

Equilibrium. Quarterly Journal of Economics and Economic Policy

Volume 16 Issue 2 June 2021

p-ISSN 1689-765X, e-ISSN 2353-3293

www.economic-policy.pl



ORIGINAL ARTICLE


Citation: Shkolnyk, I., Kozmenko, S., Kozmenko, O., Orlov, V., & Shukairi, F. (2021). Modeling of the financial system's stability on the example of Ukraine. *Equilibrium. Quarterly Journal of Economics and Economic Policy*, 16(2), 377–411. doi: 10.24136/eq.2021.014

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Received: 11.01.2021; Revised: 28.04.2021; Accepted: 19.05.2021; Published online: 30.06.2021


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Modeling of the financial system's stability on the example of Ukraine

JEL Classification: E44; E60; G17; G20

Keywords: financial institute; financial market; stock market; financial depth; assets; efficiency

Abstract

Research background: Financial stability is one of the key tasks in the functioning of the country's financial system. National financial systems have significant differences in the level of their development, structure and approaches to regulation. There are no uniform world standards for methods and indicators of assessing financial stability. International financial institutions, including the International Monetary Fund, only outline certain areas and offer an indicative list of indicators that should be taken into account.

Purpose of the article: Taking into account the peculiarities of the subject and object structure of Ukraine's financial system, this study formed groups of indicators that reflect the state of finan-

cial depth, level of access and efficiency of the financial system, systematized by subject (financial institutions) and object financial markets) characteristics.

Methods: The basis for the formation of a set of indicators is a matrix of characteristics of the financial system's stability, which is formed according to the principle of 4x2 proposed by experts of the International Monetary Fund. The list of indicators to calculate the integrated indicator that characterizes the stability of the financial system of Ukraine, covers the period 2007–2019 and includes 29 indicators that take into account the peculiarities of its formation and development. Harrington's desirability function is used to determine the integrated indicator that characterizes the state of financial stability.

Findings & value added: The intermediate calculations obtained by modeling groups of indicators showed that the level of access to the financial system and the state of its depth are balanced during the study period (the range of variation of integrated indicators for these groups is minimal — from 0.1 to 0.18), is at a satisfactory level and the basis for ensuring the financial system's stability. Conversely, the efficiency of the financial system is low, and characterized by a high degree of volatility (range of variation — 0.51). The obtained integrated indicator, which is in the range from 0.41 to 0.54 on the Harrington desirability scale, makes it possible to assess the state of the financial system's stability in Ukraine as satisfactory, but with a high level of sensitivity to both external and internal shocks.

Introduction

The issue of assessing the stability of the financial system is considered for countries with different levels of financial market development (developed, accelerated development and moderate development). It is also relevant for Ukraine. At the same time, it is not possible to form a single agreed list of indicators in order to assess financial stability at the international level due to significant differentiation in national financial systems. The latter differ not only in the level of development, but also according to their structure, subjects of the financial system, legally regulated financial instruments, the defining role of the banking system or stock market as major financial intermediaries, the level of state influence not only in terms of the activities of financial regulators, but also in terms of the state's participation in the financial system, which can determine the volumes of financial flows. In this regard, it is necessary to determine not only a set of indicators that, on the one hand, would correspond to the list of indicators taken into account by international financial institutions, and, on the other hand, would reflect the peculiarities of the national financial system, as well as methods of integrated assessment of the stability level of Ukraine's financial system. Taking into account that the National Bank of Ukraine periodically changes the methodology for determining financial stability and the list of indicators used for this, as well as the fact that as a result of calculations, an integrated indicator is not determined that would allow assessing the overall situation in the system, and not in individual sectors, it is important to use such a method that would make it possible to obtain an integrated indicator.

Given that the financial systems of different countries do not operate separately, but are part of (more or less) the global financial system, developing countries, as well as countries with emerging market economies, can pose significant risks to global financial stability. According to the International Monetary Fund (2021), having large and fairly stable budget deficits (including Ukraine) can create significant financial risks when prolonging government debt instruments. That is why the assessment of the stability of national financial systems is not only something that is carried out by national financial regulators, but also in scientific research, as it can be of significant interest to the international scientific community and practitioners. The article uses a unique set of indicators, defined by the authors, to build an integrated indicator of the stability of Ukraine's financial system, which allows taking into account not only the depth of financial flows into the economy and their efficiency, but also the availability of financial transactions for individuals and businesses. In particular, data from the National Bank of Ukraine, the Ministry of Finance of Ukraine, and the National Commission on Securities and Stock Market of Ukraine were used. In addition, all indicators are grouped into those that characterize the development of financial markets, and those that characterize the state of financial institutions. According to this approach, the assessment of the stability of Ukraine's financial system was not carried out before.

The purpose of the article is to assess the state of the financial system's stability based on the method of integrated assessment of the quality and efficiency of financial institutions and financial markets in Ukraine.

This method is based on the use of Harrington's desirability function with one-sided constraints, which allows the original multicriteria problem with criteria characterized by non-uniformity to be aligned with a multicriteria problem with one-dimensional criteria. In addition, the resulting function allows assessing the level of sensitivity of the obtained integrated index to the effects of internal and external shocks.

The remaining part of the paper is organized as follows. Section 2 provides a review of the literature on existing studies of assessing the stability of the financial system and justifying the feasibility of taking into account when assessing and choosing indicators of the national financial system, its focus on the banking system or the stock market, as well as the role of public finance. Section 3 reveals the research algorithm and describes a set of indicators used for calculations. Section 4 presents the results obtained and their detailed interpretation. Section 5 defines certain discussion provisions. The Conclusions section summarizes the research results.

Literature review

The structure of a country's financial system as a condition for the formation of financial stability

According to Crockett (1997), financial stability exists when key financial institutions are stable, when the financial system is in a stable condition and it is able to “withstand disturbances while preventing cumulative processes that could harm savings, investments and payments in the economy (Padoa-Schioppa, 2002), when the system promotes an efficient allocation of economic resources in time and space, manages financial risks and maintains its ability to perform key functions, even when faced with external shocks or growing imbalances” (Schinasi, 2005). If we consider the definition of financial stability from the point of view of the National Bank of Ukraine, it is in fact similar to the definition of Schinasi (2005).

Sahoo (2014) notes that financial intermediation plays an important role in the development of financial system and ensuring stability using India as an example. The evaluation of financial development indicators made it possible to state that bank-based and market-based intermediation processes have undergone remarkable improvements in the last six decades. In addition, the growth in financial depth indicator plays an important role in stimulating India's economic growth. According to Foot (2003), financial stability exists if there is “a) monetary stability; b) the level of employment is within the natural limits for the economy; c) confidence in the functioning of key financial institutions and markets in the economy and d) there is no volatility in prices for real or financial assets, which can lead to destabilization in points a) or b). Kormilicyna (2011) notes that “the essence of financial stability is revealed through the concept of “financial system” and its functions” depending on the peculiarities of the financial system and its key elements.

Pennesi (2021) argues that three procedural safeguards are important to ensure financial stability in EU countries “a) ex ante assessment of third countries' regulation to ensure regulatory compatibility between the EU and the third country; b) ex post withdrawal of market access if cross-border liberalization triggers a “race to the bottom”; and c) direct supervision of systemic third-country entities to prevent them from becoming vectors of cross-border systemic risk”.

Kisel'áková *et al.* (2020) note that monetary policy has a decisive influence on the formation of financial stability and the level of financial development, in particular in the EU. In addition, they note that in the context of sustainable financial development, the monetary policy of the European

Central Bank has positively affected and stimulated the labor market and development in goods and services markets.

Golemi (2020), studying the state of stability of the financial system in Albania, focuses on the role of macroprudential policy pursued by the Bank of Albania considering the leading role played by the banking system in this country and coming to the conclusion that the implementation of macroprudential policy measures can help contribute to a stable financial intermediation by raising the resilience of the financial system against risks.

Khalatur *et al.* (2020) conducted a study to determine the state of financial stability on the example of banks under VUCA-world conditions. They note that the modern business environment is characterized by variability, uncertainty, complexity and ambiguity (VUCA-world) and is chaotic and volatile. In these circumstances, the authors note that the tools for assessing the state of financial stability should also change. Therefore, in their work they analyze the impact of the modern business space “VUCA” on the financial stability of the country’s banks. A factor analysis using a regression model was conducted on the example of Eastern European countries, such as Ukraine, Belarus, Latvia, Lithuania and Moldova. It was proved that macroeconomic factors, namely per capita GDP growth and the costs of research and development have a significant impact on banks’ financial stability, the volume of foreign direct investments and net capital inflows into the country. These dependencies are also confirmed for the European Union via the impact of R&D costs on multifactor productivity and connected indicators of growth (Bilan *et al.*, 2020b; Kijek & Matras-Bolibok, 2020).

