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The influence of financial stress on economic activity and monetary policy in Belarus

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Abstract

The paper determines episodes of financial stress in Belarus during 2004-2016 period using constructed financial stress index, and offers an analytical framework to evaluate the influence of financial turmoil on Belarus's economy, in particular economic activity and monetary policy. The findings show evidence of two episodes of financial stress and two episodes of recessions in Belarus during studied period. The results from the estimated ARDL models show that high level of financial stress causes the substantial downturn in economic activity of Belarus. Moreover, the results of Toda and Yamamoto causality analysis indicate that higher financial stress in Belarus has led to lower economic activity that caused higher inflation, which in turn led to higher policy rate introduced in order to constrain inflation in Belarus. Finally, from theoretical point of view results also signify that there is no evidence for the support of the conventional wisdom hypothesis in Belarus since 2004. Therefore, price stability is not a sufficient condition to support financial stability in Belarus and should certainly be addressed independently with the objective of price stability of the National Bank of Belarus.

Keywords: financial stress, economic activity, monetary policy, recession, ARDL model, Belarus

JEL Classification: E52, E61, G01, G28, O11

Belarusian Economic Research and Outreach Center (BEROC) started its work as joint project of Stockholm Institute of Transition Economics (SITE) and Economics Education and Research Consortium (EERC) in 2008 with financial support from SIDA and USAID. The mission of BEROC is to spread the international academic standards and values through academic and policy research, modern economic education and strengthening of communication and networking with the world academic community.

1. Introduction

Schumpeter (1911) claims that entrepreneurs need credit to finance the implementation of new production technologies. Therefore, well-tuned and developed financial system serve as a key mechanism in the mobilization and utilization of savings, simplification of transactions and controlling the redistribution of resources towards productive usage. Moreover, an efficient financial system improves the efficiency of the economy and its growth process. In particular, it allows to increase investment activity by providing loans at lower interest rates, contributes to the expansion of trade, risk management, monitoring the functioning of enterprises and their production process in order to stimulate economic activity.

However, according to Minsky (1991) and his "financial instability hypothesis", an economy naturally evolves from a system with a robust financial structure to a system with a fragile financial structure. Periods of economic growth contribute to risky economic behavior, transforming the economy to a boom phase encouraged by speculative economic activities (for example, real estate operations). As a result, the debt load of the companies sharply increases creating conditions for crisis, which arises because of the inability of companies to repay their debts. The increase in the financial expenses and decrease of incomes (in particular, the profitability of operations) altogether lead to the growth of overdue debt and the subsequent growth of bankruptcies, which result in economic recession.

These tradeoffs are also important for the existing theoretical debate on the realization of monetary policy, that is on monetary policy instruments and objectives (Smets, 2014). The dominant agreement in the literature on central bank's monetary policy has indeed omitted the concern about financial instability, mainly attributing the objective of price stability and only indirectly the objective of financial stability (Clarida et al., 1999; Svensson, 1999). Consequently, there is a need for an in-depth examination of the relationship between financial instability (determined by the level of financial stress in the economy), economic activity and monetary policy, especially for Belarus, where financial instability is primarily issue for the last ten years.

Therefore, the aim of this research is to fill this gap and to study evidence on the relationship between financial stress, economic activity and monetary policy since 2004 for Belarus. The estimated period consists of two parts, first, a stable period of 2004 till 2008 and, second, a highly volatile period of 2009 till 2016, which makes it possible to assess the effect of changing financial conditions on the economic activity and empirical relevance of the monetary policy in Belarus.

The paper tries to find answer on the following questions:

- How financial stress affects economic activity in Belarus over the 2004-2016 period?
- Does the monetary policy interest rate is influenced by financial stress in Belarus over the 2004-2016 period.
- Are there causal relationships between financial stress, economic activity, and monetary policy, which may run in either directions in Belarus over the 2004-2016 period?

The links between financial stress, economic activity, and monetary policy in Belarus are examined using two different methods. First, the research hypotheses are tested with Autoregressive Distributed Lag (ARDL) models. Next, to confirm my conclusions from the results of the ARDL models about the relationships between financial stress and economic activity and between financial stress and monetary policy the results of Toda and Yamamoto Granger causality tests on a selected set of indicators are reported.

The main findings of the research are as follows:

- First, the results indicate that the subcomponents (indicator of banking sector fragility, exchange market pressure index, and growth in external debt) of the presented in this paper FSI capture main features of financial stress in Belarus as the index tops at known financial stress episodes during 2004-2016 period.
- Second, using constructed CLI index two recessions were identified for Belarus for the period 2004-2016: October 2008 – October 2009 in the first case, and June 2012 – September 2016 in the second case.
- Third, the results of estimated ARDL models show that high level of financial stress causes the substantial downturn in economic activity of Belarus. Moreover, the results of Toda and Yamamoto causality analysis show that higher financial stress in Belarus has led to lower economic activity that caused higher inflation (triggered by policy of preferential crediting or direct lending), which in turn led to higher policy rate (tight monetary policy) introduced in order to constrain inflation in Belarus.
- Finally, from theoretical point of view results also signify that there is no evidence for the support of the conventional wisdom hypothesis in Belarus since 2004. The FSI does not Granger causes CPI and vice versa. Therefore, price stability is not a sufficient condition to support financial stability. Subsequently, for the National Bank of Belarus it is suggested that financial instability through FSI should certainly be addressed independently with the objective of price stability.

