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FINANCIAL STRESS INDEX: ESTIMATION AND APPLICATION IN EMPIRICAL RESEARCHES IN UKRAINE

Abstract

The article is an overview of advanced scientific researches, dedicated to estimation financial stress index. It describes theoretical nature and practical applications of the indicator as a tool for monitoring the crisis on the financial markets. Based on the previous findings and taking into account specific demands of national finances, was offered own concept of estimation Ukrainian financial stress index. Authors demonstrate analytical capabilities of this index to analyze fiscal policy. Also was provided number of theoretical conclusions about regimes of fiscal policy and corresponding levels of financial security. According to the survey, fiscal policy behavior is the same on the extreme points of the interval of financial stress and makes diametric changes in main parameters, when reaches an average level.

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Key words:

Financial stress index, financial crisis, episode of financial stress, fiscal policy, fiscal policy regime switches, non-linear fiscal reaction functions.

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Introduction

Increased volatility and dynamics of global financial markets, which observes humankind over the past few decades, attracted the attention of scientists to study the behavior of financial indicators. Based on the fact that the financial system is inherently not a homogeneous structure, the volatility behaves itself in different ways in different time horizons and sectors. In order to unify the information about the financial threats in the academic literature are used various statistical indexes. They are similar in content and focused on monitoring and forecasting of financial volatility.

In addition, the recent economic literature, devoted to the exploration of global instability, there are many works in which researchers are trying to expand the practical application of sustainability indicators. Most studies aimed to improve methods of evaluation indexes through better integration of information from all sectors of the financial system and application results as tools for empirical verification of hypotheses. Thus, the estimation of this indicator for Ukraine is of considerable scientific interest.

The purpose of this article is to develop a methodology for estimation the financial stress index for Ukraine and demonstrate its practical application for the study fiscal policy regimes.

Literature review

Financial crisis passes five stages. The first stage begins with a sharp increase in the volatility of prices in the stock market and lowering the quality of financial assets. Simultaneously, the growing demand for short-term financial resources, results in increased value of monetary instruments and reducing their liquidity. The second stage is the banking sector crisis. This phase is characterized by failure of debtors to meet its obligations against the background of lower liquidity and limited access to debt capital. The close relationship between the real economy and the financial system causes general economic decline – the third stage of the crisis. At this stage, there is a gradual spreading of risks in the global environment through financial and trade channels. Further development of the crisis results in a deep and lasting recession – the fourth stage. This phase is accompanied by numerous defaults, rising unemployment, increased capital outflows and exchange rate fluctuations reach a critical point. As a result, the financial capacities of the state to pursue a flexible and stimulating fiscal policy are exhausted. From this moment begins the final fifth stage of the crisis, when the economy is showing signs of recovery. This period is characterized by shrinking the ratio of credit resources and activation of capital markets, decreased volatility and reduced uncertainty, as well as recovery of economic activity (Zeti, 2014).

Thus, in the process of its development financial crisis goes certain stages, beginning with fluctuations in the banking sector and ending in an economic depression. Consequently, nowadays the economists are faced with an important task - to determine the conditions of financial stress.

Stress can be considered as a result of fluctuations that arise from an exogenous shock. It reflects the stability of the financial system. For example, when the dynamics of cash flow slow down or lenders are riskier, there is a greater possibility that the next shock will lead to a crisis. Based on this provision, the financial crisis is one of the possible consequences of financial stress. However, Canadian scientists M. Illing and Y. Liu (Illing and Liu, 2003) separate these two concepts. Financial crisis has a local effect and is concentrated mainly in one segment of the market while a stress spreads throughout the whole financial system. Agreeing with this, the aim of our study is to cover the entire financial system and, therefore, focus on «systemic stress».

Unfortunately, both in national and foreign financial science have not formed a unified view on the nature of financial stress. In a broad sense the episode of financial stress is defined as «a period of economic development, during which the financial system is under heavy stress (pressure or condition) and cannot perform its functions well» (Ekinci, 2013, pp. 213–229). In other words, financial stress is an interruption of the normal functioning of the economic system (European Central Bank, 2009).

Frequently the essence of financial stress revealed via the concept of «financial instability». In fact, these notions are similar in their economic content, but still they have some distinctive features. J. Chant (Chant, 2003) defines financial instability as «…conditions in financial markets that harm or threaten to harm an economy's performance through their impact on the working of the financial system». He pointed out that the term «financial instability" encapsulates several different kinds of such instability, ranging from banking crises to the stock market crashes. Hence, different forms of instability affect different parts of the financial system and may also differ in their consequences. Further, Chant proposed that financial instability should be distinguished from other forms of instability such as macroeconomic instability. The primary difference is that financial instability has its immediate source in financial markets (broadly defined) while macroeconomic instability is often due to aggregate demand or supply shocks. Finally, Chant points out that financial market are characterized by constant changes in prices and conditions, all of which would not qualify as financial instability. He, therefore, proposes that financial instability should be viewed in terms of the potential impact of changes in financial conditions on the real economy.

