# A FINANCIAL STRESS INDEX FOR UKRAINE

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*In this paper, we develop a daily Financial Stress Index (FSI) for the comprehensive quantitative measurement of the degree of stress in Ukraine's financial system. We use 14 individual indicators grouped into four sub-indices – the banking sector, corporate debt, government debt, and the foreign exchange market – to construct the FSI. The index measures the level of stress and vulnerability of the financial sector and enables to compare this level at current moment with its dynamic in the past. The FSI can signal the start of a financial crisis and can be used to assess the effectiveness of anti-crisis measures.*

## I. INTRODUCTION

Since the establishment of financial markets, financial crises have occurred periodically. The most recent crises have shown that an accurate method for assessing the degree of stress is essential to properly monitoring the state of the financial sector. Therefore, international financial institutions, central banks, researchers, and some major financial market players have created various indicators that assess the level of economic stress. The most well-known indicators are financial stress indices (FSIs).

Hakkio and Keeton (2009) proposed five key features of financial stress:

- Uncertainty about fundamental asset value and high volatility of market prices;

- Chaotic behavior by investors;

- Informational asymmetry;

- A sharp increase in risk or uncertainty;

- Low liquidity of the financial system.

Based on those criteria, financial stress can be defined as a state of uncertainty for financial system participants that leads to losses in asset values and in economic activity. Estimating stress levels at a given time has proven difficult, which has resulted in the need to quantify it.

Therefore, the main purpose of a Financial Stress Index (FSI) is to measure the current state of stress in the financial system using various indicators for different financial segments into a single quantitative statistic. The index allows policymakers to monitor the state of the financial system and to use it as a complementary tool in macroprudential analysis and policy decisions. The FSI also aims to define the systemic nature of the stress and assess whether the financial stress requires special attention. Growth in the index measure is an argument for additional monitoring of developments in the financial markets. By identifying growth in financial stress (or an existing high level of stress), policymakers can halt the development of negative factors and act to mitigate the potential impact on the economy.

A financial stress index is also a useful visual display that can be presented to the public to underscore the necessity for policy changes.

[1] Views presented here are those of the authors and do not necessarily reflect the official view of the World Bank.

In summary, the FSI can be used to:

- Measure the level of stress in the financial system;

- Assess the depth and duration of the instability on financial markets and the stress level relative to past crises;

- Identify the nature of the financial system's distress and its individual components (systemic or segment-specific);

- Help identify the appropriate policy tools for decision-making;

- Assess the effectiveness of crisis countermeasures.

The indicators used to measure the level of financial stress should be selected taking into consideration the specifics of the country, including the availability and quality of the input data. Ideally, the interpretation of the index should be straightforward and intuitive. When selecting input indicators, the behavior of the indicators and the final index must broadly correspond to an expert assessment of the degree of stress at various periods of time. In Ukraine's case, we selected a final set of indicators that generate an index that matches our understanding of the stress periods in Ukraine's financial sector over the past decade. The National Bank of Ukraine's Financial Stress Index (FSI) consists of four sub-indices that reflect the banking sector, the markets for corporate and government debt, and the FX market.

Each sub-index is weighted by the size of the respective financial market relative to GDP. We built the index starting in 2008 and analyzed its past performance; we conclude that it closely matches our assessment of the state of the financial system. The NBU plans to maintain the FSI and regularly publish its performance in its Financial Stability Reports.

The purpose of this article is to provide an in-depth overview of the methodology for the Financial Stress Index (FSI) for Ukraine.

The article is structured as follows: chapter II reviews the growing literature on stress indices and their application and limitations; chapter III outlines the methodology used in building Ukraine's FSI; chapter IV provides an analysis of the evolution of Ukraine's FSI and its sub-indices over the past decade; and chapter V concludes.

## II. REVIEW OF THE LITERATURE: THE EMERGENCE AND EVOLUTION OF FINANCIAL STRESS INDICES

Global financial markets have been turbulent in recent decades. In response to major financial crises in developing and advanced countries, policymakers and researchers have invested substantial resources in quantifying the degree of stress in the financial sector to understand the degree of stress relative to past crises. These efforts have resulted in various financial stress indicators – indices that track developments in the financial sector over a long period.

Initially, methodologies relied predominantly on one variable to measure the level of financial stress. For instance, the slope of the yield curve, the spread of 10-year treasury notes over the federal funds rate, the M2 money supply, or the short-term credit spread as described by Estrella, Hardouvelis (1990), Freidman, Kuttner (1992). The Chicago Board of Exchange established the popular Volatility Index (VIX) based on equity option prices, which still fails to capture the degree of stress for the entire financial system.