The rest of the paper is structured as follows. Section 2 presents the literature review. Section 3 describes the empirical methodologies and Section 4 describes the data. The empirical results of the research are presented in Section 5. Section 6 outlines main conclusions of the paper.

2. Literature review

2.1. Theory

The influence of financial cycles on the real economy stays one the main questions both from academic and policy points of view. One part of the research aims to study the influence of the financial accelerator¹ on the growth of the real economy, in particular, examining the effect of changes in the values of collateral on the willingness of the financial system to lend to the economy (Bernanke and Gertler, 1995; Kiyotaki and Moore, 1997). According to this view, the growth in financial stress

¹ The **financial accelerator** in macroeconomics means that adverse shocks in the real economy and in the financial markets accelerate the financial and macroeconomic downturn.

that determines the state of financial instability influences the solvency of borrowers increasing the fluctuations in output that can lead to a decrease in the business cycle.

For example, Paries et al. (2011) show that increase in money market spreads leads to decrease in bank lending, which subsequently reduces economic activity. In addition, Bloom (2009) shows that rise of uncertainty ultimately triggers economic contractions. Moreover, financial stress changes the behavior of private sector investment and consumption².

Another strand of research focuses on balance sheets of lenders and studies the so-called bank capital channel – the role of bank capital in influencing aggregate credit (Bernanke and Lown, 1991; Kashyap and Stein, 1995; Diamond and Rajan, 2000; Van den Heuvel, 2002). Their findings show that the decline in the capital of banks also reduces lending to the economy and may force them to use the loans by themselves (in order to support their balance sheets) leading to sharper economic downturns.

Finally, the literature also examines how the role of financial accelerator in the economy changes depending on the type of financial system (Rajan and Zingales, 2003). One of the possible positive consequences of changes in the financial systems is a general trend in their evolution from more relationship-based lending to more arm's-length-based financing leading to better absorption of financial stress, because both companies and households has now a possibility to replace banks for capital markets, or vice versa³.

Further, the relationship between financial stress and economic activity is very important question for the implementation of monetary policy, because most of the central banks tend to be responsible for financial stability. However, taking into account the relevance of the topic, the number of empirical studies on it is scarce and mostly dominated by "conventional wisdom hypothesis"⁴, which links monetary and financial stability, i.e. monetary regime that establishes aggregate price stability will, in turn, support financial stability (Schwartz, 1995).

The conventional wisdom hypothesis was developed by Schwartz (1995) and underlines a micro and a macro channel in the relationship between inflation and asset prices. Considering micro channel, she connects price instability with inflation distortion, increasing uncertainty, shifting to short-term investment projects, and governments' nominal gains. All these dimensions generate financial instability. Considering macro channel, she analyzes the effect of price instability on the value of collateral and on financial risk, i.e. inflation increases speculative investment leading to financial instability. Therefore, she concludes that end of price instability and, thus, financial instability is dependent on sound monetary policy.

However, the significant amount of criticism is granted to conventional wisdom hypothesis (Rajan, 2005; White, 2006; Leijonhufvud, 2007). These authors argue that the stability of monetary system might lead to financial instability meaning that it allows for very low interest rates ("cheap money"),

² The effects of financial stress through the investment channel are determined by long-term interest rates and the cost of capital for end users, while the effects through the consumption channel are caused by wealth and income effects triggered by inflation expansion and sharp devaluation.

³ The so-called twin engines of the financial system.

⁴ Also known as the Schwartz hypothesis and states that price and financial stability demonstrate a positive correlation.

favoring high-risk projects. Furthermore, they also admit that inflationary pressures does not precede major economic and financial crises. This is so-called the "paradox of credibility" according to which if the credibility in reducing inflation is granted to central banks, it will eventually lead to growth of the vulnerability of the financial system and subsequently to financial instability.

2.2. Empirical evidence

The problem of financial instability is studied since the mid-1990s suggesting that financial variables systematically influence real economy and strongly interact with each other. For example, Frankel and Rose (1996) examine the determinants of currency crashes in 100 developing countries from 1971 to 1992 and show that in most cases currency crashes are caused by run out of foreign direct investment, low foreign exchange reserves, heightened domestic credit growth, significantly overvalued real exchange rate and constantly increasing interest rate. Hardy and Pazarbasioglu (1999) also find that countries with high levels of inflation are more vulnerable to financial crises.

Using the results of Frankel and Rose (1996), Kaminsky and Reinhart (1999) extend the analysis to broader types of crises, including banking and balance of payment crises of the 1990s. They discover that both types of crises are closely related to the outcomes of financial liberalization, which triggers boom/bust cycles with banking crises preceding a sharp depreciation of the national currency. Moreover, according to Caprio and Klingebiel (2006) in the event of systemic banking crises bank capital is eroded, lending disrupted, which leads to substantial public financial interventions.