Consequently, financial instability is a disruption of the economy, resulting volatility in the financial markets. Financial instability is not an absolute condition. It has a certain perspective. The financial crisis stands extreme manifestation of financial instability, during which pressure on the financial system gives the economy for a long period. However, the financial system may be subjected to stress long before the crisis. Therefore, the costs and consequences of financial instability will depend on the magnitude of stress (Chant, 2003).

As can be seen, existing theories present rather abstract vision of the nature of financial stress. Development of a single definition is extremely challenging task because the conditions of stressful episodes vary considerably. In this regard, most economists have concluded that instead of trying to define the financial stress, better is need to focus on the development of unique criteria for identification stressful situations in the economy.

Detailed study of current crisis made it possible to identify five basic parameters that determine the level of stress in the economy (Hakkio and Keeton, 2009): 1) uncertainty about the fundamental value of assets and the high volatility of market prices; 2) chaotic behavior of investors; 3) the existence of informational asymmetry; 4) a sharp increase in risk or uncertainty; 5) low liquidity of the financial system.

In conclusion, summarizing the main criteria of financial stress, we can formulate the definition of the notion as market environment in which participants are under uncertainty and with the objective incentives to abrupt change their expectations of future losses, asset value, and economic activity in general.

However, in addition to identifying key parameters of financial stress, dynamic and comprehensive nature of the latest wave of financial crisis has set dif-

ficult task to theorists and practitioners of financial science to develop an effective monitoring system. In order to solve this problem authority, central banks and international organizations, and other financial market participants have developed a number of statistical indicators that estimate the level of economic pressure. These indicators are often called Financial Stress Index (FSI) or Financial Conditions Indexes (FCI).

In early studies, devoted to exploration nature of the crisis, a number of independent variables were used as indicators of financial stress. They gave detailed information about specific sectors of the financial market. Such as the incline of the yield curve, the spread between long-term treasury bonds, monetary aggregate M2, the S & P 500 and others. However, the use of these variables had one major drawback: they all analyzed economic development only from one angle and had limited ability to make definite conclusions about the level of financial stress.

The development of econometric modeling and factor analysis had given an impulse to improve the methodology of calculation of the generalized index of financial stability through the usage binary variables. Thus, the stability period was marked as 1 and its absence – 0. It gives a clear explanation of the definition of stress as a disruption of the economic system.

The main disadvantage of this methodology is estimation method. On the one hand, the relative simplicity of calculations provide fast information processing, on the other – it does not take into account all factors that affect the economy and thus limits the possibilities experts predict the size of future decline. Another qualitative and quantitative limit is the degree of market coverage. Most of the calculated indexes reflect the pressure on a specific sector of the economy and are ineffective in reaching all components of the economic system.

One of the first indexes, which allowed scientists to reflect comprehensively the level of financial stress, was created by experts of the Canadian central bank M. Illing and Y. Liu (Illing and Liu, 2006). It is a combination of several methods: factor analysis, regression causality, and GARCH-modeling. Practical application of such broad analytical tools made it possible to cover three major sectors of the financial markets: stocks, bonds, and foreign exchange. The main advantages of this approach were: first, creation of one single aggregate index, which can be used as benchmark for comparison analysis; secondly, identification of the relationship, how instability in the financial markets could influence the economic activity, in general (Park and Mercado, 2013).

The critical need for calculating the FSI was recognized after the financial crisis of 2007–2009. In that period, international organizations as key macroeconomic regulators intensified their activities. In 2008, the OECD has developed a financial stress index, which included six sectors of financial market. This indicator is fundamentally different from previous counterparts. It included variable for estimation credit standards (Ekinci, 2013, pp. 213–229).

During this period, Cardarelli R. et al (Cardarelli, Elekdag and Lall, 2009) made an attempt to calculate the financial stress index in advanced economies. The authors investigated the systemic stress episodes in 17 countries[1] in a range that covers more than 30 years. For each country FSI was calculated as a weighted average of three subindexes. It reflected the state of the banking sector, fluctuations in the cost of capital and foreign exchange.

For the analysis of the banking sector were used the following variables: the spread between interest rates on interbank loans and short-term US government debt and the slope of the yield curve; stock market included: corporate bond spreads, monthly income stock market volatility and volume of transactions; the currency market – the volatility of the nominal value of the currency.

