.8 \cdot \min_{t} \left\{ k_{it}^{v} \right\} \\ 1, k_{it}^{Iv} < Popt_{iv}^{min} = 0.2 \cdot \max_{t} \left\{ k_{it}^{v} \right\} + 0.8 \cdot \min_{t} \left\{ k_{it}^{v} \right\} \end{cases},$$ (3)

$$b_{jt}^{Iz} = \begin{cases} 0, k_{jt}^{Iz} \geq Popt_{jz}^{min} = 0.2 \cdot \max_{t} \left\{ k_{jt}^{z} \right\} + 0.8 \cdot \min_{t} \left\{ k_{jt}^{z} \right\} \\ 1, k_{jt}^{Iz} < Popt_{jz}^{min} = 0.2 \cdot \max_{t} \left\{ k_{jt}^{z} \right\} + 0.8 \cdot \min_{t} \left\{ k_{jt}^{z} \right\} \end{cases},$$

where $b_{it}^{Iv}$ ($b_{jt}^{Iz}$) is abinary value of the $i$-th internal (respectively, $j$-th external) indicator of the first group of the financial system's characteristics for the considered time interval; $k_{it}^{Iv}$ ($k_{jt}^{Iz}$)-normalized value of $i$-th internal (respectively, $j$-th external) indicator of the first group of the financial system's characteristics for the $t$ time period;

♦ the second subset includes indicators the values of which should be increased incomparison with the optimal compromise values:

$$b_{it}^{IIv} = \begin{cases} 0, k_{it}^{IIv} \leq Popt_{iv}^{max} = 0.8 \cdot \max_{t} \left\{ k_{it}^{v} \right\} + 0.2 \cdot \min_{t} \left\{ k_{it}^{v} \right\} \\ 1, k_{it}^{IIv} > Popt_{iv}^{max} = 0.8 \cdot \max_{t} \left\{ k_{it}^{v} \right\} + 0.2 \cdot \min_{t} \left\{ k_{it}^{v} \right\} \end{cases},$$ (4)

$$b_{jt}^{IIz} = \begin{cases} 0, k_{jt}^{IIz} \leq Popt_{jz}^{max} = 0.8 \cdot \max_{t} \left\{ k_{jt}^{z} \right\} + 0.2 \cdot \min_{t} \left\{ k_{jt}^{z} \right\} \\ 1, k_{jt}^{IIz} > Popt_{jz}^{max} = 0.8 \cdot \max_{t} \left\{ k_{jt}^{z} \right\} + 0.2 \cdot \min_{t} \left\{ k_{jt}^{z} \right\} \end{cases},$$

where $b_{it}^{IIv}$ ($b_{jt}^{IIz}$) are binary values of the $i$-th internal (respectively, $j$-th external) indicator of the second group of the financial system's characteristics for the considered time interval; $k_{it}^{IIv}$ ($k_{jt}^{IIz}$)-normalized values of the $i$-th internal (respectively, $j$-th external) indicator of the second group of the

financial system's characteristics for the $t$ time period;

♦ the third subset includes indicators the values of which should not change (increase or decrease) in comparison with the values obtained according to the Pareto optimal plan:

$$b_{it}^{IIIv} = \begin{cases} 0, Popt_{iv}^{\min} = 0.2 \cdot \max_t\{k_{it}^v\} + 0.8 \cdot \min_t\{k_{it}^v\} \le k_{it}^{IIz} \le Popt_{iv}^{\max} = 0.8 \cdot \max_t\{k_{it}^v\} + 0.2 \cdot \min_t\{k_{it}^v\} \\ 1, k_{it}^{IIIv} > Popt_{iv}^{\max} = 0.8 \cdot \max_t\{k_{it}^v\} + 0.2 \cdot \min_t\{k_{it}^v\}, k_{it}^{IIIv} < Popt_{iv}^{\min} = 0.2 \cdot \max_t\{k_{it}^v\} + 0.8 \cdot \min_t\{k_{it}^v\} \end{cases},$$

$$b_{jt}^{IIIz} = \begin{cases} 0, Popt_{jz}^{\min} = 0.2 \cdot \max_t\{k_{jt}^z\} + 0.8 \cdot \min_t\{k_{jt}^z\} \le k_{jt}^{IIz} \le Popt_{jz}^{\max} = 0.8 \cdot \max_t\{k_{jt}^z\} + 0.2 \cdot \min_t\{k_{jt}^z\} \\ 1, k_{jt}^{IIzv} > Popt_{jz}^{\max} = 0.8 \cdot \max_t\{k_{jt}^z\} + 0.2 \cdot \min_t\{k_{jt}^z\}, k_{jt}^{IIzv} < Popt_{jz}^{\min} = 0.2 \cdot \max_t\{k_{jt}^z\} + 0.8 \cdot \min_t\{k_{jt}^z\} \end{cases},$$