In 2000, Bordo, Dueker, and Wheelock attempted to develop an index that would combine both quantitative and qualitative data. Their index, covering the 1870-1997 period, brought together a summary of business and bank bankruptcy rates, ex-post real interest rates, and interest rate quality spreads. A qualitative index based on descriptive sources was used to estimate data for the 1790-1869 period that lacked statistical records. To test the methodology, the qualitative index was extended to 1997 and an empirical model proved accurate based separately on the qualitative and quantitative indices. However, since the index was based on annual data, it was useful to analyze past trends, but its application in analyzing the current situation is limited.

The financial stability index built by investment bank J.P. Morgan uses different components of global risk – liquidity and credit and volatility risk – and combines them into a single index (LCVI). Liquidity risk is calculated based on the spread between on-the-run and off-the-run US Treasury bonds and US swap spreads; credit risk is measured by the spread between corporate 10-year bonds over U.S. Treasuries; and volatility risk is based on the volatility of currency and options markets. This index is often used to determine the level of risk in global financial markets (International Monetary Fund, 2002, 2003a).

The lack of methods for measuring stress levels in the whole financial system was one of the most significant limitations of these indices. A new generation of financial stress indices were developed in the 2000s, aiming to embrace a much broader set of financial market data.

The Bank of Canada in 2003 introduced the first inclusive financial stress index to measure stress across the entire Canadian financial system. The new methodology marked a breakthrough and was further improved in 2006 by Illing and

Liu. The Canadian index was built on eleven financial system variables (sub-indices) that covered the markets considered most important for the stability of the financial system: the banking sector, equity markets, bond markets, and foreign exchange. The sub-indices were weighted by the relative size of the respective market segments. The model was tested on several aggregation methodologies: factor analysis (principal components), econometric benchmarking, and generalized autoregressive conditional heteroskedasticity (GARCH) modeling. A credit weighting approach was used due to its best fit with the results of a qualitative survey by the Bank of Canada that looked at market participants' perceptions of periods of financial stress in Canada. This index was the first to cover most of the financial system and it became an inspiration for many financial stress indices developed later.

The global financial crisis of 2007–2009 and the European sovereign debt and banking problems that began in 2010 underscored the acute need for assessing the level of financial stress and calculating an FSI. The crises prompted academics and practitioners to intensify their efforts to develop appropriate measures.

The Federal Reserve Banks of the U.S. developed several financial stress indices to measure financial stress in the U.S.: the Federal Reserve Bank of Kansas City's Financial Stress Index (KCFSI) in 2009, the Federal Reserve Bank of St. Louis' Financial Stress Index (STFSI) in 2010, and the Federal Reserve Bank of Cleveland's Financial Stress Index (CFSI) in 2011.

Hakkio and Keeton (2009) used monthly data to construct the KCFSI. They used several criteria to select 11 indicators that reflect the key features of financial stress. "Each indicator had to represent features of financial stress – to reflect prices or yields on financial markets, because market prices and yields embody the largest amount of information and are the quickest to reflect changes in financial conditions; to be available on a monthly basis, so that a monthly financial stress index could be constructed; to be available at least since 1990, in order to assess the ability of the KCFSI to identify past episodes of financial stress."[2] A principal component analysis (PCA) approach was used to aggregate the stress indicators. While the KCFSI relies on monthly data, all the processes sped up significantly during periods of severe stress, as was the case with the Bear Stearns and Lehman Brothers failures. In this respect, an index that quickly reflects market developments, ideally in real time, would be preferable.

This limitation prompted the Federal Reserve Bank of St. Louis to create a weekly financial stress index in 2010. The calculation of the index uses seven interest rate series, six yield spreads, and five other financial indicators, all of which are available back to 1993. The STLFSI and the KCFSI both use principal component analysis for aggregation. However, the STLFSI has an advantage in that its weekly basis allows it to reflect the current state of the financial system.

The Cleveland Fed's Financial Stress Index (CFSI) was developed in 2009 by M. Oet, T. Bianco, et al. and published in 2011. The index is based on daily financial market data to allow current stress levels to be assessed. The CFSI is based on 11 indicators covering four financial sectors: credit markets, equity markets, foreign exchange, and interbank markets. These sectors offer extensive coverage of the financial system, and stress in any of them can spread to the entire financial sector. A dynamic weighting method was used to capture changes in the relative importance of each of the four sectors.