In Ukraine, public finance has a significant influence on the formation of the financial system’s stability, as noted in many studies. The relationship between the state of public finances and the state of the financial system of the EU and Ukraine is studied in the work of Chornovol *et al.* (2020). They note that one of the main restraining factors in the development of the public finance system is a significant level of uncertainty in economic processes, which exacerbates macroeconomic fluctuations, significant public debt and budget deficit pose risks to financial and economic stability; their potential negative impact on socio-economic processes is much more destructive than the pro-cyclical nature of fiscal policy. Therefore, it is important to optimize the financial and budgetary instruments used in the public finance management system.

The role of public finance in ensuring the financial system’s effective development and formation of stability are considered in the work of Zhuravka *et al.* (2018). In their further study, Zhuravka *et al.* (2021) noted that an excessive increase in public debt has negative consequences for the

financial system of any country, as evidenced by the use of the ARIMA model in analyzing data on public debt in Ukraine for the period of 2004–2020. The obtained results showed an unstable debt situation, a significant increase in public debt in the last 6 years and justified the need to increase the efficiency of public debt management in the context of financial stability.

Chernadchuk (2017) identifies the main elements of the financial system of Ukraine and highlights the public finance sector, corporate finance sector, household finance, as well as a detailed presentation of the financial market with its financial institutions and infrastructure. At the same time, elements of the financial system are harmonized with the current legislation of Ukraine. Frolov and Shukairi (2020), agreeing with the same approach to the composition of the financial system of Ukraine, note that its features include a significant predominance of bank assets among financial assets, as well as a significant role of the state, which owns four biggest banks in Ukraine according to the size of their assets.

Financial stability largely determines the level of financial security of the country, which is studied on the example of Ukraine and Poland in the work of Shkolnyk *et al.* (2020). This study notes that the level of financial security of both countries depends on the nature of the existing financial architecture and the level of its economic and financial development.

Bukhtiarova *et al.* (2020) note that to ensure a high level of financial security and, accordingly, stability of the financial system, the level of de-shadowing of the economy and, therefore, effective financial monitoring becomes important, which is primarily aimed at implementing measures to combat money laundering. This issue is extremely relevant for Ukraine, which is confirmed by the study of Vitvitskiy *et al.* (2021), who found that the consequences of increasing money laundering are the formation of a significant budget deficit, reduced social funding and lower living standards, which negatively affects the state of the financial system's stability.

In addition, the level of financialization of the economy and financial stability have a significant impact on the state of socio-economic development of the country. This is proven by the studies of Kozmenko *et al.* (2014). Later, the work of Shkolnyk *et al.* (2019) notes a significant impact of the level of the country's financial stability on socio-economic development, which is in line with findings about impact on social safety of the state, and supported by confirmed links of social factors with financial results in entrepreneurial environment proved by Bilan *et al.* (2020a). At the present stage, the problem of increase in the global economy's financialization is complicated by the spread of the COVID-19 pandemic, which exacerbates the risks of financial market instability, price stability and sustaina-

bility of the existing public debt. This problem was studied by Bogdan and Lomakovich (2021), who proposed a set of financial and organizational measures to promote the creation of a financial base for sustainable economic growth in Ukraine and related to the development of the national capital market, fiscal policy adjustment, acceleration of inflows of direct foreign investments, changes in the monetary policy of the National Bank of Ukraine and management of foreign exchange reserves.

Determination of indicators for assessing the stability of the financial system

In determining the stability of the financial system, the set of indicators by which it will be evaluated, as well as the system of methods that will be used, becomes important.

According to the Financial Soundness Indicators Compilation Guide developed by the International Monetary Fund (2019), indicators include the indicators of the current financial condition and stability of the entire sector of financial institutions, as well as the corporate sector and households that are clients of financial institutions. All indicators are divided into two groups — the key and additional, which in turn include the following groups of indicators: the key indicators characterizing the state of depository institutions (banks) — indicators of capital adequacy, asset quality, profitability, liquidity, risk sensitivity and real estate market indicators; additional indicators — characterizing the state of deposit-taking corporations, other financial corporations in general, and, particularly, insurance companies, private pension funds, investment funds, non-financial corporations (real sector of the economy), households and the real estate market. It should be noted that the set of indicators proposed in the Financial Soundness Indicators, Compilation Guide 2006, has changed as a result of new international regulatory documents, primarily Basel III (International Monetary Fund (2006).

At the same time, the set of these indicators needs to be critically rethought for each country. Currently, the approach proposed by a group of scientists Čihák *et al.* (2012) is quite common. Having conducted a benchmarking of the global financial system, these researchers formed a matrix of financial stability 4x2. The proposed set of indicators is quite comprehensive and systematizes the indicators of the International Monetary Fund according to four main characteristics (depth, accessibility, efficiency, stability) and two groups — financial institutions and financial markets.

Faryna and Dadashova (2015) believe that “The selected set of indicators should take into account the existing links between the real and finan-

cial sectors of the economy. “Indicators of financial stability should reflect the main characteristics of the financial system, indicating its stability or, conversely — susceptibility to disturbances, and accordingly determine the state of stability”.

The main tasks in determining the stability of Ukraine’s financial system include: firstly, the choice of method for assessing financial stability taking into account the peculiarities of the economic system, secondly, adequate implementation of world experience, including recommendations of international organizations, including the International Monetary Fund, the World Bank and the Financial Stability Board, thirdly, scientific justification of the feasibility of using certain indicators, models and methods of their evaluation, fourthly, a systematic revision of the set of indicators taking into account the variability of the financial system under the influence of innovative financial technologies. In this context, it should be noted that the National Bank of Ukraine, which, like most central banks, has one of the main tasks to ensure financial stability, while drawing up a financial stability report, periodically revises not only a set of indicators, but also the methodology for calculating financial risks. Starting from 2021, the National Bank is introducing a new methodology for constructing a financial risk map. In its calculation, 40 indicators are taken into account, which are quantitative risk indicators and characterize macroeconomic risk, household credit risk, corporate credit risk, banks' capital risk, their profitability and liquidity risks, and currency risk. These indicators take into account the situation in the financial market in terms of the depth and efficiency of the financial system, but do not consider the state of the availability of financial services, which can also significantly affect the provision of financial stability. Therefore, in our opinion, when determining the state of financial stability, one should also pay attention to this characteristic.

The methodological approach for analyzing financial stability

A number of methods are used to assess financial stability. Central banks and other financial regulators of national financial systems use different methods to assess financial stability, which differ both in the set of indicators and methods of information processing (Gospodarchuk & Suchkova, 2019). The research also uses methods other than the officially defined ones.

Gospodarchuk and Amosova (2020) note that globalization processes have a significant impact on global financial stability. Based on the use of structured system methods, comparative and cluster analysis, the authors propose criteria for qualitative assessment of the level of financial stability

of the global banking system and its individual elements in terms of regional and national banking systems. As a result of the study of 126 countries for the period from 1998 to 2017, the authors come to the conclusion that potential threats to the financial stability of the global banking system come from the European and Asian banking systems, as well as from the Australian banking system.

To assess the stability of the Chinese financial market Shi *et al.* (2014) used quantile regression, which made it possible to determine an effective quantitative indicator to monitor the financial markets, which can provide support for financial regulation.

Brůha and Kočenda (2018) use a Bayesian inference in panel estimation as a methodology to assess the stability of the banking sector in Europe. Based on the calculations, it is noted that there is a connection between the stability and sovereign risks of EU countries and the impact is manifested through financial depth, interbank competition and the penetration of foreign capital into national financial systems, as well as the share of non-performing loans.

Almahadin *et al.* (2020), studying the relationship between financial stability and stability of the banking system using the FMOLS approach on the example of Jordan, state that most indicators of banking reliability have a positive effect on financial stability when a stable interest rate policy plays a key role in this.

Blahun I. S. *et al.* (2020) modeled the stability of the banking system of Ukraine, which is the main element of its financial system using the method of fuzzy Mamdani logic, assessed the level of stability as average and proved that the state of the banking stability system is largely determined not only by internal but also external factors at both national and international levels.

For assessing the financial stability of the banking system, Kuznyetsova and Pogorelenko (2018) constructed the banking system financial stability index (by multiplicative convolution of central bank financial stability sub-index and three banks' financial stability subindices). The intervals developed according to the “ 3σ ” rule were used to determine the level of financial stability. This made it possible to determine three levels of stability: stable, conditionally stable or critical.

Thus, currently there are different approaches using different lists of indicators, which is associated with the peculiarities of the formation of the structure of national financial systems. The vast majority of them are based on indicators characterizing the state of financial markets and do not take into account the state of access of individuals and legal entities to the financial system.