(5)

where $b_{it}^{IIIv}$ ($b_{jt}^{IIIz}$) are binary values of the $i$-th internal (respectively, $j$-th external) indicator of the third group of the financial system's characteristics for the considered time interval; $k_{it}^{IIIv}$ ($k_{jt}^{IIIz}$)-normalized values of the $i$-th internal (respectively, $j$-th external) indicator of the third group of the financial system's characteristics for the $t$ time period.

The results of calculations with equations (3)-(5) are presented in Table 4. At the same time, it should be noted that binary values make it possible to assert the stability of the financial system only in the context of this area of research, not allowing to generalize the characteristics of the financial system's stability level for each year. Therefore, the final stage of implementation of the scientific and methodical approach to assessing the financial system's stability under conditions of economic transformation is the determination of binary values both in a group of internal and external indicators and their aggregation into one indicator of the "total sum of binary indicators" that is a quantitative estimate of the stability level. Mathematical formalization of the described calculations takes the following form:

$$SBP_t = \left[ \sum_i b_{it}^{Iv} + \sum_i b_{it}^{IIv} + \sum_i b_{it}^{IIIv} \right] +$$

$$+ \left[ \sum_j b_{jt}^{Iz} + \sum_j b_{jt}^{IIz} + \sum_j b_{jt}^{IIIz} \right],$$

(6)

where $SBP_t$ is the sum of binary internal and external indicators of the three designated groups for the $t$ time period.

Although the total sum of binary indicators is a quantitative assessment of the financial system's

stability, it can not give a definite answer to the following question: is the financial system in the studied period stable or not? This is explained by the fact that the analyzed indicator assumes a wide range of values from zero to 16 with various combinations of binary indicators. Therefore, on the basis of the minimal possible Pareto optimal value it is necessary to move from the quantitative assessment of the stability level directly to the level of stability: zero if the financial system is stable and one in the opposite case:

$$RS_t = \begin{cases} 0, SBP_t \le 0.2 \cdot max_t\{SBP_t\} + 0.8 \cdot min_t\{SBP_t\} \\ 1, SBP_t > 0.2 \cdot max_t\{SBP_t\} + 0.8 \cdot min_t\{SBP_t\}, \end{cases}$$

(7)

where $RS_t$ is the level of the financial system's stability for the $t$ time period.

Based on the results obtained from equation 7 (see Table 4) it is possible to conclude that during the period 2000-2012 the financial system of Ukraine was characterized by instability from 2008 to 2011. The calculations a dequately confirm the real situation in Ukraine characterized by a lengthy period of destructive factors during the crisis of 2008-2009.

## Conclusions

The choice of internal and external factors of the national financial system's characteristics; clusterization based on identification of the factors' influence; normalization of indicators with the help of the relative approach and with the Pareto optimal plan create scientific-based pre-conditions for the effective analysis of the financial system's stability. Consequently, the proposed scientific and methodical approach makes it possible to create an adequate crisis early warning system.

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# Appendix

Table 1. Internal and external indicators describing the financial system in the period 2000-2012, % (compiled on the basis of [4,6])

| Period | Indicators of the financial system functioning | | | | | | | |
|--------|---|---|---|---|---|---|---|---|
| | Internal indicators | | | | | | | |
| Year | Internal debt/GDP | The growth rate of per capita GDP | Inflation rate | The balance of state budget to GDP | Foreign exchange reserves to GDP | Bank assets/GDP | The growth rate of industrial production | The growth rate of household savings | The ratio of stock market capitalization to GDP |
| 2000 | 12,2 | 118,9 | 128,2 | 0,6 | 4,8 | 25,6 | 108,7 | 117,8 | 7,1 |
| 2001 | 10,3 | 122,1 | 112 | -0,3 | 8,0 | 26,3 | 114,0 | 127,6 | 3,9 |
| 2002 | 9,5 | 111,7 | 100,8 | 0,7 | 10,4 | 27,8 | 108,9 | 115,4 | 10,2 |
| 2003 | 7,7 | 119,3 | 105,2 | -0,2 | 13,8 | 25,4 | 125,9 | 95,4 | 9,6 |
| 2004 | 6,1 | 130,1 | 109 | -3,0 | 14,6 | 39,1 | 138,6 | 190,9 | 20,6 |
| 2005 | 4,3 | 128,9 | 113,5 | -1,8 | 22,2 | 41,6 | 116,9 | 146,9 | 33,3 |
| 2006 | 3,1 | 124,1 | 109,1 | -0,7 | 20,7 | 52,8 | 117,7 | 96,8 | 41,0 |
| 2007 | 2,5 | 133,2 | 112,8 | -1,4 | 22,8 | 70,6 | 130,0 | 108,1 | 78,3 |
| 2008 | 4,7 | 132,3 | 125,2 | -1,3 | 25,6 | 79,7 | 127,9 | 108,9 | 19,1 |
| 2009 | 11,5 | 96,8 | 115,9 | -3,9 | 23,4 | 49,4 | 88,0 | 154,5 | 15,9 |
| 2010 | 14,4 | 119,0 | 109,4 | -5,9 | 25,6 | 84,8 | 132,1 | 201,4 | 23,5 |
| 2011 | 13,3 | 120,7 | 108 | -1,8 | 19,7 | 79,0 | 124,8 | 70,4 | 9,6 |
| 2012 | 13,5 | 108,5 | 100,6 | -3,8 | 14,1 | 79,3 | 83,0 | 91,8 | 19,7 |