Interesting results are obtained by Cardarelli et al., (2011) – periods of financial instability generated by problems in the banking sector are associated with deeper economic recession than the periods of financial stress, which are largely determined by instability in the securities or foreign exchange markets. In addition, it is found that economic activity reacts to a greater extent to financial instability in periods of high stress than in low ones (Hubrich and Tetlow, 2015). Further, Hakkio and Keeton (2009) show (on the example of the USA) that growth of financial instability lead to more prudent behavior of credit institutions, which in turn causes reduction in total loans supplied and subsequently decreases economic activity.

Consequently, there is an increasing interest in developing special measures of financial stress in the economy. Iling and Ying (2006) are among the first researchers who have developed a financial stress indicator (for Canada) including data on equity, bond, foreign exchange and banking sector. They define financial stress as the force that influences economic agents generated by uncertainty and changing expectations of losses in the financial markets and from activities of financial institutions. Cardarelli et al. (2011) develop financial stress indices for a large number of developing and developed countries. Further, the European Central Bank (ECB, 2009) has established a financial stress index for the global economy.

However, the empirical evidence on the response of central banks to financial instability is very scarce. There are only few studies that use broader indicators of financial imbalances to measure the response of monetary policy. Borio and Lowe (2004) assess the reaction of central banks in four countries (Australia, Germany, Japan, and the USA) to financial imbalances measured by the ratio of private-

sector credit to GDP, inflation-adjusted equity prices, and using their composite measure. They discover either negative or controversial evidence for all countries except the USA. Borio and Lowe (2004) come to the conclusion that the Fed⁵ responded to financial imbalances in an asymmetric and reactive way. First, when Fed encountered with the problem of increase in imbalances the federal funds' rate was unreasonably decreased, and, second, after the built up of imbalances the federal funds' rate was not increased beyond normal.

Cecchetti and Li (2008) calculate a Taylor rule for the USA, Japan and Germany taking into account a measure of banking stress, specifically the deviation of leverage ratios⁶ from their Hodrick–Prescott trend. Their results show that the Fed corrects the interest rate to respond to the procyclical impact of a banks' capital requirements, whereas the Bank of Japan⁷ and the Bundesbank⁸ do not.

Bulir et al., (2011) estimate the response of monetary policy to seven different indicators of vulnerability of financial sector including measures of crisis probability, time to crisis, distance to default in a panel of 28 countries. The results are twofold, first, in the panel setting they obtain statistically significant negative response of monetary policy (i.e. policy easing) to measures of financial instability, whereas in the country-level regressions the response was statistically insignificant. Li and St-Amant (2010) discover that intensity of financial stress lead to different effects of monetary shocks on economy.

Belke and Klose (2010) study factors that influenced the decisions of the European Central Bank and the Fed to determine the interest rates during the 2008-2009 crisis. They find that the estimated policy rule for the Fed was significantly altered, whereas the European Central Bank decided to preserve temporarily the level of interest rate with the aim of inflation stabilization, but at the cost of some output losses. Baxa, Horvath and Vasicek (2014) examine the response of central banks' policy of inflation targeting to financial stress. They find no reaction to financial stress in normal situation, however, in periods of large and long financial stress the behavior of central banks changes.

3. Methodology

3.1. Construction of financial stress index

Financial stress can be determined as the force that influences economic agents by uncertainty and changing expectations of loss in financial markets and financial institutions due to financial shocks (Iling and Ying, 2006). Usually, the influence of negative financial shocks (e.g. banking or currency crises) emerges in several segments of financial market leading to or preceding the bankruptcies of financial institutions (if the market expects the occurrence of banking distress). The larger and broader the financial instability, the higher the co-movement among variables reflecting its interactions. Consequently, financial stress should reflect the combination of these tensions at the financial market

⁵ **Fed** – the central bank of the United States of America.

⁶ Total assets to the sum of bank capital and reserves and total loans to the sum of equity and subordinated debt.

⁷ **Bank of Japan** – the central bank of Japan.

⁸ **Bundesbank** – the central bank of Germany.

and measured by a composite index – the Financial Stress Index (FSI). Its extreme values are called financial crisis.

The aggregation of variables into one composite measure has a number of advantages. First, it allows to assess the dynamics of financial stress that is caused by various factors and, therefore, is not limited to one specific type of instability. Second, the inclusion of additional variables in the index does not significantly affect the dynamics of the resulting indicator (Cardarelli et al., 2011). Third, the composition of the factors used to calculate the index allows to estimate the reaction of the central banks regarding the various components of financial stress. Therefore, by calculating composite indicator that evaluates different types of financial stress, the estimated financial stress index can detect the beginning and the development of a financial crisis.

There are several specific indicators that can be used in order to construct the FSI for particular country. For example, Balakrishnan et al. (2011) distinguish five main components of the FSI in developing countries: the beta indicator in the banking sector, the return on the stock market, the volatility of the stock market at a particular point in time, the spread of sovereign debt and the Exchange Market Pressure Index (EMPI). Similarly, Hollo et al., (2012) and Lo Duca and Peltonen (2011) focus their attention on the sector of financial intermediaries, money market, stock market, securities market and currency market.