Data and methodology

To assess the state of the financial system, we chose the methodology proposed by Čihák *et al.* (2012) in the form of a matrix of financial stability 4 x 2. This matrix contains 42 indicators which are presented in the form of 4 groups that characterize depth, accessibility to the financial system, efficiency and stability, which in turn are divided into financial institutions (as a characteristic of subjects) and financial markets (as a characteristic of objects of the system). This matrix is used as a source of division of indicators into groups. At the same time, the set of indicators was formed taking into account the peculiarities of development of the financial system in Ukraine.

The calculation of the integral index was carried out using the Harrington desirability function. This makes it possible to bring the original multicriteria problem with criteria characterized by diversity into line with the multicriteria problem with criteria measured on the same scale. This function has a number of advantages, in particular, it “is quite simple to convert indicators; is quantitative and unambiguous, i.e. one value function corresponds to a certain list of values of individual indicators; the function is universal and can be used both in economic research and in other scientific fields; it is adequate (the adequacy of the partial and general desirability function is considered as equivalence of the measured values of optimization parameters, which can be used to carry out certain computational actions” (Samokhvalov & Burba, 2018).

Two variants of the Harrington desirability function are typical — with one-sided constraints and with two-sided constraints. This study uses the Harrington desirability function with one-sided constraints. The assessment of desirability with one-sided constraint assumes that an improvement in the indicator — its increase or decrease occurs unilaterally in the following way:

$$y_i \leq y_{max} \quad (1)$$

or

$$y_i \geq y_{min} \quad (2)$$

The applied scientific and methodological approach to determining the integrated indicator of the state of the financial system’s stability involves implementation in several stages.

At the first stage, a system of indicators was formed that characterizes the state of the financial system of Ukraine in terms of three basic characteristics: depth, accessibility and efficiency of the financial system. The fourth group, which characterizes the indicators of the financial system's stability, according to the matrix 4×2 , was not formed due to the lack of the vast majority of indicators required for calculation and considering that it is methodologically impractical in determining the system's stability as a whole to include in the calculation those indicators that already characterize stability. Each of these groups of indicators is, in turn, divided into indicators characterizing the state of financial institutions and indicators characterizing the state of financial markets.

Indicators for the period from 2007 to 2019 were used for the analysis. The values of the indicators selected for the building of the model are given in Tables 1–3. Sparklines are built to understand the dynamics of the selected indicators, which make it possible to make preliminary conclusions about the groups of indicators. This period was chosen to analyze changes in the financial system during the protracted recession after the global financial crisis of 2007–2008 and in other periods with internal manifestations of crisis phenomena under the influence of both economic and non-economic factors.

In total, 29 indicators were selected for analysis (Figure 1). In some ways, this distribution of indicators between institutions and markets is quite conditional, but at the same time it makes it possible to determine the impact of each group on the depth, accessibility and efficiency of the financial system. This set of indicators is the basis for the formation of a matrix of input data Y

$$Y = \begin{bmatrix} Y_{11} & \dots & Y_{1m} \\ Y_{n1} & \dots & Y_{nm} \end{bmatrix} \quad (3)$$

where:

m – the above-mentioned indicators characterizing the state of the financial system;

n – number of observations, annual.

The second stage of the scientific and methodological approach provides for the normalization of selected indicators using the method of relative normalization, which will bring different indicators to a single scale of measurement. The maximum values of indicators are used as reference vectors. The basic formulas for normalization are given below.

$$E(e_q) \xrightarrow{Norm} E^N(e_q), q = 1, \dots, Q, \quad (4)$$

$$e_q^N(s_k) = \frac{e_q(s_k)}{e_q^{ideal}}, k = 1, \dots, m \quad (5)$$

$$e_q^{ideal} = (\max_{s_i \in S} e_1(s_i); \dots; (\max_{s_i \in S} e_q(s_i)); \dots (\max_{s_i \in S} e_Q(s_i))) \quad (6)$$

$$e_q^N(s_k) = \frac{e_q(s_k)}{\max_{s_i \in S} e_1(s_i)}, q = 1, \dots, Q; k = 1, \dots, m \quad (7)$$

During the third stage, partial functions for each of the formed groups of indicators are determined using the Harrington desirability function.

Bringing desirability criteria into quantitative parameters is carried out using the following formula:

$$d_k = \exp(-\exp(-\bar{x}_k)) \quad (8)$$

where:

k – the number of indicators used to determine desirability;

d_k – partial function, according to the Harrington scale;

\bar{x}_k – an indicator in dimensionless form.

At the fourth stage, in order to calculate integral indicators, one uses the Fishburne's rule for normalization of weighting factors calculated by the following formula:

$$W_i = \frac{2(N-n+1)}{N(N+1)} \quad (9)$$

where:

W_i – the weighting factor of the i -th indicator;

N – the total number of indicators;

n – weight of the indicator.

The next stage involves determination of the total index that characterizes the state of financial system's stability in Ukraine by the formula:

$$D = \sqrt[n]{\prod_{i=1}^n d_i} \quad (10)$$

where:

n – the number of used indicators for the parameters compared within the system.

This approach is used in the following way: before calculating the total index of the financial system's stability and based on the matrix approach and the formed groups of indicators — depth, availability and efficiency, as well indicators characterizing the state of the financial market and financial institutions, integrated indicators are calculated for these groups.

After the analysis of the behavior of intermediate integrated indicators that characterize groups of indicators of the stability matrix of Ukraine's financial system, a total index was built using Formula 10.

Results

According to the selected indicators and in terms of financial institutions, the depth of Ukraine's financial system can be defined as gradually declining, which is a negative trend and indicates a decrease in financial resources in the economy, which slows down the country's economic development (Table 1, Figure 2). All indicators calculated in relation to the GDP indicator, starting from 2016, quite synchronously show a negative downward trend, while both loans and deposits are decreasing. A decrease in the share of the monetary aggregate M2 in the GDP of Ukraine is also a matter of concern. This indicator characterizes the level of monetization of the economy and reflects the level of provision of economic processes with money supply. On the other hand, the level of monetization of the economy reflects the state of confidence of economic agents in the national currency, as well as the level of confidence in monetary policy implemented by the state. The reduction in assets of financial institutions also results in reduction of the gross added value created in the financial sector in relation to GDP.

Regarding the situation with indicators of the depth of Ukraine's financial system in terms of the financial market, in contrast to institutions, the dynamics is less uniform, but the conclusion is clear about a significant reduction in depth since 2016 (Table 1, Figure 3). In this case, the reduction of indicators characterizing the state of the financial market can be interpreted as a clearing of the market from speculative assets on the stock market. The issuance of securities is almost non-existent, the level of market capitalization relative to GDP is close to zero and, therefore, the use of the stock market to increase capital by the real sector actors of the economy is virtually impossible. In the analyzed period, there is a significant increase in the stock market activity in 2012–2014. A significant negative indicator is the reduction in the volume of trading in shares relative to GDP. This demonstrates that entities in both the real and financial sectors of the econ-

omy do not carry out the initial public offering of shares and, therefore, there is no real increase in equity. The result is a further reduction in the ability of businesses to expand their activities and attract larger amounts of borrowed capital. Therefore, it already creates the conditions for further reduction in the depth of the financial system and assets of financial institutions.

The behavior of indicators that characterize the state of access to the financial system of Ukraine in terms of financial institutions is ambiguous, but also has some explanations (Table 2, Figure 4). In particular, the reduction in the number of bank branches is not consistent with the number of ATMs per 100 thousand people. The reduction in the number of bank branches was due to a significant decrease in the number of banks themselves, which was a consequence of the policy of cleaning of the banking system pursued by the National Bank of Ukraine. This led to an increase in the concentration of the banking system and in no way affected the number of ATMs, the majority of which belong to those banks that control most of the assets of the banking system, including PJSC CB “Privatbank”, PJSC “State Savings Bank of Ukraine” and others. With the growing number of ATMs and self-service terminals, the need for a significant number of bank branches is gradually disappearing. Banks are constantly optimizing the network of their branches, which in turn allows them to optimize their costs.

Regarding the behavior of indicators that characterize the state of access to the financial market (Table 2, Figure 5), it is uneven, but fully confirms its public nature as the vast majority of indicators in this group are related to the state of issuance of government debt securities, which is essentially the only segment that is actively growing in Ukraine in recent years. The share of private bonds in the total amount of issued debt obligations within the Ukrainian market is also significant. Over the last four years, this figure has approached zero, which also indicates the transformation of the financial market into a service sector for public finances. Therefore, the financial market does not fulfill its key function of supplying capital, including debt capital, and cannot be considered a serious alternative to bank lending.