| External factors | | | | | | | |
|------|---|---|---|---|---|---|---|
| Year | External debt/GDP | The current account balance to GDP | Direct investments to GDP | The growth rate of the exchange rate of the Ukrainian hryvna to the U.S. dollar | Foreign exchange reserves to weekly imports | The share of capital of foreign banks in general capitalization of the national banking system | Export/import |
| 2000 | 61,1 | 3,9 | 12,7 | 104,2 | 0,9 | 13,3 | 108,78 |
| 2001 | 53,6 | 3,7 | 12,7 | 97,5 | 1,7 | 12,5 | 102,99 |
| 2002 | 51,1 | 7,7 | 13,9 | 100,6 | 1,9 | 13,7 | 108,64 |
| 2003 | 47,5 | 5,8 | 15,1 | 100,0 | 2,4 | 11,3 | 104,66 |
| 2004 | 47 | 10,5 | 14,8 | 99,5 | 2,8 | 9,6 | 113,71 |
| 2005 | 45,9 | 2,9 | 19,9 | 95,2 | 4,4 | 19,5 | 101,54 |
| 2006 | 50,6 | -1,5 | 21,5 | 100,0 | 3,7 | 27,6 | 94,24 |
| 2007 | 60,2 | -4,2 | 26,7 | 100,0 | 4,7 | 30,3 | 88,70 |
| 2008 | 55,9 | -7 | 25,8 | 152,5 | 6,7 | 36,7 | 85,64 |
| 2009 | 88,3 | -1,5 | 44,4 | 104,5 | 4,3 | 35,8 | 96,53 |
| 2010 | 86 | -2,2 | 42,5 | 99,3 | 4,2 | 40,6 | 94,56 |
| 2011 | 77,3 | -6,3 | 39,5 | 100,9 | 3,6 | 41,9 | 89,74 |
| 2012 | 76,6 | -8,4 | 41,3 | 100,3 | 2,8 | 41,6 | 86,27 |

Table 2. Normalized internal and external indicators of the financial system functioning