Further Balakrishnan R. et al (Balakrishnan, Danninger, Elekdag and Tytell, 2009) improved estimation methodology. In particular, the index expanded sample of 25 developing countries, thereby allowing researches to analyze a larger number of parameters for a limited time horizon. This expansion in the range of the dependent variables had significantly increased the quality of calculations and allowed more accurate identification of stressful events in the economy. Furthermore, in contrast to previous approaches, the authors changed significantly the procedure for calculating the index. Conventionally available methods of index calculation methodology can be divided into two groups: the component approach and the estimation by weighting average (Manamperi, 2013). Gadanecz B. and Kaushik J. (Gadanecz and Kaushik, 2009) argue that weighting variables can able scientists to describe more precisely the financial system. However Illing M. and Liu Y. (Illing and Liu, 2006) emphasized that the weighting variables does have a significant effect on the quality of results. That is why authors used a simplified method instead of calculating the weighted average. This structure model has provided a number of significant advantages, including high adaptability and fast processing of incoming information.

Valuable was the study of Oet M. V. (Oet, Bianco, Gramlich and Ong, 2013). They developed a Cleveland Financial Stress Index (CFSI). It includes 11 variables that provide information about the status of the loan, securities, foreign exchange, and interbank markets. Most of the components of CFSI's are spreads, reflecting the yield on the financial markets; other components are relative and used to capture the volatility of the stock market.

The main purpose of this index was information provision of financial market data on the state of the economic system. It also tries to estimate the level of risk in different sectors of the financial system and submit it as a single aggregate statistics. Moreover, the calculation of this indicator allows conducting historical

[1]Australia, Austria, Belgium, Britain, Denmark, Finland, France, Japan, Italy, Netherlands, Norway, Spain, Sweden, Switzerland, USA.

analysis of stressful events, as well as to the comparative characteristic value of stress at different stages of the crisis.

According to Oet M. V. (Oet, Eiben, Bianco, Gramlich and Ong, 2011), the main functions of financial stress index, as a monitoring tool, is to inform market participants about the causes of the crisis, reduce information uncertainty and help risk managers to develop an anti-crisis measures.

This has determined high practical value of the index in the financial system management. For example, in many developed countries, such as Sweden, index plays an important role in the development of countercyclical policies, which is aimed to support economic growth. Moreover, the indicator is often used as monetary tool to support bank liquidity during the recession (Haefcke and Skarholt, 2011).

However, despite a significant amount of studies devoted to estimation FSI, unfortunately, scientist has not formed a unified view about variables that are able to assess the financial stability of the market. The basic parameters are profitability of financial resources as a reward for the risk, urgency, liquidity indicators of the stock market volatility in exchange rates, loan rate.

K. L. Kliesen (Kliesen, Owyang and Vermann, 2012) conducted a comparative analysis of financial stress indexes, which were used to monitor the financial condition by federal agencies in USA. The main assumption of the study is that all indices have a common purpose and, therefore, their value must be closely correlated. In practice, the authors found that the correlation of the coefficients is lower than expected. The scientists point to macroeconomic nature of the error. Important feature is the duration of observation. Some variables provide information within the 10-year interval while others – for 30 years or more.

Valuable practical achievements in econometric modeling of financial indices were made by J. W. Slingenberg and J. de Haan (Slingenberg and Haan, 2011). The main aim of the study is to identify key variables that are most informative in explaining financial stress index. In particular, researchers interested in the question: whether or not large number of variables best describe episodes of financial stress. In order to estimate these hypothesis authors use 30 variables from 13 developed countries of OECD. The survey results were quite unexpected. Only two variables have significant meaning in predicting the stress index. They are: MSCI (Morgan Stanley Capital International World) and local stock index. In 7 of the 13 cases, coefficients near the variables were statistically significant. Concerning the variables that have the strongest predicting power, their number varies considerably between countries, from 1 in Sweden and 13 in Spain. The main variable is credits growth. In addition, the authors formulate criteria of variables in order to provide an accurate representation of the stress in the future, among them are: 1) index should consist of variables that fully cover all sectors of the financial market (money, credit, banking, currency markets); 2) indicators should be updated frequently and form long time series; 3) the re-

sults need to be relative, in order to provide a comparison analysis. The obtained results made it possible to make two general conclusions. First, the code is hard to predict. There is only small limited set of variables that can provide an accurate forecast of financial stress. Even with careful selection of variable accuracy of the results is the size of the margin. Second, only the dynamics of credit is able to predict the behavior of the index in the future. This is not about academics previous notions predictive power of variables such as real estate prices and stock value.

A similar approach is used Vermeulen R. (Vermeulen, Hoeberichts, Žigraiová, Šmídková and Haan, 2014). Researchers examine episodes of financial stress and recession for 28 OECD countries from 1980 to 2010. They focused on six subindexes for banking, monetary, foreign exchange, and real estate sectors. It appears that the relationship between variables equations and the end result is pretty weak. In other words, the available variables cannot effectively describe the flow of financial stress in the economy. Therefore, the authors conclude that the policy must be careful to use these indicators when assessing financial stability.