Cardarelli, Elekdag, and Lall (2009, IMF) developed a financial stress index for advanced economies (AE_FSI). They explored stress episodes in 17 economies from 1980 to 2008. For every country, the index was calculated as a weighted average of three sub-indices: the banking sector, fluctuations in the cost of capital, and foreign exchange. Unlike the KCFSI, STLFSI, and Bank of Canada indices, which use principal components to determine the variable coefficients, the variables in the AE_FSI are standardized and assigned equal weights. Episodes when the AE_FSI diverges positively by more than one standard deviation from its historical mean value were identified as periods of financial stress. The authors also examined the correlation between financial stress and economic recessions. One of their conclusions is that episodes of financial turmoil and stress for banks are deeper and longer during economic downturns than episodes caused by turbulence in securities markets or foreign exchange markets. Economic recessions not connected with banking stress usually last half the time, or less.

Expanding the sample to 25 developing countries, Balakrishnan, Danninger, Elekdag, and Tytell (2009) improved the methodology and developed the Emerging Country Financial Stress Index (EM_FSI). This research allowed an exploration of the transmission channels of financial stress between advanced and developing economies, improved the quality of calculations, allowed a more accurate determination of stressful events, and provided the possibility of analyzing which factors – including common regional factors – led to increases in stress levels in developing economies.

In 2009, the European Central Bank developed its own financial stress index. The index applied to a sample of 28 counties, 10 classified as advanced economies and 18 as developing countries. The raw financial market data used by the ECB was standardized, log-transformed, and aggregated for three key markets: fixed income, equity, and foreign exchange. The most noteworthy contribution of the ECB index was that it also created the Global Index of Financial Turbulence to evaluate the average degree of stress in the world's most advanced economies.

In 2011 especially, central banks continued researching the topic of financial stress. In particular, Slingenberg and Haan (De Nederlandsche Bank, the central bank of the Netherlands) developed a financial stress index for 13 OECD countries. In 2015,

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2 Hakkio, Keeton(2009). Financial Stress: What Is It, How Can It Be Measured, and Why Does It Matter? https://core.ac.uk/download/pdf/6592699.pdf

they extended the coverage of the index to 29 countries. The authors intended to determine the key indicators for measuring financial stress. The variables they used were standardized by subtracting the mean and dividing by the standard deviation. The index was constructed as the un-weighted sum of standardized variables. The authors also attempted to establish a method for forecasting financial stress based on macro-financial variables. The results proved that accurately predicting financial stress in general is difficult, with the exception of credit growth, which has good predictive ability for most countries. At the same time, some variables that are acceptable as predictive variables in certain economies fail to produce accurate forecasts in other cases.

Haefcke and Skarholt of the Riksbank of Sweden built the Swedish Financial Stress Index (SFSI) using 14 daily indicators aggregated into five sub-indices: money markets, bond markets, the foreign exchange market, equity markets, and the banking sector. These sub-indices were weighted by the size of the respective sector in the financial system and their time-varying cross-correlation matrix. This aggregation method was eventually selected by comparing the output with the results of expert surveys.

Hollo, Kremer and Lo Duca of the ECB developed and introduced in 2012 a new weekly index, the Composite Indicator of Systemic Stress (CISS). The index is important because it reflects the current stress level in the financial system of the euro area. The CISS index marked a methodological breakthrough by using portfolio theory to aggregate five sub-indices, which, in turn, are built on 15 independent financial indicators. The aggregation involves time-varying cross-correlations between sub-indices, which yields a higher index level when the stress manifests itself across several markets simultaneously. The index therefore reflects the notion that financial stress is more likely to be systemic if it spreads to several markets; systemic financial stress puts the entire economy at greater risk of instability.

To summarize, the research in measuring the level of stress in the financial system has advanced significantly. The starting point was a simple single parameter index or indices for single markets. More recent approaches have relied on a set of variables that covers most of or the entire financial system. Index aggregation techniques have also varied – from equal weightings to weightings based on the relative size of market segments or a principal component analysis.

In building our FSI for Ukraine, we strive to develop a composite indicator covering several financial market segments, in-line with the findings and recommendations of recent research papers.

## III. CONSTRUCTING A FINANCIAL STRESS INDEX FOR UKRAINE

The National Bank of Ukraine (NBU) initiated the development of a Financial Stress Index (FSI) for Ukraine to assess the degree of stress in the country's financial system and compare it to the historical long-term average. The index is built on daily data. The FSI calculation methodology is based on the methodologies applied in other countries, but adjusted to the country-specific features of Ukraine's financial system. The key constraint is the limited availability of good-quality, high-frequency indicators with long observation periods. Another challenge is the low liquidity of some of the local financial markets; certain indicators can change abruptly and significantly as markets remain extremely sensitive to external and internal shocks.