The quality of the financial system is characterized by indicators of efficiency for the functioning of financial institutions and the financial market. Among the indicators that characterize the efficiency of financial institutions there are significant negative trends in the rate of return on assets and the rate of return on capital, which, with the exception of 2018 and 2019, show losses (Table 3, Figure 6). An important indicator is the ratio of non-performing loans to total gross loans, their share increased significantly in 2017–2019. This indicates a significant deterioration in the quality of credit

resources of banks. In addition, the ratio of deposits to the amount of total loans indicates an increase in the deposit base against the background of a slowdown in lending. It also indicates the formation of excess liquidity and, accordingly, a decrease in the efficiency of the existing resource base in the banking system.

The dynamics of indicators that characterize the efficiency of the financial market shows that it is developing unevenly (Table 3, Figure 7). The real interest rate and profitability of the stock market has not only an unstable, but in general a negative trend. In 2018 and 2019 the liquidity of the stock market also decreased significantly, primarily due to a decrease in the issue of shares.

The results of normalization of selected indicators with a group of indicators that characterize the depth are shown in Tables 4–6.

Partial functions for each of these groups of indicators were determined using the Harrington desirability function. The desirability scale itself is defined as a universal psychophysical verbal-numerical scale, which is a logistic S-shaped curve. The lower limit of each interval is included in the corresponding interval. In the intervals between 0.2 and 0.8, indicators have the maximum sensitivity, i.e. a slight change in parameters can lead to a significant change in desirability, and approaching 0 and 1 the sensitivity is much lower.

Next, the desirability criteria are reduced to quantitative parameters. The results of calculations for the group of indicators that characterize the depth are shown in Tables 7–9.

To calculate integral indicators, the Fishburne rule was used to normalize weight coefficients. As a result of calculations, the following results of intermediate integral coefficients in relation to groups of indicators were obtained (Table 10).

After calculating intermediate integral coefficients, the total index is determined, which characterizes the state of stability of the financial system of Ukraine. Integral ratios are defined for all groups of indicators, namely the depth, access, efficiency, as well as those that characterize the state of the subjects — financial institutions and the state of objects — financial markets (Table 11, Figure 8).

The calculated indicators in groups demonstrate that some indicators have a fairly stable behavior, while others show a significant range of variation. For example, an indicator that characterizes the state of access to the financial system has the smallest gap between the minimum and maximum values and is 0.1. The biggest gap is for the values of indicators reflecting the efficiency of the financial system (0.51) and the state of financial institutions (0.54). This confirms that, on the one hand, access and depth of the

financial system are key factors that ensure a certain stability. On the other hand, the efficiency of use of the existing assets is extremely low, which causes significant differences in the values of financial institutions' indicators.

Figure 8 of dynamics of the calculated indicators showed that the state of access to the financial system is quite balanced, but as evidenced by the polynomial, it will deteriorate in the forecast period. A similar situation can be observed in the context of the financial system's depth.

Based on the obtained intermediate coefficients characterizing groups of indicators for the stability matrix of the financial system of Ukraine, the total index is built with the results shown in Figure 9. Visualization of the obtained values of the total index indicates that the financial system of Ukraine is unstable. Deterioration of stability occurred as a result of political events of 2013–2014. The lowest value of the indicator was observed in 2016. At the same time, the value of indicators during the analyzed period is in the range from 0.41 to 0.54, i.e. on the verbal-numerical scale of Harrington such range of values is in the interval that is defined as satisfactory. In addition, the obtained values have a high level of sensitivity, i.e. minor changes in indicators can lead to significant changes in the financial system's stability, which also shows a significant instability of the financial system.

Therefore, the stability of Ukraine's financial system cannot be considered as high. According to Harrington's desirability scale, it can be defined as satisfactory. At the same time, the financial system's stability is quite sensitive to minor changes, which can be demonstrated by the analyzed indicators in terms of the financial market and financial institutions and in terms of access, depth and efficiency of the financial system.

Discussion

As it was already mentioned, one of the widely used approaches to assessing the financial system's stability is the approach recommended by the International Monetary Fund, which is based on building a matrix of the financial system according to the principle of 4x2, which defines a set of indicators (42 indicators proposed) in four groups (depth of the financial system, access to it, efficiency and stability) by subject (financial institutions) and object (financial markets) components. At the same time, the list of indicators proposed in the matrix in assessing the state of national financial systems should be adjusted to take into account its structural arrangements.

In order to assess the financial system's stability in Ukraine and taking into account the peculiarities of its functioning, 29 indicators were selected, grouped by three key characteristics — depth, access to the financial system, efficiency, which in turn are grouped to reflect the state of financial institutions and financial markets.

The intermediate integrated indicators for certain groups of indicators showed that the most stable is the behavior of indicators that characterize the depth of the financial system and access to it (the value of the range of variation is minimal — 0.18 and 0.1, respectively), these indicators form the basis of the stable state of the financial system of Ukraine. However, the efficiency of using the financial assets formed within the system is extremely low, the fluctuations of the integrated indicator for this group are in the range from min — 0.02 to max — 0.53, which indicates the generation of significant levels of risks, which negatively affect the financial system.

According to the Harrington desirability scale, the obtained integrated indicator, the value of which is in the range from 0.41 to 0.54, characterizes the state of the financial system as satisfactory, but with a high degree of sensitivity to minor changes that can occur both inside and outside the system. This means that the manifestation of minimal shocks, both external and internal, can significantly both improve and worsen the level of financial stability. Therefore, at present there are no grounds to consider the financial system of Ukraine as stable.

Comparing our results with the results obtained by Gospodarchuk and Amosova (2020), it can be noted that they can be assessed partially as similar, since these authors assigned Ukraine, among other countries, to a group that is characterized as unstable and at risk. We believe that the state of financial stability is satisfactory, but we emphasize a high level of sensitivity and, depending on minor changes, both external and internal, the situation may turn into unstable. In this case, the differences in results are related both to the set of indicators used and to the period for which they were considered. The latter is important because, in contrast to our study based on data from 2007 to 2019, the study by Gospodarchuk and Amosova is based on a much smaller number of indicators and data set for the period 1998–2017, and therefore included the data from 1998 and 2004 financial crises, which ultimately could reduce the integrated indicator of Ukraine's financial stability.

Kuznyetsova and Pogorelenko (2018) also classified the state of stability as risky and unstable between 2014 and 2017. The deviations in the assessment are due to a set of indicators, which included only indicators of the banking system. On the one hand, the financial system of Ukraine is based on banks, which are the main financial intermediaries and ensure the

movement of financial flows in Ukraine, but on the other hand, when determining financial stability, one should take into account the influence of public finances in Ukraine, which is analyzed in the literature review. According to our calculations, the impact of public finances, including through the stability of servicing obligations on government securities, played a positive role in ensuring financial stability.

Despite the use of different methods and a different set of indicators for assessing stability, Blahun *et al.* (2020) obtained results similar to our study, namely, stability is determined at a medium level, which on the Harrington desirability scale can be considered a satisfactory condition. In addition, the authors also note that it is influenced by both internal and external factors. In our opinion, the coincidence of the results obtained is due to the assessment periods, which practically coincide — in our case, 2007–2019, and in the case of these authors, 2008 — the 1st quarter of 2020.

Thus, it can be argued that the assessment of the financial system stability largely depends on both a set of indicators and a period taken into account, since it may contain periods of financial crises that brought the state of stability to a qualitatively new level, which could be much worse, and much better.

Conclusions

The problems of ensuring financial stability are widely covered in the scientific literature and apply to both economically developed countries and countries with developing financial markets and emerging markets. Ensuring the financial stability of the latter is important in terms of shaping global financial stability, since the economies of the vast majority of countries, including Ukraine, have common financial flows. Disruption of financial stability in countries such as Ukraine can create significant financial risks for the global financial system.

World financial regulators have not yet developed a unified systematic approach to assessing financial stability, due to a number of factors, namely the structure of national financial systems, the level of financial relations in the country, the degree of its involvement in global financial flows, etc. Therefore, national financial regulators, the overwhelming majority of which are central banks, develop their own approaches based on different methods of calculating the stability of financial systems.

The National Bank of Ukraine periodically changes the assessment methods and the set of indicators taken into account. This means that their methods are also imperfect and, therefore, a better approach must be found.

At the same time, financial stability is assessed with a significant predominance of indicators that primarily characterize the depth and efficiency of the financial system and do not take into account the conditions created for access to financial resources for the major economic agents — households and real business.

The approach we propose takes into account a wider range of indicators characterizing the financial depth, the state of access to financial services and financial resources, and the efficiency of their use. As a result of calculations, it was proved that the state of financial depth is quite acceptable, but has a negative tendency to decrease, which in turn may lead to a lack of financial resources for individuals and legal entities. Instead, positive dynamics are formed by indicators reflecting access to the financial system; against the background of a decrease in the number of physical branches of banks, the number of self-service terminals is increasing. At the same time, there is a negative trend in business access to the stock market, which has become a market for servicing government debt securities. The dynamics of indicators characterizing the state of efficiency in the use of financial resources among all other groups of indicators is the most unstable and is the main reason for a satisfactory level of financial stability.