Experience the global crisis of 2008–2009 has illustrated how the financial shock that originated in the US can spread rapidly and extensively in the global financial environment. This behavior of the financial system could not be interested economists. In this regard, vector research has shifted significantly in research plane displacement mechanisms of stress in global financial markets.

The first attempt to build a local index system was implemented stress M. B. Grimaldi (Grimaldi, 2010). The researcher tried to follow the informational «noise» around the financial market. Later Louzis D. P. and Vouldis A. T. (Louzis and Vouldis, 2013) with multivariate GARCH-models have tried to calculate the correlation coefficient between FSI EU market. According to the developers, the results make it possible to provide exact periods of crisis in the economy.

Hollo D. (Hollo, Kremer and Lo Duca, 2012) continued researches devoted to creation macroeconomic indicators of financial monitoring. In basic portfolio theory scientist tried to create a single aggregated indicator of stress in European markets. The basis of empirical calculations easy laid multifactor regression model. Compared with some developed countries such as USA, Canada, and Sweden, creating a single regional stress index for the European Union is challenging. The main reason is the relatively short existence of financial markets.

Recent advances in this issue are presented in the study Corbet S. (Corbet, 2014). Scientific offers the calculation procedure of the European financial stability indicator, which contains 23 variables. They cover the main sources of financial stress in the European market: short-term interest rates, volatility in the securities market, changes in exchange rates, yield spreads on the stock market and real estate market. Usually, each explanatory variable is standardized by calculating the standard deviation. According to scientists, like the structure of the model will quickly recognize the signals of crisis in the economy.

Summarizing, the recent economic literature, devoted to the exploration of global instability, there are many works in which researchers are trying to expand the practical application of sustainability indicators. Most studies aimed to improve methods of evaluation indexes through better integration of information from all sectors of the financial system and application results as tools for empirical verification of hypotheses. Literature review of the main empirical approaches for assessing financial stress index presented in Table 1.

Table 1

Literature review for the construction of financial stress index

Authors	Country(ies) (time period)	Methodology
Illing & Liu (2006)	Canada (1981–2005)	Daily data from banking sector, foreign exchange, debt and equity markets were combined into a Financial Stress Index (FSI) using various methods (Principal Components Analysis (PCA), credit weights, variance-equal weights and transformations using sample CDFs). «Refined» measures of financial stress i.e. modified raw variables that capture more systematically the stress conditions and GARCH techniques were also proposed. An event was characterized as highly stressful if the index was above a two standard deviation threshold.
Nelson & Perli (2007)	US (1994–2005)	The Financial Fragility Indicator was based on weekly data and shows the probability of crisis in the US economy. A set of twelve financial variables was utilized to construct three subindicators combined into a single probability index by estimating a logit model.
Cardarelli et al. (2009)	17 advanced economies (1981–2009)	A quarterly FSI for each country was constructed as a variance-equal weighted average of seven variables grouped into three subindices (banking sector, securities and foreign exchange). The authors identified as episodes of financial stress, those periods that the FSI is greater than one standard deviation from its trend (which is calculated using a Hodrich–Prescott filter).
ECB (2009)	World's main 29 economies (1994–2010)	The raw stress variables for each country were standardized and converted through logistic transformation. They were categorized into three marketтsegments corresponding to fixed income, equity and for-

		eign exchange markets. The Global Index of Financial Turbulence (GIFT) is a weighted average of individual country and market-specific indices.
Hakkio & Keeton (2009)	US (1990–2009)	The monthly Kansas City FSI (KCFSI) emphasized on the selection of market variables that can capture five key features of financial stress, specifically: (i) increased uncertainty about fundamental value of assets, (ii) increased uncertainty about the behavior of other investors, (iii) increased asymmetry of information, (iv) decreased willingness to hold to risky assets (flight-to-quality), (v) decreased willingness to hold illiquid assts (flight-to-liquidity). A Principal Component Analysis (PCA) was applied in order to produce the index.
Blix Grimaldi (2010)	Euro area (1999–2009)	A list of stressful events defining the crisis periods were linked with sixteen market variables through a logit model in order to construct the weekly FSI, which shows the probability of crisis
Hollo et al. (2012)	Euro area (1987-2011)	Five subindices consisting of money, bond, equity, foreign exchange market data and financial intermediaries data were used to construct the Composite Indicator of Systemic Stress (CISS). The systemic risk was taken into account by estimating the time varying correlation matrix of the subindices with an EWMA model. The aggregation of the subindices was based on the portfolio risk theory.

Source: (Louzis, 2013).

Evaluation financial stress index for Ukraine

In order to estimate Ukrainian Financial Stress Index (UFSI), we used a fairly simple approach, created by Park C. and Mercado R. (Park and Mercado, 2013). Our version of FSI determines the level of volatility in the major markets, which are responsible for circulation of finance in the economy: banking, foreign exchange, the stock market and government debt.