| Period | Indicators of the financial system functioning | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Internal factors | | | | | | | | | |
| Year | Internal debt/GDP | The growth rate of per capita GDP | Inflation rate | The balance of state budget to GDP | Foreign exchange reserves to GDP | Bank assets/GDP | The growth rate of industrial production | The growth rate of household savings | The ratio of stock market capitalization to GDP |
| 2000 | 0,2 | 0,1 | 0,00 | 0,1 | 0,8 | 0,7 | 0,2 | 0,4 | 0,9 |
| 2001 | 0,3 | 0,1 | 0,13 | 1,4 | 0,7 | 0,7 | 0,2 | 0,4 | 1,0 |
| 2002 | 0,3 | 0,2 | 0,21 | 0,0 | 0,6 | 0,7 | 0,2 | 0,4 | 0,9 |
| 2003 | 0,5 | 0,1 | 0,18 | 1,3 | 0,5 | 0,7 | 0,1 | 0,5 | 0,9 |
| 2004 | 0,6 | 0,0 | 0,15 | 5,2 | 0,4 | 0,5 | 0,0 | 0,1 | 0,7 |
| 2005 | 0,7 | 0,0 | 0,11 | 3,6 | 0,1 | 0,5 | 0,2 | 0,3 | 0,6 |
| 2006 | 0,8 | 0,1 | 0,15 | 2,0 | 0,2 | 0,4 | 0,2 | 0,5 | 0,5 |
| 2007 | 0,8 | 0,0 | 0,12 | 3,0 | 0,1 | 0,2 | 0,1 | 0,5 | 0,0 |
| 2008 | 0,7 | 0,0 | 0,02 | 2,9 | 0,0 | 0,1 | 0,1 | 0,5 | 0,8 |
| 2009 | 0,2 | 0,3 | 0,10 | 6,6 | 0,1 | 0,4 | 0,4 | 0,2 | 0,8 |
| 2010 | 0,0 | 0,1 | 0,15 | 9,4 | 0,0 | 0,0 | 0,0 | 0,0 | 0,7 |
| 2011 | 0,1 | 0,1 | 0,16 | 3,6 | 0,2 | 0,1 | 0,1 | 0,7 | 0,9 |
| 2012 | 0,1 | 0,2 | 0,22 | 6,4 | 0,5 | 0,1 | 0,4 | 0,5 | 0,7 |
| External factors | | | | | | | | | |
| Year | External debt/GDP | The current account balance to GDP | Direct investments to GDP | The growth rate of the exchange rate of the Ukrainian hryvna to the U.S. dollar | | Foreign exchange reserves to weekly imports | The share of capital of foreign banks in general capitalization of the national banking system | | Export/import |
| 2000 | 0,3 | 0,6 | 0,7 | 0,3 | | 0,9 | 0,7 | | 0,0 |
| 2001 | 0,4 | 0,6 | 0,7 | 0,4 | | 0,7 | 0,7 | | 0,1 |
| 2002 | 0,4 | 0,3 | 0,7 | 0,3 | | 0,7 | 0,7 | | 0,0 |
| 2003 | 0,5 | 0,4 | 0,7 | 0,3 | | 0,6 | 0,7 | | 0,1 |
| 2004 | 0,5 | 0,0 | 0,7 | 0,3 | | 0,6 | 0,8 | | 0,0 |
| 2005 | 0,5 | 0,7 | 0,6 | 0,4 | | 0,3 | 0,5 | | 0,1 |
| 2006 | 0,4 | 1,1 | 0,5 | 0,3 | | 0,4 | 0,3 | | 0,2 |
| 2007 | 0,3 | 1,4 | 0,4 | 0,3 | | 0,3 | 0,3 | | 0,2 |
| 2008 | 0,4 | 1,7 | 0,4 | 0,0 | | 0,0 | 0,1 | | 0,2 |
| 2009 | 0,0 | 1,1 | 0,0 | 0,3 | | 0,4 | 0,1 | | 0,2 |
| 2010 | 0,0 | 1,2 | 0,0 | 0,3 | | 0,4 | 0,0 | | 0,2 |
| 2011 | 0,1 | 1,6 | 0,1 | 0,3 | | 0,5 | 0,0 | | 0,2 |
| 2012 | 0,1 | 1,8 | 0,1 | 0,3 | | 0,6 | 0,0 | | 0,2 |

Table 3. Pareto optimal values of the internal and external indicators of the financial system functioning

| Statistical indicator | Indicators of the financial system's functioning | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Internal factors | | | | | | | | |
| | Internal debt/GDP | The growth rate of per capita GDP | Inflation rate | The balance of state budget to GDP | Foreign exchange reserves to GDP | Bank assets/GDP | The growth rate of industrial production | The growth rate of household savings | The ratio of stock market capitalization to GDP |
| Maximal value | 0,8 | 0,3 | 0,2 | 9,4 | 0,8 | 0,7 | 0,4 | 0,7 | 1,0 |
| Minimal value | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| Pareto optimal maximal value | 0,7 | 0,2 | 0,2 | 7,5 | 0,6 | 0,6 | 0,3 | 0,5 | 0,8 |
| Pareto optimal minimal value | 0,2 | 0,1 | 0,0 | 1,9 | 0,2 | 0,1 | 0,1 | 0,1 | 0,2 |
| External factors | | | | | | | | | |
| | External debt/GDP | The current account balance to GDP | Direct investments to GDP | The growth rate of the exchange rate of the Ukrainian hryvna to the U.S. dollar | Foreign exchange reserves to weekly imports | The share of capital of foreign banks in general capitalization of the national banking system | | | Export/import |
| Maximal value | 0,5 | 1,8 | 0,7 | 0,4 | 0,9 | 0,8 | | | 0,2 |
| Minimal value | 0,0 | 0 | 0 | 0 | 0 | 0 | | | 0 |
| Pareto optimal maximal value | 0,4 | 1,4 | 0,6 | 0,3 | 0,7 | 0,6 | | | 0,2 |
| Pareto optimal minimal value | 0,1 | 0,4 | 0,1 | 0,1 | 0,2 | 0,2 | | | 0,0 |