However, due to low level of development of stock market in Belarus the risk indicator arising from this financial sector and prices of financial assets is excluded from construction of the Belarusian financial stress index. At the same time, in the financial system of Belarus there are additional problems, for example, external debt and sovereign risk. Therefore, the constructed in this research FSI of Belarus considers the risk of banking sector using the Banking Sector Fragility Index (BSF), currency risk using the EMPI and the risk of external debt underfinancing using the growth of external debt, but excludes the sovereign risk due to lack of data for the studied period⁹ (without significant influence on the final results)¹⁰.

Risk of banking sector

According to McKinnon (1973) investment in the typical developing economy is accomplished mostly on a self-financed base. However, taking into account the lumpy nature of investment it cannot realize without sufficient amount of savings accumulated in the form of bank deposits. This complementarity between money and physical capital is called the "complementarity hypothesis". From the other point of view, there is a "debt-intermediation hypothesis" (established by Shaw (1973)) that states that financial intermediaries stimulate investment and increase output growth through borrowing and

⁹ The measure of sovereign risk is supposed to include in the FSI since 2010. It reflects changes in the perception of country risk by investors, who determine the direction of short-term capital flows. Because interest rate spreads between the examined country and the USA can be used as indicator of risk perception in the studied country, it is proposed to use the spread on sovereign bonds of Belarus (the difference between the EMBI index (Emerging Market Bond Index) of Belarus and 10-year US Treasury yield) in construction of the financial stress index of Belarus starting from 2010.

¹⁰ The PCA results show that it explains only small part of the variation of the FSI of Belarus.

lending. Taking together, these two statements suggest that an increase in level of financial development of the banking sector will lead to higher output growth.

Therefore, the stability of the banking sector is essential to overall financial stability in the economy. Consequently, in order to take into account the riskiness of the banking sector in assessing financial stress in Belarus, the corresponding parameter will be evaluated using the index of banking sector fragility proposed by Kibritcioglu (2003)¹¹.

The BSF index is constructed in the next way:

$$BSF_t = - \frac{\left[\frac{[\Delta DEP_t - \mu_{\Delta DEP}]}{\sigma_{\Delta DEP}} \right] + \left[\frac{[\Delta CPS_t - \mu_{\Delta CPS}]}{\sigma_{\Delta CPS}} \right] + \left[\frac{[\Delta FL_t - \mu_{\Delta FL}]}{\sigma_{\Delta FL}} \right]}{3} \quad (1)$$

where Δ – difference operator – indicates changes in variables over a 12-month period¹²; μ and σ – the mean and standard deviation of the corresponding variables; DEP – real deposits of banks; CPS – real¹³ claims on the domestic private sector; and FL – real foreign liabilities of banks.

The BSF index takes into account the assets and liabilities of the banking sector, therefore, this index can be used to assess the stability of the banking sector. It shows fluctuations in the domestic banking sector and the increase in the indicator means an increase in the fragility of the banking system, which may be due to reduction in bank deposits (caused by their withdrawals), growth of credit claims on the private sector (caused by the growth of overdue debt) and an increase in foreign liabilities (caused by the devaluation of the national currency). Moreover, Shen and Chen (2008) used the BSF index to determine a causal link between currency and banking crisis and find the presence of bilateral causal relationship between banking sector and exchange rate instability.

Currency risk

Currency risk represents another essential part of the financial stress for developing countries. The first attempt to calculate such a measure was conducted by Girton and Roper (1977), who tried to assess the degree of pressure on the exchange rate using the EMPI calculated as a simple average of exchange rate and international reserves changes.

According to Bussiere and Fratzscher (2006) considering changes in exchange rate allows to identify both successful and unsuccessful speculative attacks on national currencies. In turn, the main incentive for accumulation of significant international reserves is an attempt to self-insure against a sudden stop in capital inflows and against the loss of possibility to borrow at the international capital market (Aizenman and Lee, 2007; Mendoza, 2010). Countries with high volumes of international reserves have both a possibility to decrease the losses from financial crises and make their occurrence less likely

¹¹ Other methods to assess the riskiness of the banking system (first of all in the developed countries) include Capital Asset Pricing Model (CAPM) or the conditional variation of the stock market index of the banking sector.

¹² Kibritcioglu (2003) suggested to use the period of change equal to 12 months as opposed to changes equal to 1 month, because changes equal to one month are too short to account for changes in the components of FSI.

¹³ The Consumer Price Index is used to calculate real variables.

(Rodrik, 2006). Moreover, high volumes of reserves help to borrow at external markets at lower costs and to improve credit ratings on sovereign foreign currency debt (Hviding, Nowak, and Ricci, 2004).

In this paper the EMPI is calculated in the next way:

$$EMPI_t = \frac{\Delta e_t}{\sigma_{\Delta e}} - \frac{\Delta Res_t}{\sigma_{\Delta Res}} + \frac{\Delta i_t - \Delta i_{US,t}}{\sigma_{\Delta i} - \sigma_{\Delta i_{US}}} \quad (2)$$

where Δe_t and ΔRes_t – 12-month percent changes in the exchange rate and total foreign international reserves minus gold of Belarus; i_t and $i_{US,t}$ – the overnight interest rate for Belarus and the US, respectively; $\sigma_{\Delta e}$, $\sigma_{\Delta Res}$, σ_{i_t} and $\sigma_{i_{US,t}}$ – the standard deviations of the corresponding variables.