This article differs from others in that it uses the method of complex assessment of financial stability based on the use of the Harrington desirability function, which differs significantly from the methods most commonly used by other researchers. Therefore, it can be considered as special value added of the current contribution, but still it has some limitations. These limitations should be faced during future studies. In particular, in further studies, this method will be used not only on the basis of data for Ukraine, but also for other countries, which in turn will fully justify the advantages and disadvantages of this approach, as well as on the basis of the calculated integrated indicators for a number of countries to conduct a cluster analysis with further systematization of recommendations to improve financial stability, depending on the results obtained.

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Annex

Table 1. Indicators that characterize the depth of the financial system

Period	Financial institutions					
	1*	2*	3*	4*	5*	
2007	57.22455	84.97995	52.09291	36.67618	5.56739	
2008	74.83112	98.7539	51.72771	36.04563	6.87401	
2009	73.65344	98.3424	51.18791	65.88266	6.959248	
2010	61.99072	89.39593	53.24858	61.46765	6.210243	
2011	56.00128	82.28443	50.53455	57.45519	4.695303	
2012	52.83936	84.30793	52.84957	55.60573	4.183686	
2013	56.91039	91.85317	59.51682	59.88007	4.362571	
2014	61.85725	91.84842	60.20165	62.03427	4.374714	
2015	50.60703	70.90307	49.97677	45.06796	3.311166	
2016	42.10996	58.94703	46.21469	47.4776	2.657872	
2017	34.89548	50.46809	40.50286	39.30192	2.652183	
2018	31.3411	43.77159	33.94256	33.83543	2.673232	
2019	26.00421	44.20061	33	33.31533	2.793011	
Period	Financial markets					
	6*	7*	8*	9*	10*	11*
2007	15.24152	5.921934	0	1.469832	9.31959	37.75035
2008	12.16405	3.164049	0	3.183225	9	35.60953
2009	24.12008	1.067534	10.45255	4.578466	12.6	49.70935
2010	47.7643	0.846673	31.59365	6.823344	15.32398	52.23112
2011	140.1565	63.41269	63.41269	3.213809	13.33108	47.93813
2012	185.8096	83.41192	83.41192	5.241602	18.98573	40.69246
2013	115.2374	47.38231	47.38231	5.454938	20.47277	11.23371
2014	115.9305	43.36023	43.36023	1.744895	29.21	26.25961
2015	30.03834	14.24962	12.57872	17.35943	3.21	23.27224
2016	15.05554	0	14.23219	1.160828	0.823353	20.22868
2017	9.163901	0	8.583784	2.783622	0.580117	4.242566
2018	11.92629	0.288351	11.4141	1.563502	0.223839	2.537742
2019	7.689431	0.220449	7.428474	0.664727	0.040508	1.174589

*1 – Private sector loans to GDP, %; 2 – Financial institutions’ assets to GDP, %; 3 – M2 to GDP, %; 4 – Deposits to GDP, %; 5 – Gross value-added of the financial sector to GDP, %; 6 – Stock market capitalization plus outstanding domestic private debt securities to GDP, %; 7 – Private debt securities to GDP, %; 8 – Public debt securities to GDP, %; 9 – International debt securities to GDP, %; 10 – Stock market capitalization to GDP, %; 11 – Stocks traded to GDP, %.

Table 2. Indicators that characterize access to the financial system

Period	Financial institutions			
	1**	2**	3**	4**
2007	3010.98	3.856948	52.42	48.5886
2008	3102.43	3.736707	70.37	49.722
2009	3214.828	3.220112	73.14	47.193
2010	3238.335	2.32794	76.57	48.333
2011	3353.436	1.604381	84.3	49.5383
2012	3383.357	1.073017	92.8	26.9864
2013	1917.779	0.920654	104.06	28.7134
2014	1944.525	0.769136	95.09	30.1083

Table 2. Continued

Period	Financial institutions			
	1**	2**	3**	4**
2016	1618.266	0.496606	88.77	34.192
2017	1675.524	0.454732	97.83	39.1809
2018	1509.774	0.433896	97.39	
2019	1657.57	0.420795	96.3	
	Financial markets			
	5**	6**	7**	8**
2007			80.11527	0
2008			49.84894	0
2009	19.76	21.43	71.55975	9.266728
2010	11.39	17.44	82.62174	2.609939
2011	7.93	12.23	97.52858	50
2012	13.55	11.27	96.95372	50
2013	7.02	9.32	94.55701	50
2014	13.11	17.11	98.0276	50
2015	17	16.66	60.71439	53.11407
2016	16.64	17.85	92.45874	0
2017	15.23	14.89	75.51225	0
2018	17.92	16.18	88.21417	2.464021
2019	18.4	16.73	92.00439	2.882087

** 1 – Accounts per thousand adults (commercial banks); 2 – Branches per 100,000 adults (commercial banks); 3 – ATMs for 100 thousand people; 4 - Concentration of the banking system; 5 – Weighted average yields on government bonds up to 1 year, %; 6 – Weighted average yields on government bonds up to 3 years, %; 7 – Ratio of domestic and total debt securities, %; 8 – Ratio of private and total debt securities (domestic), %

Table 3. Indicators that characterize the efficiency of the financial system

Period	Financial institutions					
	1***	2***	3***	4***	5***	6***
2007	61.90	58.64	1.69	14.28	33.67	2.68
2008	48.36	51.16	1.46	11.96	40.28	3.88
2009	45.27	66.76	-4.42	-33.71	23.85	13.70
2010	56.01	65.98	-1.46	-10.29	31.39	15.27
2011	61.19	63.07	-0.65	-4.44	26.58	14.73
2012	69.80	64.15	0.48	3.26	35.15	16.54
2013	73.34	58.56	0.26	1.72	33.24	12.89
2014	64.45	48.46	-4.24	-31.95	41.79	18.98
2015	71.22	39.00	-5.54	-65.51	51.06	28.03
2016	80.51	45.94	-12.47	-122.17	40.07	30.47
2017	84.59	50.20	-1.76	-15.34	46.27	54.54
2018	81.83	52.02	1.60	14.61	47.39	52.85
2019	103.08	47.39	4.70	37.55	37.84	48.36
	Financial markets					
	7***	8***	9***	10***		
2007		-7.48				-0.25382
2008	10.35323	-8.62				2.097239
2009	9.273952	6.94		-37.65		6.326675
2010	8.953132	1.71		92.69		3.309442
2011	12.07106	1.53		5.97		2.128076
2012	9.136055	9.83		-46.87		-0.91354

Table 3. Continued

Period	Financial markets			
	7***	8***	9***	10***
2007		-7.48		-0.25382
2008	10.35323	-8.62		2.097239
2009	9.273952	6.94	-37.65	6.326675
2010	8.953132	1.71	92.69	3.309442
2011	12.07106	1.53	5.97	2.128076
2012	9.136055	9.83	-46.87	-0.91354
2013	5.379559	11.8	-21.82	1.147259
2014	5.095563	1.57	22.71	8.110082
2015	34.19341	-12.28	-13.13	4.14456
2016	108.3274	1.62	-25.83	4.555861
2017	27.07626	-4.67	52.75	2.859372
2018	0.446588	3.13		-0.14152
2019	0.475976	10.81		0.093263

*** 1 – The ratio of customer deposits to total gross loans (excluding interbank); 2 – The ratio of interest margin to gross income; 3 – Rate of return on assets; 4 – Rate of return on capital; 5 – Non-interest income to total income; 6 – The ratio of non-performing loans to total gross loans Stock market liquidity ratio; 7 – Real interest rate; 8 – Stock market profitability, % 9 – Net acquisition of financial assets (% to GDP)

Table 4. Normalization of indicators characterizing the depth of the financial system

Period	Financial institutions					
	1*	2*	3*	4*	5*	
2007	0.76472	0.86052	0.86531	0.55669	0.80000	
2008	1.00000	1.00000	0.85924	0.54712	0.98775	
2009	0.98426	0.99583	0.85027	1.00000	1.00000	
2010	0.82841	0.90524	0.88450	0.93299	0.89237	
2011	0.74837	0.83323	0.83942	0.87208	0.67469	
2012	0.70611	0.85372	0.87788	0.84401	0.60117	
2013	0.76052	0.93012	0.98862	0.90889	0.62687	
2014	0.82662	0.93007	1.00000	0.94159	0.62862	
2015	0.67628	0.71798	0.83016	0.68406	0.47579	
2016	0.56273	0.59691	0.76766	0.72064	0.38192	
2017	0.46632	0.51105	0.67279	0.59654	0.38110	
2018	0.41882	0.44324	0.56381	0.51357	0.38413	
2019	0.34751	0.44758	0.55543	0.50568	0.40134	
Period	Financial markets					
	6*	7*	8*	9*	10*	11*
2007	0.08203	0.07100	0.00000	0.08467	0.31905	0.72276
2008	0.06547	0.03793	0.00000	0.18337	0.30811	0.68177
2009	0.12981	0.01280	0.12531	0.26375	0.43136	0.95172
2010	0.25706	0.01015	0.37877	0.39306	0.52461	1.00000
2011	0.75430	0.76024	0.76024	0.18513	0.45639	0.91781
2012	1.00000	1.00000	1.00000	0.30195	0.64997	0.77908
2013	0.62019	0.56805	0.56805	0.31423	0.70088	0.21508
2014	0.62392	0.51983	0.51983	0.10052	1.00000	0.50276
2015	0.16166	0.17083	0.15080	1.00000	0.10989	0.44556
2016	0.08103	0.00000	0.17063	0.06687	0.02819	0.38729