These sectors are selected because they are, first, are the channels through which the liquidity and investments move in the economy, and secondly, because of these markets financial shocks are distributed in the financial system. For example, finance of households in Ukraine closely associated with the state

of the banking sector and the foreign exchange market, the financial position of the business sector depends on the banking system, the foreign exchange market, the stock market, the sector of public finances critically dependent on the market for government bonds. These links are not unique because the country's financial system is an integrated structure, but they give an idea that dynamics of selected markets determines the overall financial conditions in the national economy.

As an indicator of the banking sector was used first difference of logarithms of households deposits multiplied by (-1)[2]. The currency sector was determined based on a standard index of pressure on the foreign exchange market:

$$EMPI_{i,t} = \frac{(\Delta e_{i,t} - \mu_{i,\Delta e})}{\sigma_{i,\Delta e}} - \frac{(\Delta RES_{i,t} - \mu_{i,\Delta RES})}{\sigma_{i,\Delta RES}}, \quad (1)$$

where $\Delta e_{i,t}$ – increase in the nominal exchange rate of currency *i* at time *t*, $\Delta RES_{i,t}$ – increase in reserves of the central bank's foreign currency *i* at time *t*, μ and σ – arithmetic mean and the standard deviation of the relevant parameters.

Volatility in the stock market was modeled using GARCH (1,1) model, where the dependent variable acted as the first difference of the logarithm of the PFTS Index[3]. In the first stage we built a model AR (1)[4], then based on residuals of the model is created a model of conditional heteroscedasticity following form:

$$h_t^2 = 0{,}00003 + 0{,}32e_{t-1}^2 + 0{,}6h_{t-1}^2. \quad (2)$$

For study the dynamics of government loans was taken index EMBI + Ukraine. It is a spread yield between Ukrainian government debt and Treasury bonds of the USA. Scheme weighting and combining these indicators can be described as follows: all indicators were standardized ($y_t = (x_t - x)/\sigma$) and aggregated with equal weights. Estimation the level of household deposits and data for calculation index of pressure on the currency market has been taken from the official statistics NBU, daily dynamics of PFTS Index was formed on the basis of the exchange site, EMBI+Ukraine was taken from the statistical base DATASTREAM. Data were not available on a quarterly discrete (conditional heteroskedasticity PFTS Index, spreads EMBI + Ukraine) and were quarterly aver-

[2] Data for calculation of standard indicators of the banking sector, such as β-rate of bank shares on the stock market and the share of risky loans are not available in the required discrete and required period. The multiplication by (–1) was conducted in order to synchronize the dynamics of the subindexes with other indicators, like increase in values and increase financial pressure and vice versa.

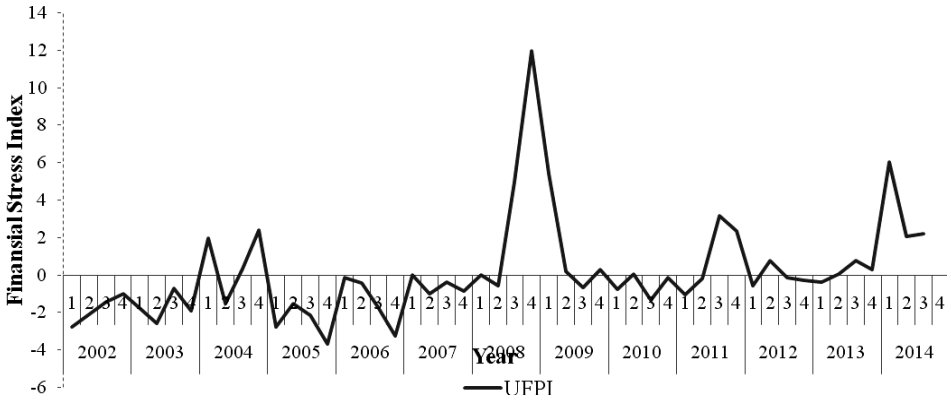
[3] PFTS is one of the largest stock exchanges in Ukraine, which has the longest history of operation and publishes the data required for the calculation.

[4] General form of the model: $y_t = a_0 + a_1 y_{t-1} + e_t$.

aged. The result of the evaluation and integration subindexes received in aggregate financial stress index. Its dynamics is shown in Figure 1.

Figure 1

Dynamics of Ukrainian financial stress index (UFSI), 2002–2014



Visual analysis of the index makes it possible to identify several periods of high stress on the Ukraine's financial system. In particular, the index identifies periods of high volatility in 2004, during the financial crisis of 2008–2009 years and in 2014, when there is a clear increasing trend.