The increase in the spread between Belarusian overnight interest rate (which represents the average interest rate at which Belarusian banks lend unsecured short-term funds to other market participants) and US overnight interest rate (the benchmark for secured money market operations) reflects an increase in uncertainty in the money market and can be interpreted as a risk premium.

External debt risk

External debt plays an important role for sustainability of economic growth in the developing countries. For example, a sharp increase of the short-term external debt was one of the main triggers of the Asian and Russian 1997-1998 crises. Therefore, in empirical studies of developing countries external debt is considered as a potential indicator of financial stress (Kaminsky et al., 1998; Bussiere and Fratzscher, 2006). For example, Aizenman and Pasricha (2012) used total external debt in their index of financial stress.

Therefore, in the current research, I will use the growth rate of total external debt of Belarus as a component of the Belarusian FSI¹⁴. However, in the empirical literature there is no agreement on the influence of external debt on economic activity or economic growth for developing countries (Bellas et al., 2010). From one hand, external debt plays an important role for maintaining sustainable growth and serves as an indicator of solvency of the debtor country (which is especially important for Belarus) reducing the level of financial stress. From other hand, its excessive amount has a considerable negative effect on future economic growth.

Form these points of view, this research assumes that currently growth in total external debt has a positive effect on Belarusian economy, which often lacks external financing. However, it is also assumed that after certain threshold level of external debt to GDP the increase in it may question its sustainability and subsequently negatively influence creditworthiness of Belarus as the debtor country.

Normalization of variables

Further, before calculation a single aggregate index, all individual subcomponents are converted to a common scale (with a zero mean and unit variance) using statistical normalization procedure presented as follows:

¹⁴ Since external debt is measured on a quarterly basis in Belarus, the method of cubic splines is used in order to obtain the monthly values.

$$Z_t = \frac{(X_t - \bar{X})}{\sigma_X}, \quad (3)$$

where Z_t is a normalized indicator; X_t is the value of indicator at time t ; \bar{X} and σ_X are the respective value of mean and standard deviation of indicator X evaluated in the period t

The subtraction of mean value removes the problem of aggregation distortions possible due to differences in indicators' mean and subdivision by standard deviation is used to scale the indicators to a common base.

Principal component analysis

Next, the aggregation of standardized subcomponents into FSI is accomplished using Principal Component Analysis (PCA)¹⁵. PCA is a statistical technique that determines the relationships in the data and converts variables into a smaller number of components, thus reducing the dimensionality of the data space. Under the assumption that each variable is sensitive to the financial stress, and if the financial stress is recognized as one of the main factors that influence the observed correlations among the variables, then it can be defined as a principal component. An advantage of principal component analysis is that it helps to separate variables with minimal loss of information.

Using the results of principal component analysis the financial stress index of Belarus is constructed on the basis of the first principal component as an average of three normalized subcomponents of FSI, so that a positive value indicates deterioration in financial stability and negative value indicates improvement in financial stability.

3.2. Construction of index of composite leading indicators

As a measure of economic activity I will use the index of Composite Leading Indicators (CLI) of Belarus that includes next variables: (1) growth in export of goods; (2) growth in cargo turnover by motor vehicles; (3) growth in industrial production; (4) growth in bank's credits. These subcomponents are proposed and used by the Macroeconomic Policy Department of the Eurasian Economic Commission in order to assess the dynamics of economic activity in Belarus. Using the same methodology as for construction of FSI all data for CLI is calculated as year-on-year growth rates, normalized in the same way as components of FSI and aggregated into composite index using principal component analysis.

3.3. Unit root tests and ARDL cointegration analysis

In order to check the stationarity of the studied variables Augmented Dickey Fuller (ADF) (Dickey and Fuller, 1979), Phillips Perron (PP) (Phillips and Perron, 1988), Dickey Fuller-Generalized Least Squares (DF-GLS), and ERS point optimal unit root tests are applied.

¹⁵ Other aggregation methods used to develop a financial stress index include equal variance weights, methods based on quantile transformation and cumulative distribution function.

Next, the study employs the cointegration approach to investigate the long-run relationship between economic activity and financial stress, and between monetary policy and financial stress in Belarus during 2004-2016¹⁶.

Due to the constraints of conventional approaches to cointegration – the Engle and Granger (Engle and Granger, 1987) and Johansen and Juselius (Johansen and Juselius, 1990) cointegration methods¹⁷, this study uses the bounds testing approach to cointegration based on the Autoregressive Distributed Lag modeling developed by Pesaran et al. (1999), (2001).

The ARDL approach has several advantages. First, it can be applied to study long-run associations either the variables are integrated of order $I(0)$, $I(1)$ or both $I(0)$ and $I(1)$. Second, the evaluation of ARDL with proper lag structure can correct both autocorrelation and heterogeneity problem. Third, in the ARDL approach the short-run and long-run coefficients are calculated jointly. Fourth, the ARDL performs better in small sample sizes. Thus, it can be a very appropriate approach to examine the underlying relationships of this research, because addresses the problem associated with the omitted variables and provides unbiased and efficient estimates (Narayan, 2004).