▪ The domestic equity market is extremely small (UAH 14 billion in turnover in 2016, 0.6% of GDP). In contrast, the government bonds section of the stock exchange is significant (UAH 211 billion, 9% of GDP).

▪ The Ukrainian hryvnia is a volatile currency that is dependent on the balance of payments and sensitive to the frequent political and social stresses, as well as abrupt changes in sentiment by the population, which uses foreign currency as a store of value.

▪ Ukrainian debt securities have been among the highest-yielding and riskiest papers in the global investment universe.

Considering the above factors, certain indicators that are used widely in other countries are inappropriate to be included in Ukraine's FSI.

The work to establish the Financial Stress Index is divided into three stages:

▪ Selecting sub-indices and their components (indicators);

▪ Normalizing the indicators;

▪ Weighting the sub-indices to generate the FSI.

### Selecting sub-indices and their components (indicators)

The construction of the FSI starts with the selection of sub-indices that, after weighting, provide a comprehensive measure of stress in the financial sector at a given time. Each sub-index is designed to reflect the state of the respective financial market segment. Each sub-index is based on individual financial market indicators. Ideally, at least three indicators are used; if some

were to be used alone, they may fail to properly capture changes in market conditions. Taking an average of at least three variables provides a more robust and reliable assessment. To select a proper set of relevant sub-indices and their components, we analyzed the historical behavior of the different indicators and chose those whose performance fits with the different stages of past financial crises. In addition, the availability of daily data was an important criterion in selecting indicators.

We construct four sub-indices, each capturing the state of one segment of the financial market: the banking sector, corporate securities, government debt, and the foreign exchange market. Each sub-index is calculated as a simple average of the normalized individual indicators. These four sub-indices are then aggregated into a single FSI through a specific weighting approach (described later).

We use a daily time series for the 14 individual indicators starting from 2008 and update them on a regular basis. If an indicator is missing data, the last available value is used.

### Components of the banking sector sub-index:

▪ Change in the overnight interbank rate.[3] During periods of stress, interbank market rates rise as banks lend less to each other due to liquidity constraints and a higher bankruptcy risk.

▪ Liquidity of the Eurobonds of large Ukrainian banks, as measured by the average bid-ask spreads. The data is based on bonds issued by Oschadbank, Ukreximbank, First Ukrainian International Bank, and PrivatBank (until the bail-in in mid-December).[4] The bid-ask spread reflects difficulties in pricing Eurobonds due to uncertainty and therefore represents a good indicator of banking market conditions. The higher the spread, the higher the level of stress in the banking sector.

▪ Bank liquidity – the total negative deviations from the double of the minimum instant liquidity requirement (2*20% = 40%),[5] weighted by the share of deviating banks of total banking sector liabilities. The floor ratio is doubled because the floor is rarely binding and most banks easily comply with the ratio. The threshold is increased (doubled) to better capture signs of liquidity problems building in the banking sector. The more liquidity (and less stress) in the banking sector, the lower this indicator.

▪ Households' confidence in banks – the percentage change in the stock of retail deposits over the 30 days prior to the calculation date, separately for hryvnia and foreign currency deposits (in dollar terms). Changes in hryvnia and foreign currency deposits are then weighted by their respective market shares.[3] The higher the change, the higher the customer confidence in banks. Historically, during periods of banking sector vulnerability, trust in banks falls, and households scramble to withdraw deposits and keep their savings in cash. Therefore, this indicator is a negative value ('–'); lower confidence levels translate to a higher FSI value.

### Components of the corporate securities sub-index:

▪ The premium corporates pay on debt relative to the government – the yield spread on Ukrainian corporate Eurobonds over sovereign Eurobonds.[6] This value reflects the risk of the corporate sector relative to sovereign risk. The wider the spread, the higher the stress level in the corporate debt market.

▪ The Cmax indicator for Ukrainian stocks (Cmax = 1 – Xt/max(XT)) shows the deviation of an index of stocks on a specified date from its maximum over the previous 12 months. This enables the identification of stock market declines/crashes by measuring the maximum cumulative loss over the past year. The PFTS Index is used for calculations before 2011 and the WIG Ukraine Index from the Warsaw Stock Exchange afterwards.[7] The WIG Ukraine Index is appropriate because it tracks relatively liquid stocks of Ukraine-based companies listed in Warsaw. Ukraine's local stock market is almost non-existent and is subject to price manipulation. The higher the value of this indicator, the larger the decline on the stock market is in comparison with its rolling 12-month maximum.