Application financial stress index in exploring fiscal policy

In order to demonstrate the possibility of application financial stress index in investigation fiscal policy, we used non-linear fiscal reaction function (NFRF). This function is provided in the form of Logistic Smooth Transition Regression (LSTR-model) and allows tracking switching policy regimes. In general, a standard linear reaction function of fiscal policy with the addition of the political cycle factor can be described as follows:

$$prsurpl_t = a_0 + a_1 prsurpl_{t-4} + a_2 debt_{t-4} + a_3 gap_{t-4} + a_4 pol_t + \sum_{j=1}^{n} b_j D_j + u_t, \quad (3)$$

where *prsurpl* – the ratio of the primary budget deficit to GDP; *debt* – the ratio of the total amount of public and guaranteed debt to GDP; *gap* – the cyclical fluctuations of GDP; *pol* – a dummy variable indicating the period between presidential or parliamentary elections; *D* – dummy variable to control for significant deviations.

The traditional data to study the behavior of fiscal policy are the annual variables. Since the budget is adopted on an annual basis, the government is likely reflecting their response to changes in the economic environment with one lag. However, it should be understood, that the use of annual data critically reduce the number of observations for Ukraine because the study interval is only 12 years from 2002 to 2013. Therefore, the evaluation function is used for quarterly data. This type of data has led to the necessity of the injection in the model the fourth lag of explanatory variables.

The disadvantage of function (3) is the assumption about the constancy of regression coefficients, and hence the sustainability of fiscal policy regimes. In this regard, the empirical literature more appropriate use of approaches that take into account the change in fiscal policy regimes. One such approach is to build LSTR-models. Within our study, it has taken the following form:

$$\Delta_4 prsurpl_t = \phi' x_t + \theta' x_t G(\gamma, c, s_{t-n}) + u_t, \quad t = 1, ..., T, \quad (4)$$

where x_t – vector of exogenous explanatory variables; $\phi = (\phi_0, \phi_1, ..., \phi_m)'$ and $\theta = (\theta_0, \theta_1, ..., \theta_m)'$ – the parameter vector dimension $((m+1)\times 1)$, $u_t \sim i.i.d.(0, \sigma^2)$.

For this class of models is expected transitive function of following form:

$$G(\gamma, c, s_{t-n}) = (1 + \exp\{-\gamma \prod_{k=1}^{K} (s_{t-n} - c_k)\})^{-1}, \quad \gamma > 0, \quad (5)$$

where s_{t-n} – transitive variable that in our study is introduced with lag *n*; c_k – one of the options ranging from a vector $c = (c_1, ..., c_k)'$ with restriction $c_1 \le ... \le c_k$; γ – angle setting.

As exogenous variables were used the same variables as in the model (3), but switching coefficients assumed the level of public debt and GDP cycle.

According to the model (4) fiscal policy demonstrates switch modes, that depend on the size of transitive variable (s_{t-n}) relative to variable c_k, which is the threshold switching modes. Weight factors particular mode is θ_m, and the parameter $\gamma > 0$ defines a smooth transition between modes. This type of models

and stages of construction are well described in the T. Terasvirta (Terasvirta, 2004), the idea of such a specification NFRF implemented Legrenzi G. and M. Costas (Legrenzi and Costas, 2013). Unlike previous studies, we test the model on LSTR-dimension vector. The most common results are regression with coefficients $K = 1$ and $K = 2$. In the case of $K = 1$ model parameters vary monotonically according to functional connection with s_{t-n}, moving to the final switch to another mode. These models describe the behavior of asymmetric variables in the model at high and low values of transitive variable. The transition between modes is smooth. LSTR-model with $K = 2$ (LSTR2) predict that rates vary symmetrically around the point $(c_1 + c_2)/2$, which situated in the middle of range of transitive variable. These models are used when variables behave the same at high and low values s_{t-n}, but switched to another mode by averages. Our empirical results indicate that these models can be used to build NFRF.

Before construction, the model should be done a number of tests for identifying nonlinearity connection, caused by transitive variables. In our case, such variable is financial stress index. Index is used with a lag of *t*–4 to *t*–8. The choice of this potential transitive variable predetermined by assumption that switches in the fiscal regime is determined by the level of pressure caused by favorable or unfavorable financial conditions. In addition, this transitive variable is standard in similar studies (Legrenzi and Costas, 2013). Choice of the lags caused the assumption that the budgets parameters on the next year depend on information on the stability of the financial system, received by governors previous year.

Specifications

We use quarterly data for the period 2002–2013 years. The data of the public debt are taken from the statistic database on the official website of the Ministry of Finance of Ukraine; information about budget parameters are taken from the website of the State Treasury; macroeconomic parameters are based on statistical data of the NBU. Indicators *prsurpl* and *debt* were previously seasonally adjusted because they present a quite strong seasonality, and the introduction of seasonal dummies worsened the problem of sufficient degrees of freedom. GDP gap (*gap*) was assessed using Hodrick–Prescott filter, but previous nominal GDP seasonally adjusted and taken its logarithm.