Table 4. Binary internal and external indicators of the financial system functioning and the level of its stability

| Period | Indicators of the financial system's functioning | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Internal factors | | | | | | | | | | |
| Year | Internal debt/GDP | The growth rate of per capita GDP | Inflation rate | The balance of state budget to GDP | Foreign exchange reserves to GDP | Bank assets/GDP | The growth rate of industrial production | The growth rate of household savings | The ratio of stock market capitalization to GDP | The sum of binary indicators |
| 2000 | 1,0 | 0,0 | 1,00 | 0,0 | 1,0 | 1,0 | 0,0 | 0,0 | 1,0 | 5,0 |
| 2001 | 0,0 | 0,0 | 0,00 | 0,0 | 1,0 | 1,0 | 0,0 | 0,0 | 1,0 | 3,0 |
| 2002 | 0,0 | 0,0 | 1,00 | 0,0 | 0,0 | 1,0 | 0,0 | 0,0 | 1,0 | 3,0 |
| 2003 | 0,0 | 0,0 | 1,00 | 0,0 | 0,0 | 1,0 | 0,0 | 1,0 | 1,0 | 4,0 |
| 2004 | 0,0 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 2005 | 0,0 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 2006 | 0,0 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 2007 | 0,0 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 2008 | 0,0 | 0,0 | 1,00 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1,0 |
| 2009 | 0,0 | 1,0 | 0,00 | 0,0 | 0,0 | 0,0 | 1,0 | 0,0 | 1,0 | 3,0 |
| 2010 | 1,0 | 0,0 | 0,00 | 1,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 2,0 |
| 2011 | 1,0 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | 1,0 | 1,0 | 3,0 |
| 2012 | 1,0 | 0,0 | 1,00 | 0,0 | 0,0 | 0,0 | 1,0 | 1,0 | 0,0 | 4,0 |

Table 4 (cont.). Binary internal and external indicators of the financial system functioning and the level of its stability

| External factors | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | External debt/GDP | The current account balance to GDP | Direct investments to GDP | The growth rate of the exchange rate of the Ukrainian hryvna to the U.S. dollar | Foreign exchange reserves to weekly imports | The share of capital of foreign banks in general capitalization of the banking system | Export/ import | The sum of external factors binary indicators | The sum of binary indicators | The level of stability |
| 2000 | 0,0 | 0,0 | 0,0 | 1,00 | 0,0 | 0,00 | 1,00 | 2,0 | 7,0 | 1 |
| 2001 | 0,0 | 0,0 | 0,0 | 1,00 | 0,0 | 1,00 | 0,00 | 2,0 | 5,0 | 1 |
| 2002 | 0,0 | 1,0 | 1,0 | 1,00 | 1,0 | 1,00 | 1,00 | 6,0 | 9,0 | 1 |
| 2003 | 1,0 | 0,0 | 0,0 | 1,00 | 0,0 | 1,00 | 1,00 | 4,0 | 8,0 | 1 |
| 2004 | 0,0 | 1,0 | 1,0 | 1,00 | 1,0 | 1,00 | 1,00 | 6,0 | 6,0 | 1 |
| 2005 | 0,0 | 0,0 | 1,0 | 1,00 | 1,0 | 1,00 | 1,00 | 5,0 | 5,0 | 1 |
| 2006 | 0,0 | 0,0 | 1,0 | 1,00 | 1,0 | 1,00 | 0,00 | 4,0 | 4,0 | 1 |
| 2007 | 0,0 | 0,0 | 1,0 | 1,00 | 1,0 | 1,00 | 1,00 | 5,0 | 5,0 | 1 |
| 2008 | 0,0 | 0,0 | 1,0 | 1,00 | 0,0 | 1,00 | 0,00 | 3,0 | 4,0 | 0 |
| 2009 | 0,0 | 0,0 | 1,0 | 1,00 | 0,0 | 1,00 | 1,00 | 4,0 | 7,0 | 0 |
| 2010 | 0,0 | 0,0 | 0,0 | 1,00 | 0,0 | 0,00 | 0,00 | 1,0 | 3,0 | 0 |
| 2011 | 0,0 | 0,0 | 0,0 | 1,00 | 0,0 | 0,00 | 0,00 | 1,0 | 4,0 | 0 |
| 2012 | 0,0 | 0,0 | 0,0 | 1,00 | 0,0 | 0,00 | 1,00 | 2,0 | 6,0 | 1 |