Table 4. Continued

Period	Financial markets					
	6*	7*	8*	9*	10*	11*
2017	0.04932	0.00000	0.10291	0.16035	0.01986	0.08123
2018	0.06419	0.00346	0.13684	0.09007	0.00766	0.04859
2019	0.04138	0.00264	0.08906	0.03829	0.00139	0.02249

*1 – Private sector loans to GDP. %; 2 – Financial institutions' assets to GDP. %; 3 – M2 to GDP. %; 4 – Deposits to GDP. %; 5 – Gross value-added of the financial sector to GDP. %; 6 – Stock market capitalization plus outstanding domestic private debt securities to GDP. %; 7 – Private debt securities to GDP. %; 8 – Public debt securities to GDP. %; 9 – International debt securities to GDP. %; 10 – Stock market capitalization to GDP. %; 11 – Stocks traded to GDP. %.

Table 5. Normalization of indicators characterizing access to the financial system

Period	Financial Institutions			
	1**	2**	3**	4**
2007	0.88994	1.00000	0.50375	0.88343
2008	0.91697	0.96882	0.67624	0.90404
2009	0.95019	0.83489	0.70286	0.85805
2010	0.95714	0.60357	0.73583	0.87878
2011	0.99116	0.41597	0.81011	0.90070
2012	1.00000	0.27820	0.89179	0.49066
2013	0.56683	0.23870	1.00000	0.52206
2014	0.57473	0.19942	0.91380	0.54742
2015	0.53886	0.14637	0.83721	0.67770
2016	0.47830	0.12876	0.85307	0.62167
2017	0.49523	0.11790	0.94013	0.71238
2018	0.44624	0.11250	0.93590	0.99091
2019	0.48992	0.10910	0.92543	1.00000
Period	Financial markets			
	5**	6**	7**	8**
2007	0.00000	0.00000	0.81727	0.00000
2008	0.00000	0.00000	0.50852	0.00000
2009	1.00000	1.00000	0.73000	0.17447
2010	0.57642	0.81381	0.84284	0.04914
2011	0.40132	0.57070	0.99491	0.94137
2012	0.68573	0.52590	0.98905	0.94137
2013	0.35526	0.43490	0.96460	0.94137
2014	0.66346	0.79841	1.00000	0.94137
2015	0.86032	0.77741	0.61936	1.00000
2016	0.84211	0.83294	0.94319	0.00000
2017	0.77075	0.69482	0.77032	0.00000
2018	0.90688	0.75502	0.89989	0.04639
2019	0.93117	0.78068	0.93856	0.05426

** 1 – Accounts per thousand adults (commercial banks); 2 – Branches per 100.000 adults (commercial banks); 3 – ATMs for 100 thousand people; 4 - Concentration of the banking system; 5 – Weighted average yields on government bonds up to 1 year. %; 6 – Weighted average yields on government bonds up to 3 years. %; 7 – Ratio of domestic and total debt securities. %; 8 – Ratio of private and total debt securities (domestic). %

Table 6. Normalization of indicators characterizing the financial system's efficiency

Period	Financial Institutions					
	1***	2***	3***	4***	5***	6***
2007	0.60050	0.87837	0.35957	0.38029	0.65942	0.04914
2008	0.46915	0.76633	0.31064	0.31851	0.78888	0.07114
2009	0.43917	1.00000	-0.94043	-0.89774	0.46710	0.25119
2010	0.54336	0.98832	-0.31064	-0.27403	0.61477	0.27998
2011	0.59362	0.94473	-0.13830	-0.11824	0.52056	0.27008
2012	0.67714	0.96090	0.10213	0.08682	0.68841	0.30326
2013	0.71149	0.87717	0.05532	0.04581	0.65100	0.23634
2014	0.62524	0.72588	-0.90213	-0.85087	0.81845	0.34800
2015	0.69092	0.58418	-1.17872	-1.74461	1.00000	0.51393
2016	0.78104	0.68814	-2.65319	-3.25353	0.78476	0.55867
2017	0.82062	0.75195	-0.37447	-0.40852	0.90619	1.00000
2018	0.79385	0.77921	0.34043	0.38908	0.92812	0.96901
2019	1.00000	0.70986	1.00000	1.00000	0.74109	0.88669
Period	Financial markets					
	7***	8***	9***	10***		
2007	0.00000	-0.63390	0.00000	-0.03130		
2008	0.09557	-0.73051	0.00000	0.25860		
2009	0.08561	0.58814	-0.40619	0.78010		
2010	0.08265	0.14492	1.00000	0.40807		
2011	0.11143	0.12966	0.06441	0.26240		
2012	0.08434	0.83305	-0.50566	-0.11264		
2013	0.04966	1.00000	-0.23541	0.14146		
2014	0.04704	0.13305	0.24501	1.00000		
2015	0.31565	-1.04068	-0.14165	0.51104		
2016	1.00000	0.13729	-0.27867	0.56175		
2017	0.24995	-0.39576	0.56910	0.35257		
2018	0.00412	0.26525	0.00000	-0.01745		
2019	0.00439	0.91610	0.00000	0.01150		

*** 1 – The ratio of customer deposits to total gross loans (excluding interbank); 2 – The ratio of interest margin to gross income; 3 – Rate of return on assets; 4 – Rate of return on capital; 5 – Non-interest income to total income; 6 – The ratio of non-performing loans to total gross loans Stock market liquidity ratio; 7 – Real interest rate; 8 – Stock market profitability. % 9 – Net acquisition of financial assets (% to GDP)

Table 7. Partial desirability functions for indicators that characterize the depth of the financial system

Period	Financial Institutions				
	1*	2*	3*	4*	5*
2007	0.62784	0.65512	0.65644	0.56377	0.63806
2008	0.69220	0.69220	0.65476	0.56067	0.68907
2009	0.68817	0.69114	0.65227	0.69220	0.69220
2010	0.64614	0.66735	0.66172	0.67477	0.66386
2011	0.62304	0.64749	0.64924	0.65831	0.60091
2012	0.61045	0.65323	0.65990	0.65052	0.57801
2013	0.62661	0.67401	0.68929	0.66833	0.58610
2014	0.64563	0.67400	0.69220	0.67705	0.58665
2015	0.60139	0.61401	0.64663	0.60377	0.53720
2016	0.56572	0.57666	0.62870	0.61481	0.50533

Table 7. Continued

Period	Financial Institutions					
	1*	2*	3*	4*	5*	
2017	0.53403	0.54889	0.60032	0.57654	0.50504	
2018	0.51798	0.52626	0.56607	0.54972	0.50609	
2019	0.49339	0.52773	0.56337	0.54711	0.51200	
Period	Financial markets					
	6*	7*	8*	9*	10*	11*
2007	0.39802	0.39398	0.36788	0.39899	0.48344	0.61544
2008	0.39195	0.38183	0.36788	0.43498	0.47959	0.60307
2009	0.41550	0.37259	0.41386	0.46386	0.52224	0.67972
2010	0.46148	0.37161	0.50424	0.50916	0.55334	0.69220
2011	0.62479	0.62653	0.62653	0.43562	0.53069	0.67073
2012	0.69220	0.69220	0.69220	0.47741	0.59330	0.63203
2013	0.58401	0.56744	0.56744	0.48174	0.60887	0.44643
2014	0.58518	0.55177	0.55177	0.40480	0.69220	0.54615
2015	0.42710	0.43043	0.42315	0.69220	0.40823	0.52705
2016	0.39766	0.36788	0.43036	0.39246	0.37825	0.50718
2017	0.38602	0.36788	0.40567	0.42663	0.37519	0.39773
2018	0.39148	0.36915	0.41807	0.40097	0.37070	0.38575
2019	0.38310	0.36885	0.40060	0.38196	0.36839	0.37615

*1 – Private sector loans to GDP. %; 2 – Financial institutions' assets to GDP. %; 3 – M2 to GDP. %; 4 – Deposits to GDP. %; 5 – Gross value-added of the financial sector to GDP. %; 6 – Stock market capitalization plus outstanding domestic private debt securities to GDP. %; 7 – Private debt securities to GDP. %; 8 – Public debt securities to GDP. %; 9 – International debt securities to GDP. %; 10 – Stock market capitalization to GDP. %; 11 – Stocks traded to GDP. %.