The estimation results

Table 1 presents the results of modeling through LSTR-model. Tests for nonlinearity connections, using lags of financial stress index as transitive variable, always preferred LSTR2 models. This means that fiscal policy has the same behavior on the edge of transitive variable and shows different behavior in a certain range within the sample. A number of tests for nonlinearity connections for different lags of financial stress index as transitive variable allowed selecting period $t–7$[5]as the one that shows the most accurate non-linearity in the parameters of the reaction function of fiscal policy.

Table 2

Simulation results LSTR2-model using NFRF

Dependent Variable	$\Delta_4 prsurpl_t$	
Transitive variable	fpi_{t-7}	
	Linear part	Nonlinear part
Const.	0,001	
*d*_10:03	0,17	
pol_t	–0,009	
gap_{t-4}	–0,52	1,17*[6]
$\Delta_4 debt_{t-4}$	0,14	–0,3**
γ	2,14	
*C*1	–1,24**	
*C*2	5,06***	
adj. R^2	0,54	
Test of No Error Autocorrelation	lag 1 = 0,91	lag 2 = 0,46
	lag 3 = 0,55	lag 4 = 0,52
Test of Parameter Constancy	*H*1 = 0,13 *H*2 = 0,53 *H*3 = 0,63	

[5] Tests had revealed nonlinearity connection between the variables for a number of lags $fri_{t-4} – fri_{t-8}$ as a transitive variable, however statistics for this lags were the best.

[6] *, ** and *** indicates statistical significance on 10%, 5% and 1 % levels accordinally.

Analyzing these factors, we can conclude that Ukrainian fiscal policy is passive (pro-cyclical and stable). This is well seen in relatively high financial stability when the level of financial pressure is low or financial system is in turbulence, when the index of financial pressure takes high values. However, fiscal policy demonstrates active behavior on the interval [C1; C2]. In this period, system is unstable and more focused on the regulation of the economic cycle.

Apart from the regression coefficients and threshold coefficients in Table 2, also are presented number of tests on autocorrelation of residues to the 4-th lag and stability of model parameters. The results reflect high quality of the model. In addition, have been conducted tests for no remaining nonlinearity. The main argument was the number of potential transitive variables. In our case, it is significant, and, therefore, can lower the tests strength and their qualitative interpretation. Gamma-coefficient indicates that fpi_{t-7} causes relatively slow transit between modes. Lack of statistical significance of γ is neglected by the fact that for large values of the coefficient and limited data sample it is difficult to determine the curve of the transitive functions. It requires a large number of observations in the interval between C1 and C2. This fact increases the standard errors γ. Another point is that the standard t-statistic can be interpreted correctly, since it is designed to test the hypothesis $\gamma = 0$, while for LSTR is set the limit $\gamma^s > 0$ (Slingenberg and Haan, 2011).

Conclusions

Summarizing, the overall financial situation in the economy requires an integral indicator for analytical purposes. This qualitative indicator should accumulate information about potential risks and volatility in all financial sectors. In this paper, we proposed our own vision of estimation financial stress index. It was built using the best international experience and adapted to the Ukrainian statistics. We have demonstrated that the index can be used not only as an indicative value, but also as the instrument for verification in empirical research. Thus, deep study of the non-linear fiscal reaction functions in Ukraine made it possible to draw important conclusions about the different modes of behavior of fiscal authorities during the period of high, medium and low financial stability. Fiscal policy behaves same on the extreme points of financial stability, during high financial stability level and totally unstable financial environment and changes its settings when reaches average level of financial security. In the case of Ukraine, fiscal policy was passive in periods of low financial threats (very low *fpi*). So, the government can increase the budget deficit without much loss. In periods of high financial threats (extreme performance *fpi*) government was forced to keep a stable fiscal policy in order to avoid default, regardless of the stage of the economic cycle. During periods of medium stability level Ukrainian's government paid less attention to the debt problems because they were less urgent and critical. A slight increase in the budget deficit does not lead to significant losses, so the government can pursue a more active fiscal policy.