The ARDL representations of relationships between economic activity and financial stress index, policy rate and financial stress index can be presented as follows:

$$\begin{aligned}
 CLI_t = & \lambda_0 + \lambda_1 CLI_{t-1} + \lambda_2 FSI_{t-1} + \lambda_3 PR_{t-1} + \lambda_4 CPI_{t-1} + \sum_{i=1}^m \theta_{1i} \Delta CLI_{t-i} \\
 & + \sum_{i=0}^m \theta_{2i} \Delta FSI_{t-i} + \sum_{i=0}^m \theta_{3i} \Delta PR_{t-i} + \sum_{i=0}^m \theta_{4i} \Delta CPI_{t-i} + \varepsilon_t,
 \end{aligned} \tag{4}$$

$$\begin{aligned}
 PR_t = & \beta_0 + \beta_1 PR_{t-1} + \beta_2 FSI_{t-1} + \beta_3 CLI_{t-1} + \beta_4 CPI_{t-1} + \sum_{i=1}^n \gamma_{1i} \Delta PR_{t-i} \\
 & + \sum_{i=0}^n \gamma_{2i} \Delta FSI_{t-i} + \sum_{i=0}^n \gamma_{3i} \Delta CLI_{t-i} + \sum_{i=0}^n \gamma_{4i} \Delta CPI_{t-i} + \epsilon_t,
 \end{aligned} \tag{5}$$

where Δ is first difference operator; θ_i and γ_i are short-run coefficients; FSI – financial stress index of Belarus; CLI – index of composite leading indicators of Belarus; CPI – 12-month changes in the consumer price index; PR – policy rate of Belarus, share; λ_i and β_i are long-run coefficients; and ε_i and ϵ_i are error terms.

The joint null hypothesis of no cointegration relationship in the Eqn. (4) is:

$$H_{10}: \lambda_1 = \lambda_2 = \lambda_3 = \lambda_4 = 0$$

¹⁶ The cointegration approach is used because in most macroeconomic and financial time series data the presence of unit roots are identified leading to spurious results of conventional regression analysis.

¹⁷ These methods are applicable only if the underlying variables are integrated of the same order, that is, integrated of order one $I(1)$.

Alternative hypothesis of the presence of cointegration relationship is:

$$H_{11}: \lambda_1 \neq \lambda_2 \neq \lambda_3 \neq \lambda_4 \neq 0.$$

The joint null hypothesis of no cointegration relationship in the Eqn. (5) is:

$$H_{20}: \beta_1 = \beta_2 = \beta_3 = \beta_4 = 0$$

Alternative hypothesis of the presence of cointegration relationship is:

$$H_{21}: \beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq 0.$$

The first step of ARDL procedure is the conduction of the bounds test for the null hypothesis of no cointegration. The compound F-statistics of the lagged levels of the variables in the underlying ARDL model is compared with the upper critical values so-called upper critical bound (UCB) and lower critical values so-called lower critical bound (LCB) (Pesaran et al., 2001). The UCB supposes that all the series are $I(1)$, and the LCB supposes that they are all $I(0)$. The variables are supposed to be cointegrated if the estimated F-statistic lies above the UCB and not cointegrated if the calculated F-statistic is below the LCB, while if the estimated F-statistic is between UCB and LCB, the results will be inconclusive. If the long-run relationship is found among the variables then there is an error correction representation. The error correction models of the series can be presented as follows:

$$\begin{aligned} \Delta CLI_t = & \omega_0 + \sum_{i=1}^k \omega_{1i} \Delta CLI_{t-i} + \sum_{i=0}^m \omega_{2i} \Delta FSI_{t-i} + \sum_{i=0}^m \omega_{3i} \Delta PR_{t-i} + \sum_{i=0}^m \omega_{4i} \Delta CPI_{t-i} \\ & + \sum_{i=0}^m \omega_{5i} \Delta EC_{t-i} + \omega_6 EC_{t-1} + \varphi_t, \end{aligned} \quad (6)$$

$$\begin{aligned} \Delta PR_t = & \pi_0 + \sum_{i=1}^{\tau} \pi_{1i} \Delta PR_{t-i} + \sum_{i=0}^n \pi_{2i} \Delta FSI_{t-i} + \sum_{i=0}^n \pi_{3i} \Delta CLI_{t-i} + \sum_{i=0}^n \pi_{4i} \Delta CPI_{t-i} \\ & + \sum_{i=0}^n \pi_{5i} \Delta EC_{t-i} + \pi_6 EC_{t-1} + \phi_t, \end{aligned} \quad (7)$$

The coefficients of lagged error correction terms are supposed to be negative and statistically significant in order to approve the presence of cointegration relationships. Finally, the goodness of the fit of the selected ARDL models will be studied using tests for serial correlation, normality, heteroscedasticity and functional form.

3.4. Causality analysis

Causality between CLI, FSI, PR and CPI are examined using Toda and Yamamoto (TY) causality approach (Toda and Yamamoto, 1995). This technique has several advantages over traditional Granger Causality approach, first, TY statistics follows a standard asymptotic distribution (Squalli, 2007), and second, this approach does not depend on the integration properties of underlying variables and cointegration properties of the estimated system. According to this approach, vector auto-regression, (VAR) with lag length equal to $m+d_{\max}$ (where m is the lag-length and d_{\max} is the maximum

order of integration of the underlying variables) is estimated in order to use the Modified Wald (MWALD) test (by applying linear restriction – adding dmax lags) on the parameters of VAR(m).