▪ The volatility of Ukrainian stocks – the standard deviation of the values of stock indices over the 30 days prior to the calculation date. The PFTS Index is used prior to 2012 and the WIG Ukraine Index afterwards.[7] Stock market volatility increases when uncertainty grows; changes in this measure are related to financial sector stress.

### Components of the government debt sub-index:

▪ Sovereign risk – the spread between the weighted average yield of Ukrainian government Eurobonds and the yield on 10-year US Treasury bonds (US Treasury 10Y).[6] This indicator reflects the riskiness of investments into Ukrainian sovereign debt. The higher the spread, the higher the risk level.

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**3** Source: National Bank of Ukraine
**4** Source: Bloomberg
**5** Defined as the ratio of a bank's highly liquid assets to current liabilities, which must be not less than 20%
**6** Source: Cbonds
**7** Source: PFTS and the Warsaw Stock Exchange

■ The liquidity of Ukrainian government Eurobonds – a simple mean bid/ask spread of government-issued Eurobonds on a given date.[8] In times of financial instability, the bid-ask spread on government bonds usually grows.

■ Credit default swaps[8] of Ukrainian sovereign bonds – reflecting the probability of issuer default perceived by the market, which correlates highly with financial stress levels.

### Components of the FX market sub-index:

■ Expectations of devaluation – the difference between the NDF (non-deliverable forward) UAH/USD 3M and interbank spot UAH/USD exchange rates adjusted for interest rate gaps between the Ukrainian interbank market (KievPrime3M) and the London interbank market ($Libor3M), in percent.[9] NDF contracts fix an exchange rate now for settlement at a future date (3M), therefore the difference between the NDF and spot rates (adjusted for interest rate differences) reflects market expectation of future UAH/USD moves. The higher the difference, the greater the expected depreciation for the hryvnia.

■ The Cmax indicator for the interbank UAH/USD rate – calculated like the Cmax for Ukrainian stocks.[10] The higher the value of the indicator, the weaker the hryvnia is relative to its strongest level over the preceding 12-month period.

■ Volatility of the interbank UAH/USD rate – calculated like the volatility of Ukrainian stocks.[10] In times of financial stress, exchange rate volatility is typically higher.

■ FX market imbalances – the net purchase/sale of foreign currency by the NBU on the interbank FX market on the calculation date.[10] A net sale of foreign currency by the NBU is a signal of financial stress as this usually indicates a shortage of foreign currency on the market.

### Normalizing indicators

Indicators with different units of measurement need to be restated to create comparable input data that will allow them to be averaged. This is done by normalizing the indicators.

Normalization can be done in several ways, each with relative advantages and disadvantages. Hakkio and Keeton (2009), Slingenberg and Haan (2011), etc., used the standard deviation approach: the sample mean is subtracted from the raw score of the individual indicators and the difference is then divided by the sample standard deviation. This method has significant limitations. First, the sample mean and the standard deviation must be revised for new data observations, which required past values to be recalculated. Second, normalized indicators can have different scales, making the construction of a composite index a challenge.

Illing and Liu (2003); Oet and Bianco (2011); Haefcke and Skarholt (2011); Hollo, Kremer, and Lo Duca (2012) used a variety of other methods summarized in the table below:

## Table. Normalization methods

| Method | Pro | Con |
|---|---|---|
| Cumulative distribution function (CDF) | (0.1) range, more historically stable | noisy, distorts relative stress size (especially on small samples), sensetivity to outliers |
| Variance-equal | no distortion | historically unstable, accepts negative values |
| Min-Max Range | (0.1) range, no distortion | may be too sensitive to outliers |

We chose the min-max range normalization method to calculate our FSI. This method yields numbers from 0 to 1, a clear advantage – the index can be interpreted easily by non-professional users. Other methods yield outcomes from -1 to 1, and negative values can be mistakenly perceived as adverse or reflecting stress in the financial system. However, the method has one drawback – if new values for certain indicators exceed the historical highs or lows, the entire series of normalized values must be recalculated. The Ukrainian financial system has undergone two enormous financial crises since 2008, including one related to a serious geopolitical conflict, and new shocks that would drive the key indicators above previous maximums are unlikely in the foreseeable future.