Bibliography

1. Balakrishnan R. The transmission of financial stress from advanced to emerging economies / R. Balakrishnan, S. Danninger, S. Elekdag, I. Tytell // IMF Working Paper. – 2009. – WP/09/133. – P. 1–52.
2. Cardarelli R. Financial stress, downturns, and recoveries [Electronic resource] / R. Cardarelli, S. Elekdag, S. Lall // IMF Working Paper. – 2009. – № 100. – 58 p. – Available at: http://www.imf.org/external/pubs/ft/wp/2009/wp09100.pdf
3. Chant J. Financial Stability as a Policy Goal // Technical Report Essays on Financial Stability, Bank of Canada. – 2003. – № 95.
4. Corbet S. The European Financial Market Stress Index [Electronic resource] // International Journal of Economics and Financial Issues. – 2014. – Vol. 4. – № 1. – pp. 217–230. – Available at : www.econjournals.com/index.php/ijefi/.../pdf
5. ECB: Financial Stability Review. European Central Bank. – Frankfurt : Maine, 2009.
6. Ekinci A. Financial Stress Index for Turkey // DoğuşÜniversitesiDergisi. – 2013. – № 14 (2). – P. 213–229.
7. Gadanecz B., Kaushik J. Measures of Financial Stability – A Rewiew [Electronic resource] // IFC Bulletin. – 2009. – № 31. – P. 365–380. – Available at : http://www.bis.org/ifc/publ/ifcb31ab.pdf
8. Grimaldi M. B. Detecting and interpreting financial stress in the Euro area // European Central Bank (ECB) Working Paper. – 2010. – № 1214.
9. Haefcke S., Skarholt A. Swedish Financial Stress Index [Electronic resource] // Stockholm School of Economics. – 2011. – Available at : http://arc.hhs.se/download.aspx?MediumId=1418
10. Hakkio C. S., Keeton W. R. Financial Stress: What Is It, How Can It Be Measured, and Why Does It Matter? // Federal Reserve Bank of Kansas City, Economic Review. – 2009. – Is. Q 2. – P. 1–46.
11. Hollo D. CISS – a composite indicator of systemic stress in the financial system / D. Hollo, M. Kremer, M. Lo Duca // European Central Bank (ECB) Working paper series. – 2012. – № 1426.
12. Illing M., Liu Y. An Index of Financial Stress for Canada [Electronic resource] // Bank of Canada Working Paper. – 2003. – № 14. – Available at : http://www.bankofcanada.ca/wp-content/uploads/2010/02/wp03-14.pdf.
13. Illing M., Liu Y. Measuring Financial Stress in a Developed Country: an Application to Canada // Journal of Financial Stability. – 2006. – Vol. 2. – № 4. – P. 243–265.

14. Kliesen K. L. Disentangling Diverse Measures: A Survey of Financial Stress Indexes / K. L. Kliesen, M. T. Owyang, K. E. Vermann // Federal Reserve Bank of St. Louis Review. – 2012. – № 94 (5). – P. 369–397

15. Legrenzi G., Costas M. Modelling the fiscal reaction functions of the GIPS based on state-varying thresholds // Economics Letters. – 2013. – Vol. 121(3). – P. 384–389.

16. Louzis D. P., Vouldis A. T. A Financial Systemic Stress Index for Greece // European Central Bank (ECB) Working Paper. – 2013. – № 1563.

17. Manamperi N. P. A Comparative Analysis of US Financial Stress Indicators [Electronic resource] // Texas Tech University Working Paper. – 2013. – Available at : http://nimanthamanamperi.weebly.com/uploads/1/2/5/7/12572805/paper_2.pdf

18. Oet M. V. The financial stress index: identification of systemic risk conditions / M. V. Oet, R. Eiben, T. Bianco, D. Gramlich, S. J. Ong // Working papers of the Federal Reserve Bank of Cleveland. – 2011. – № 1130. – P. 11–30.

19. Oet M. V. SAFE: An early warning system for systemic banking ris / M. V. Oet, T. Bianco, D. Gramlich, S.J. Ong // Journal of Banking and Finance. – 2013. – № 37 (11). – P. 4510–4533.

20. Park C., Mercado R. Determinants of Financial Stress in Emerging Market Economies [Electronic resource] // Asian Development Bank Economics Working Paper Series. – 2013. – № 356. – P. 199–224. – Available at : http://www10.iadb.org/intal/intalcdi/PE/2013/12502.pdf.

21. Slingenberg J. W., J. de Haan Forecasting Financial stress // De Nederlandsche Bank Working Paper. – 2011. – № 292. – P. 1–27. – Available at : http://www.dnb.nl/binaries/working%20paper%20292_tcm46-253005.pdf.

22. Terasvirta T. Smooth transition regression modeling / T. Terasvirta. – Cambridge: University Press, 2004. – P. 223–243. [w] Applied Time Series Econometrics [red. H. Lütkepohl, M. Kratzig].–Cambridge: University Press, 2004.

23. Vermeulen R. Financial Stress Indices and Financial Crises / R. Vermeulen, M. Hoeberichts, D. Žigraiová, K. Šmídková, J. de Haan // de Nederlandsche Bank Working Paper, Forthcoming in Open Economies Review. – 2014.

24. Zeti A. A. Managing Financial Crisis in an Interconnected World: Anticipating the Mega Tidal Waves Per Jacobson Lecture [Electronic resource] / Basel, 29 June 2014. – Available at : http://www.bnm.gov.my/index.php?ch=en_speech&pg=en_speech_all&ac=511&lang=e.

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