Therefore, the paper considers the hypothesis that there is a relationship between CLI, FSI, PR and CPI, that is between economic activity, financial stress, policy rate and inflation in Belarus. Following four-equation VAR model is used for assessment:

$$\begin{bmatrix} \Delta CLI_t \\ \Delta FSI_t \\ \Delta PR_t \\ \Delta CPI_t \end{bmatrix} = \begin{bmatrix} a_{10} \\ a_{20} \\ a_{30} \\ a_{40} \end{bmatrix} + \begin{bmatrix} a_{11}(l) & a_{12}(l) & a_{13}(l) & a_{14}(l) \\ a_{21}(l) & a_{22}(l) & a_{23}(l) & a_{24}(l) \\ a_{31}(l) & a_{32}(l) & a_{33}(l) & a_{34}(l) \\ a_{41}(l) & a_{42}(l) & a_{43}(l) & a_{44}(l) \end{bmatrix} \times \begin{bmatrix} \Delta CLI_{t-m} \\ \Delta FSI_{t-m} \\ \Delta PR_{t-m} \\ \Delta CPI_{t-m} \end{bmatrix} + \begin{bmatrix} u_{1t} \\ u_{2t} \\ u_{3t} \\ u_{4t} \end{bmatrix}, \quad (8)$$

where m is the optimal number of lags; parameters a_{i0} and b_{i0} represent intercept terms; parameters $a_{ij}(l)$ and $b_{ij}(l)$ are the polynomials in the lag operator l ; u_{it} and v_{it} are white noise error terms.

In TY causality test, optimal lag length is selected by minimizing the value of the Akaike Information Criterion (AIC). For example, if a VAR model with a lag length of two is used to estimate Eqn. (8), then a particular variable does not Granger-cause other variable if and only if all the coefficients of $a_{ij}(l)$ are equal to zero. In the opposite case, second variable does not Granger-cause the first variable if and only if all the coefficients of $a_{ji}(l)$ are equal to zero. Thus, in the four-equation model (see Eqn. (8)), the hypotheses can be tested as next:

$$H_0: a_{1j}(1)=a_{1j}(2)=a_{1j}(3)=a_{1j}(4)=0:$$

$$H_1: a_{j1}(1)=a_{j1}(2)=a_{j1}(3)=a_{j1}(4)=0.$$

where $a_{1j}(i)$ are the coefficients of the given variables in the first equation and $a_{j1}(i)$ are the coefficients of the given variables in the jth equation in the VAR model of Eqn. (8).

4. Data

To assess the level of financial stress in Belarus the paper uses monthly and quarterly data from, National Bank of Belarus (NBB), Belstat, World Bank database and IMF-IFS¹⁸ database for January 2004 till September 2016. The method of cubic splines is used in order to obtain the monthly values from relevant quarterly series. Prior to estimation of financial stress index and index of composite leading indicators the data was seasonally adjusted using Census X-13 technique, real values were calculated applying Consumer Price Index (CPI) and using 2000 as the base year. The full description of the variables used in this study is shown in Table 1.

¹⁸ IFS – International Financial Statistics.

Table 1. Description of the variables

Variable	Source	Description
Inflation	National Bank	Consumer price index, by month (% change)
<i>Elements of Financial Stress Index</i>		
Liabilities (<i>FL</i>)	IMF-IFS	Foreign liabilities of banks, by month (current prices, mln. US dollars)
Deposits (<i>DEP</i>)	IMF-IFS	Transferable and other deposits included in broad money, by month (current prices, bn. BYN)
Claims (<i>CPS</i>)	IMF-IFS	Claims on the domestic private sector, by month (current prices, bn. BYN)
Policy rate (<i>PR</i>)	National Bank	Policy rate of National Bank of Belarus, by month (% per annum)
Overnight _{BLR} (<i>i_{BLR}</i>)	National Bank	Overnight interest rate for Belarus, by month (% per annum)
Overnight _{USA} (<i>i_{US}</i>)	IMF-IFS	Overnight interest rate for USA, by month (% per annum)
Exchange rate (<i>e</i>)	National Bank	Average exchange rate of BYN to USD, by month (BYN)
Reserves (<i>Res</i>)	IMF-IFS	Total foreign international reserves minus gold, by month (current prices, mln. US dollars)
External debt	World Bank	Total external debt, by month (current prices, mln. US dollars)
<i>Composite Leading Indicators</i>		
Investments	Belstat	Investment in fixed capital, by month (current prices, bn. BYN)
Banks' credits	National Bank	Banks' credits, by month (current prices, bn. BYN)
Cargo turnover	Belstat	Cargo turnover of motor vehicles, by month (mln. tonnes per kilometer)
Industrial production	Belstat	Industrial production, by month (current prices, bn. BYN)

Descriptive statistics for the entire sample of countries are shown in Table 2.