Each indicator is normalized using the formula:

$$V'(i) = \frac{V(i) - min(V(i))}{max(V(i) - min(V(i)))} \text{ ,}$$

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8 Source: Bloomberg
9 Source: Cbonds, National Bank of Ukraine (interbank rate)
10 Source: National Bank of Ukraine

where V(i) is the value of the raw indicator at day i, V'(i) is the value of the normalized indicator, and the min and max operators use the whole available sample.

The normalization process yields results ranging from zero to one for the indicators, the sub-indices, and the FSI itself. This allows us to explore and analyze the level of stress in the whole financial system, in individual segments, and across different indicators. The closer the value to 1, the higher the stress level at a given moment.

### *Aggregating the sub-indices into the FSI*

Next, the weights used to pool the four sub-indices into the Financial Stress Index must be determined. Since the financial market segments represented by the sub-indices carry different importance for the Ukrainian economy, the sub-indices must have weights that accurately capture the relative significance of the respective market segments. We use a weighting approach based on the size/relative importance of the various segments in Ukraine's financial system. We calculated the size of each segment relative to GDP, using the following metrics to approximate sizes:

1) Banking sector – the total volume of loans to residents (non-financial corporations and households);

2) Corporate securities – the sum of the stock market capitalization and the volume of the corporate bond market;

3) Government securities – the volume of outstanding local currency bonds and sovereign Eurobonds;

4) FX market – the volume of foreign currency securities issued by residents (both in the domestic and external markets) and foreign currency loans to residents.

Based on this exercise, we assigned the following weights to each segment / sub-index:

1) Banking sector: 0.3;

2) Corporate securities: 0.1;

3) Government securities: 0.25;

4) FX market: 0.35.