Table 8. Partial desirability functions for indicators characterizing access to the financial system

Period	Financial Institutions			
	1**	2**	3**	4**
2007	0.66320	0.69220	0.54648	0.66142
2008	0.67050	0.68418	0.60138	0.66702
2009	0.67932	0.64796	0.60947	0.65443
2010	0.68114	0.57877	0.61933	0.66015
2011	0.68994	0.51701	0.64095	0.66612
2012	0.69220	0.46900	0.66370	0.54215
2013	0.56704	0.45491	0.69220	0.55250
2014	0.56958	0.44078	0.66965	0.56077
2015	0.55799	0.42154	0.64861	0.60183
2016	0.53803	0.41512	0.65305	0.58447
2017	0.54366	0.41115	0.67667	0.61234
2018	0.52727	0.40918	0.67555	0.68988
2019	0.54190	0.40794	0.67276	0.69220

Table 8. Continued

Period	Financial markets			
	5**	6**	7**	8**
2007	0.36788	0.36788	0.64298	0.36788
2008	0.36788	0.36788	0.54805	0.36788
2009	0.69220	0.69220	0.61760	0.43175
2010	0.57012	0.64200	0.65019	0.38595
2011	0.51200	0.56828	0.69090	0.67699
2012	0.60428	0.55376	0.68940	0.67699
2013	0.49609	0.52344	0.68308	0.67699
2014	0.59746	0.63760	0.69220	0.67699
2015	0.65506	0.63154	0.58375	0.69220
2016	0.64999	0.64742	0.67747	0.36788
2017	0.62960	0.60704	0.62948	0.36788
2018	0.66779	0.62500	0.66590	0.38494
2019	0.67429	0.63249	0.67625	0.38783

** 1 – Accounts per thousand adults (commercial banks); 2 – Branches per 100.000 adults (commercial banks); 3 – ATMs for 100 thousand people; 4 - Concentration of the banking system; 5 – Weighted average yields on government bonds up to 1 year. %; 6 – Weighted average yields on government bonds up to 3 years. %; 7 – Ratio of domestic and total debt securities. %; 8 – Ratio of private and total debt securities (domestic). %

Table 9. Partial desirability functions for indicators that characterize the financial system's efficiency

Period	Financial Institutions					
	1***	2***	3***	4***	5***	6***
2007	0.57780	0.66004	0.49759	0.50477	0.59622	0.38595
2008	0.53498	0.62831	0.48048	0.48324	0.63486	0.39403
2009	0.52489	0.69220	0.07722	0.08595	0.53429	0.45938
2010	0.55946	0.68921	0.25556	0.26840	0.58230	0.46963
2011	0.57561	0.67788	0.31717	0.32448	0.55201	0.46612
2012	0.60166	0.68212	0.40539	0.39978	0.60509	0.47788
2013	0.61207	0.65971	0.38822	0.38472	0.59361	0.45407
2014	0.58559	0.61638	0.08502	0.09617	0.64332	0.49357
2015	0.60585	0.57260	0.03877	0.00327	0.69220	0.54983
2016	0.63259	0.60501	0.00000	0.00000	0.63367	0.56441
2017	0.64394	0.62410	0.23358	0.22211	0.66760	0.69220
2018	0.63629	0.63206	0.49092	0.50779	0.67348	0.68423
2019	0.69220	0.61158	0.69220	0.69220	0.62089	0.66231

Period	Financial markets			
	7***	8***	9***	10***
2007	0.36788	0.15184	0.36788	0.35637
2008	0.40299	0.12541	0.36788	0.46203
2009	0.39934	0.57386	0.22289	0.63232
2010	0.39825	0.42101	0.69220	0.51431
2011	0.40879	0.41545	0.39156	0.46338
2012	0.39887	0.64745	0.19050	0.32653
2013	0.38614	0.69220	0.28212	0.41975

Table 9. Continued

Period	Financial markets			
	7***	8***	9***	10***
2007	0.36788	0.15184	0.36788	0.35637
2008	0.40299	0.12541	0.36788	0.46203
2009	0.39934	0.57386	0.22289	0.63232
2010	0.39825	0.42101	0.69220	0.51431
2011	0.40879	0.41545	0.39156	0.46338
2012	0.39887	0.64745	0.19050	0.32653
2013	0.38614	0.69220	0.28212	0.41975
2014	0.38518	0.41669	0.45717	0.69220
2015	0.48224	0.05895	0.31595	0.54888
2016	0.69220	0.41823	0.26677	0.56541
2017	0.45894	0.22639	0.56777	0.49516
2018	0.36940	0.46440	0.36788	0.36146
2019	0.36950	0.67027	0.36788	0.37211

*** 1 – The ratio of customer deposits to total gross loans (excluding interbank); 2 – The ratio of interest margin to gross income; 3 – Rate of return on assets; 4 – Rate of return on capital; 5 – Non-interest income to total income; 6 – The ratio of non-performing loans to total gross loans Stock market liquidity ratio; 7 – Real interest rate; 8 – Stock market profitability. % 9 – Net acquisition of financial assets (% to GDP)

Table 10. Intermediate integral coefficients in terms of groups of indicators

Period	Financial Institutions			Financial markets		
	Depth	Access	Efficiency	Depth	Access	Efficiency
2007	0.63	0.64	0.53	0.44	0.42	0.29
2008	0.66	0.65	0.52	0.44	0.41	0.30
2009	0.68	0.65	0.29	0.47	0.60	0.42
2010	0.66	0.63	0.44	0.51	0.55	0.49
2011	0.64	0.62	0.47	0.58	0.61	0.42
2012	0.63	0.58	0.52	0.62	0.63	0.36
2013	0.65	0.56	0.50	0.54	0.59	0.42
2014	0.65	0.55	0.31	0.55	0.65	0.47
2015	0.60	0.55	0.16	0.48	0.64	0.26
2016	0.58	0.54	0.00	0.41	0.57	0.46
2017	0.55	0.55	0.46	0.39	0.55	0.41
2018	0.53	0.56	0.60	0.39	0.57	0.39
2019	0.53	0.57	0.66	0.38	0.58	0.43

Table 11. Integral coefficients in terms of groups of indicators

Period	Depth	Access	Efficiency	Financial Institutions	Financial markets
2007	0.52	0.52	0.39	0.60	0.38
2008	0.54	0.52	0.40	0.61	0.38
2009	0.57	0.62	0.35	0.50	0.49
2010	0.58	0.59	0.47	0.57	0.52
2011	0.61	0.62	0.44	0.57	0.53
2012	0.63	0.61	0.43	0.58	0.52
2013	0.59	0.57	0.46	0.57	0.51
2014	0.60	0.60	0.39	0.48	0.55
2015	0.53	0.59	0.21	0.38	0.43
2016	0.49	0.55	0.02	0.07	0.47
2017	0.47	0.55	0.44	0.52	0.45
2018	0.46	0.57	0.48	0.56	0.44
2019	0.45	0.57	0.53	0.58	0.46
Min.	0.45	0.52	0.02	0.07	0.38
Max.	0.63	0.62	0.53	0.61	0.55

Figure 1. Grouping of baseline indicators to assess the financial system's stability

Stability of the financial system of Ukraine			
Depth	Financial Institutions	Private sector loans to GDP, %	
		Financial institutions' assets to GDP, %	
		M2 to GDP, %	
		Deposits to GDP, %	
		Gross value-added of the financial sector to GDP, %	
	Financial markets	Stock market capitalization plus outstanding domestic private debt securities to GDP, %	
		Private debt securities to GDP, %	
		Public debt securities to GDP, %	
		International debt securities to GDP, %	
		Stocks traded to GDP, %	
		Stock market capitalization to GDP, %	
	Access	Financial Institutions	Accounts opened in banks per 1000 adults
			Bank branches per 100 thousand adults
			ATMs per 100 thousand people
Concentration of the banking system			
Financial markets		Weighted average yields on government bonds up to 1 year, %	
		Weighted average yields on government bonds up to 3 year, %	
		The share of domestic debt securities in their total amount	
		The share of private debt securities in their total amount	
Efficiency	Financial Institutions	The share of customer deposits in total gross loans (excluding interbank)	
		The share of interest margin in gross income	
		Rate of return on assets	
		Rate of return on capital	
		Non-interest income to total income	
		The share of non-performing loans in total gross loans	
	Financial markets	Stock market liquidity ratio	
		Real interest rate, %	
		Stock market profitability, %	
		Net acquisition of financial assets (% of GDP)	