## IV. THE FSI CAPTURES PERIODS OF FINANCIAL TURBULENCE IN UKRAINE WELL

### Figure 1. Ukraine's Financial Stress Index
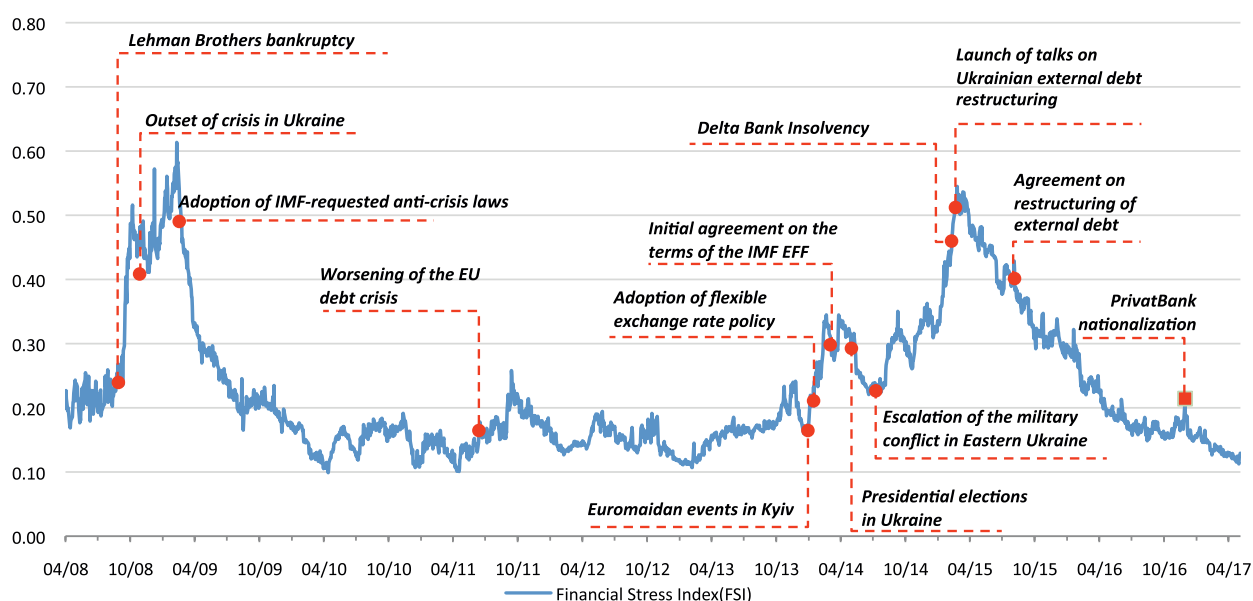


*Source: NBU*

The data available allows the FSI for Ukraine to be measured starting in April 2008. The FSI was very volatile as the world approached the global financial crisis (Figure 1). The crisis clearly broke out with the collapse of Lehman Brothers in September 2008. Global markets reacted immediately, as did the Ukrainian market as seen by the significant spike in the FSI. With additional shocks to the local financial market, the index continued to rise until March 2009. That month the FSI reached its peak value over the eight-year observation period. The financial stress had multiple origins at the time – an abrupt decline in exports, the closure of external capital markets for Ukrainian companies, and, subsequently, a currency crisis. All these undermined the solvency of the government and private borrowers, driving yields on public and private debt up. The growth in the FSI was therefore driven by turbulence in each of the four component sub-indices (Figure 2). The crisis lasted for about a year and the index returned to its pre-crisis level in Q4 2009. The situation normalized following the stabilization and global financial and commodity markets recovered gradually. Many private borrowers (Eurobond issuers) had to restructure debt to ease liquidity pressures amid the ongoing crisis. The IMF program with Ukraine also helped ease pressures, even if temporarily.

## Figure 2. FSI sub-indices for Ukraine
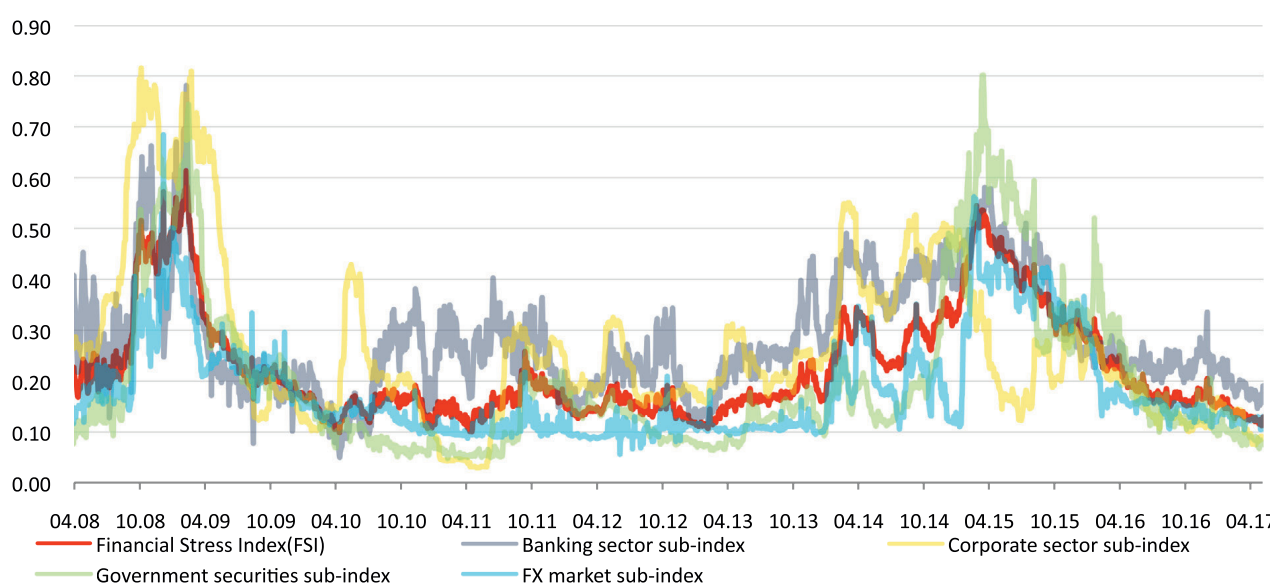


*Source: NBU*

The FSI remained volatile but at relatively low levels from early 2010 until a visible spike in Q4 2011, largely a reflection of the unfolding European sovereign debt crisis, which was contained by end-2013.

The most recent period of severe stress started in late 2013 when the Euromaidan (civil protest) led the then-president to flee and the government to resign. The subsequent invasion by Russia, annexation of Crimea, and military conflict in Eastern Ukraine fueled the largest and deepest economic and financial crisis in two decades. This period saw a sequence of severe economic challenges and policy responses. The exchange rate depreciated sharply as Ukraine lost a third of its export potential in the occupied territories. The NBU abandoned its fixed exchange rate policy and introduced a floating rate policy to ensure that external shocks are absorbed via exchange rate adjustments. The banking sector experienced a long and severe run on deposits – the population withdrew more than 20% of retail hryvnia deposits and 60% of foreign currency deposits. This caused the banking sector sub-index to rise substantially. All government Eurobonds were restructured, with a 20% haircut on the principal in exchange for VRI (Value recovery instruments) and a significant extension of maturity. The private sector followed suit, restructuring nearly all outstanding external debts. Naturally, yields on sovereign and private debt surged during 2014-15. In the latest crisis, the FSI did not reach the peak value recorded in March 2009. However, the crisis was long; the index returned to its pre-crisis level only after three years.