Figure 2. Sparkline. which characterizes the state of the depth of Ukraine’s financial system in terms of development of financial institutions

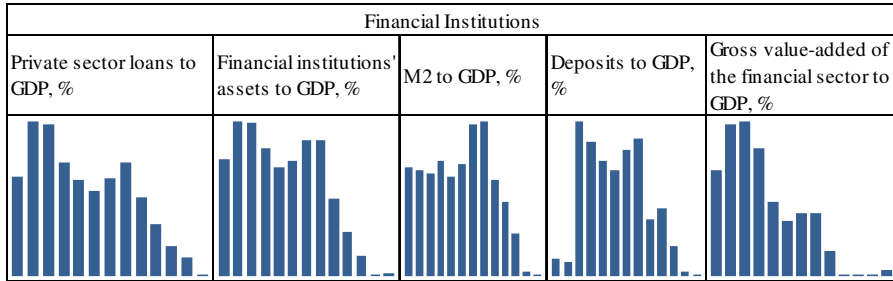


Figure 3. Sparkline. which characterizes the state of the depth of Ukraine’s financial system in terms of financial market development

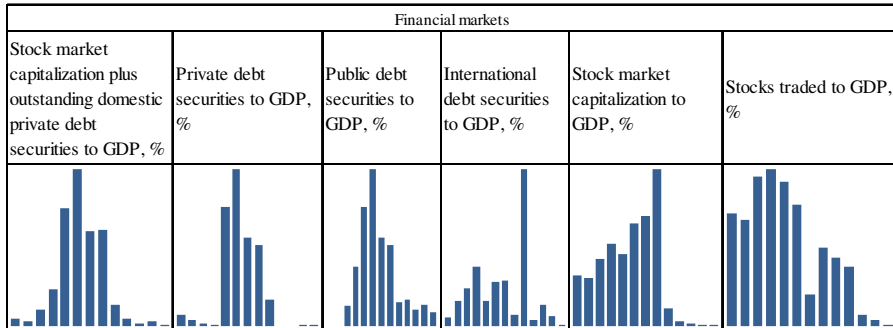


Figure 4. Sparkline. which characterizes the state of access to the financial system of Ukraine according to the indicators of development of financial institutions

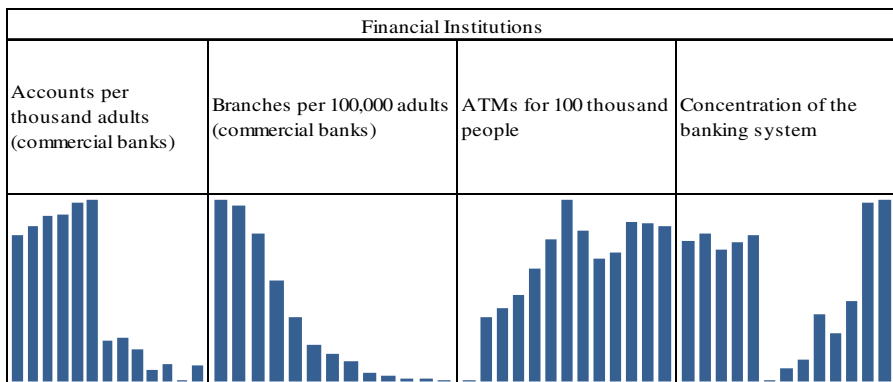


Figure 5. Sparkline. which characterizes the state of access to the financial system of Ukraine according to the indicators of the financial market development

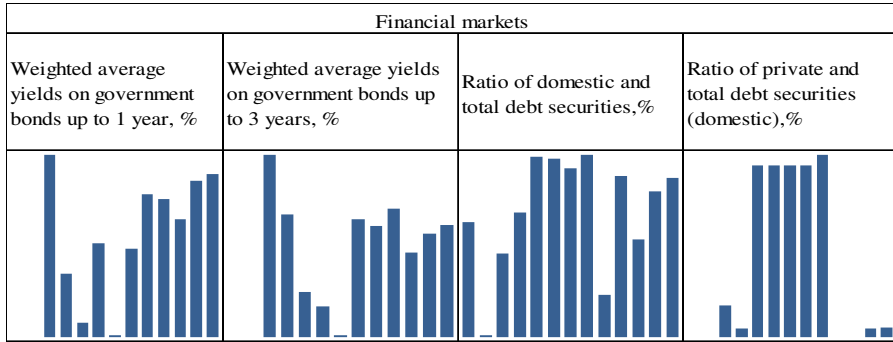


Figure 6. Sparkline. which characterizes the efficiency of the financial system of Ukraine according to the indicators of financial institutions development

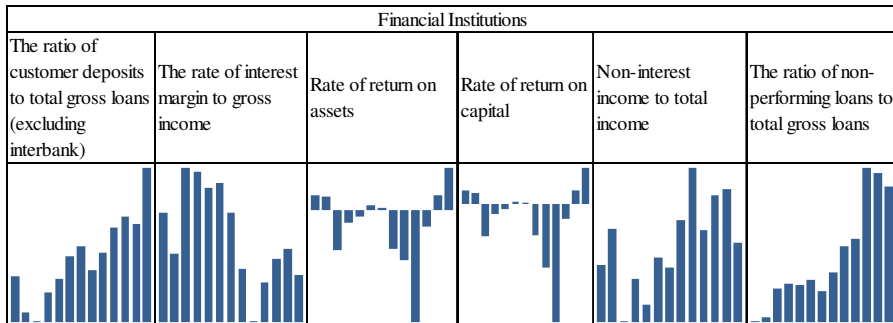


Figure 7. Sparkline. which characterizing the efficiency of the financial system of Ukraine in terms of financial market development

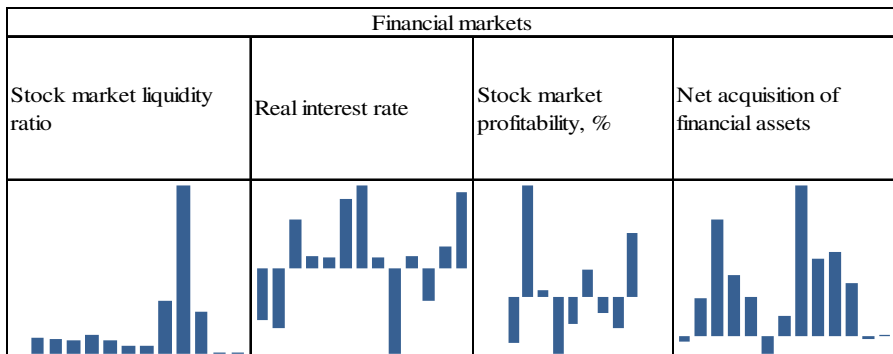


Figure 8. Dynamics of integrated indicators and polynomial trends

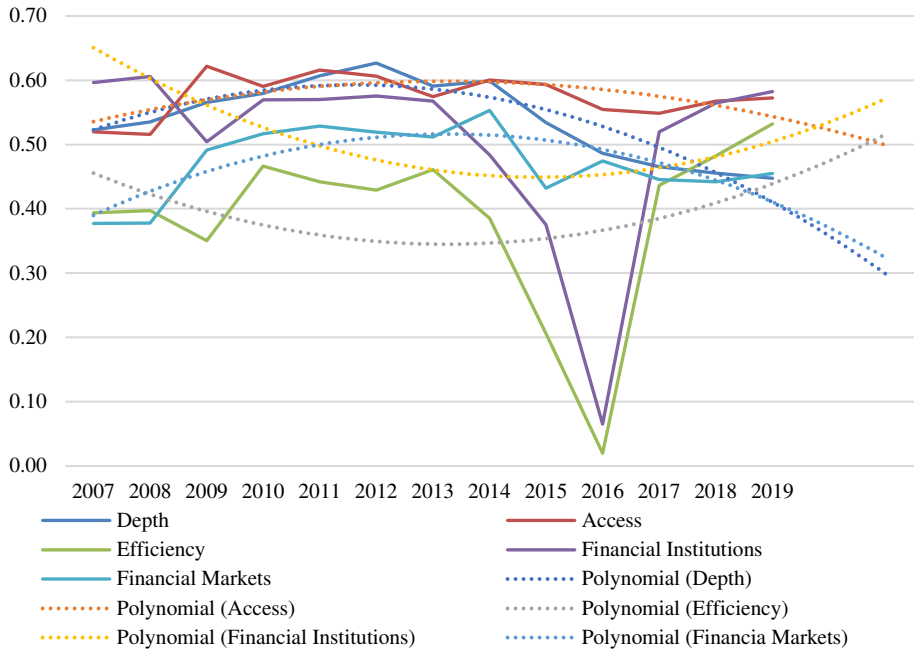


Figure 9. The total index that characterizes the stability of the financial system of Ukraine