The most recent temporary spike in the FSI was caused by uncertainty ahead of the nationalization of PrivatBank, Ukraine's largest bank, in December 2016. The index peaked on the day of the government's intervention into the bank and retreated relatively quickly in the following weeks. It is worth noting that the banking sector sub-index has been volatile nearly at all times. The sector has been vulnerable to minor and major shocks that affect the financial sector. This is a clear sign of the fundamental weakness of the Ukrainian banking sector prior to the NBU's massive clean-up of banks that began in early 2014. Now that the sector has been cleaned and is recovering, we expect a decline in volatility and in the level of the banking sector sub-index.

## V. CONCLUSIONS

Financial stress indices – composite measures of the degree of disruption in financial markets – have gained in popularity globally over the past decade. These indices usually serve as a single comprehensive measure of financial sector stress and are therefore easy to interpret. They provide a good indication of how the situation in the financial sector compares to previous periods and they serve as a gauge of the degree and duration of turbulence in the financial sector. The FSI for Ukraine is built on four sub-indices that capture the state of different segments of the domestic financial market. Each sub-index is, in turn, based on at least three indicators (14 in total) that quantify the turbulence in the respective segments. Retrospectively, the FSI for Ukraine is correlated well with a narrative account of developments in the financial sector and it seems to have captured all the major external or domestic shocks that were transmitted to the financial system. The FSI serves as a good proxy for the degree of stress facing the Ukrainian economy at any given moment of time and thus can be used by policymakers as a monitoring tool.

### References

■ Balakrishnan R., Danninger S., Elekdag S., Tytell I. (2009). The Transmission of Financial Stress from Advanced to Emerging Economies. Working paper, (WP/09/133). International Monetary Fund. Available at https://www.imf.org/external/pubs/ft/wp/2009/wp09133.pdf

■ Bordo M., Dueker M. Wheelock D. (2000). Aggregate price shocks and financial instability: an historical analysis. Working Paper, (№ 7652). National bureau of economic research. Cambridge. Available at http://www.nber.org/papers/w7652.pdf

■ Cardarelli R., Elekdag S., Lall S. (2009). Financial Stress, Downturns and Recoveries. Working paper, (WP/09/100). International Monetary Fund. Asia and Pacific Department. Available at https://www.imf.org/external/pubs/ft/wp/2009/wp09100.pdf

■ Grimaldi M. (2010). Detecting and interpreting financial stress in Euro area. Working Paper, (№ 1214). European Central Bank (ECB). Frankfurt am Main. Available at https://www.ecb.europa.eu/pub/pdf/scpwps/ecbwp1214.pdf?ad93a7dc9cca798818b13f6f03b94f95

■ Haefcke S., Skarholt A. (2011). A Swedish Financial Stress Index. Stockholm School of Economics. Available at http://arc.hhs.se/download.aspx?MediumId=1418

■ Hakkio C., Keeton W. (2009). Financial Stress: What Is It, How Can It Be Measured, and Why Does It Matter? Federal Reserve Bank of Kansas City. Available at https://core.ac.uk/download/pdf/6592699.pdf

■ Hollo D., Kremer M., Duca M. (2012). CISS – A Composite Indicator of Systemic Stress in the Financial System. Working Paper, (№ 1426). European Central Bank (ECB). Frankfurt am Main. Available at https://www.ecb.europa.eu/pub/pdf/scpwps/ecbwp1426.pdf?6d36165d0aa9ae601070927f3ab799fc

■ Illing M., Liu Y. (2003). An Index of Financial Stress for Canada. Working Paper, (№ 2003-14). Bank of Canada. Ottawa. Available at http://www.bankofcanada.ca/wp-content/uploads/2010/02/wp03-14.pdf

■ Kliesen K., Smith D. (2010). Measuring financial market stress. Economic synopses, (№ 2) Federal Reserve Bank of St. Louis. Available at https://files.stlouisfed.org/files/htdocs/publications/es/10/ES1002.pdf

■ Oet M., Eiben R., Bianco T., Gramlich D., Ong S. (2011). Financial Stress Index: Identification of Systemic Risk Conditions. Federal Reserve Bank of Cleveland. Cleveland.

■ Slingenberg J., Haan J. (2011). Forecasting Financial Stress. Working Paper, (№ 292). The Bank of the Netherlands. Amsterdam. Available at https://www.dnb.nl/binaries/working%20paper%20292_tcm46-253005.pdf