Table 2. Descriptive statistics

Series	Obs.	Mean	Std. dev.	Min	Max
Liabilities	153	4129.350	2576.929	362.640	8383.650
Deposits	153	90426.440	96440.510	5057.630	316504.300
Claims	153	81575.740	70645.850	4268.120	231283.000
Policy rate	153	0.185	0.083	0.100	0.450
Overnight _{BLR}	153	0.281	0.128	0.160	0.700
Overnight _{USA}	153	0.014	0.018	0.001	0.053
Exchange rate	153	6321.430	5507.098	2111.000	21482.000
Reserves	153	3145.769	1723.120	550.912	6354.740
External debt	153	22755.610	13622.22	4187.913	40919.460
Inflation	153	0.014	0.020	-0.007	0.136
Investments	153	7829.880	7128.765	347.000	29265.600
Banks' credits	153	14922.740	12886.370	1070.200	45879.300
Cargo turnover	153	1162.410	726.640	123.800	2888.700
Industrial production	153	27843.030	23464.930	3225.700	70314.000

5. Empirical results

5.1. Aggregation of the components of the FSI and CLI

The principal component analysis results for FSI are presented in Table 3. According to the signs of the coefficients, increase in the BSF and EMPI lead to raise of financial stress in Belarus. As for external debt, an increase in it decreases financial stress indicating that market participants still have little concern about debt sustainability of Belarus, however the ratio of external debt to GDP has already reached 70% by the end of 2016.

Table 3. Principal component analysis results for FSI

Variables	First principal component
<i>BSF</i>	0.406
<i>EMPI</i>	0.490
<i>External debt</i>	-0.771
Total variance explained (%)	44

Taking into account that all variables in the principal component analysis are standardized, each coefficient show the effect of one-standard-deviation change in the respective variable on the corresponding index. Therefore, BSF and EMPI has comparatively similar effects on financial stress in Belarus. On the other hand, external debt has quantitatively larger influence on FSI.

The last row in Table 3 indicates that 44% of the total variation in the three variables over the sample period is explained by the financial stress index. Taking into account that this variation captures the tendency of these three variables to move together, a higher number suggests that financial stress is a core element in the comovements of the variables. Therefore, the performance of the FSI is its ability to determine known episodes of financial stress and its relationship to economic activity and monetary policy in Belarus.

Table 4 represents results of principal component analysis for index of composite leading indicators of Belarus. The positive signs of all variables indicate that they positively influence economic activity in Belarus. The main influence comes from industrial production, the least important factor remains cargo turnover with the quantitatively smaller effect on CLI.

Table 4. Principal component analysis results for CLI

Variables	First principal component
<i>Exports</i>	0.535
<i>Banks' credits</i>	0.446
<i>Industrial production</i>	0.657
<i>Cargo turnover</i>	0.287
Total variance explained (%)	51

Finally, 51% of the total variation in the four variables over the sample period is explained by the index of composite leading indicators. Moreover, this large number indicates that CLI serves as a key element in the comovements of the variables.

5.2. Identifying episodes of financial stress and recessions in Belarus

Using the subcomponents described in previous section¹⁹, the financial stress index and index of composite leading indicators are constructed for Belarus for the period 2004-2016 (see Figure 1). Extreme episodes of financial stress are determined as the periods when the FSI is more than one standard deviation above its trend, which is captured by the Hodrick–Prescott (HP) filter²⁰. These episodes show that one or more of the FSI's subcomponents (banking, external debt and foreign exchange) has changed sharply. A recession is occurred if there was a serious contraction in the economic activity (CLI) during six month or more.

Overall, two financial stress episodes were identified. First of them (December 2008 – May 2009) was mainly driven by stress in the foreign exchange market and due to external debt underfinancing. Moreover, this episode of financial stress was caused mostly by exogenous financial shocks (World financial crisis of 2008 and subsequent drop in oil prices) and led to substantial macroeconomic fluctuations in Belarus triggering a persistent decline in economic activity (CLI) for up to 12 months.

In effect the government started actively pursuing expansionary monetary policy in order to stimulate demand and achieve its output growth targets lost due to recession. However, it should be mentioned here, that the empirical evidence shows that an expansionary monetary policy shock has no effect on output or economic activity (DeLong and Summers, 1988; Cover, 1992; Rhee and Rich, 1995; Kandil, 1995). Therefore, the monetary policy in Belarus in this period just only increased imbalances in the economy and made a significant groundwork for subsequent macroeconomic and financial fluctuations and resulted in next more severe episode of financial stress.

As a result, second episode of financial stress (December 2011 – May 2012) had become much more broad base – started by stress in foreign exchange market, it was extended by stress in the banking sector and external debt underfinancing. The spikes in the FSI appear to be associated with well-known events of large currency devaluations (see Figure 1).

Moreover, it is evident that starting from January 2016 there is a significant increase in BSF and external debt subcomponent (determines the lack of external finance for Belarus), which supposedly indicates the presence of risk of new episode of financial stress, but this time driven mainly by problems in the banking sector. This situation may lead to substantial credit losses and further to big concern about the capital strength of many Belarusian banks.

¹⁹ Looking at these subcomponents the types of financial stress (banking related, currency related or related to external finance) can be identified and associated with larger consequences for economic activity (CLI).

²⁰ The Hodrick–Prescott (HP) filter determines a time-varying trend needed to capture the notion that the financial system develops over time.

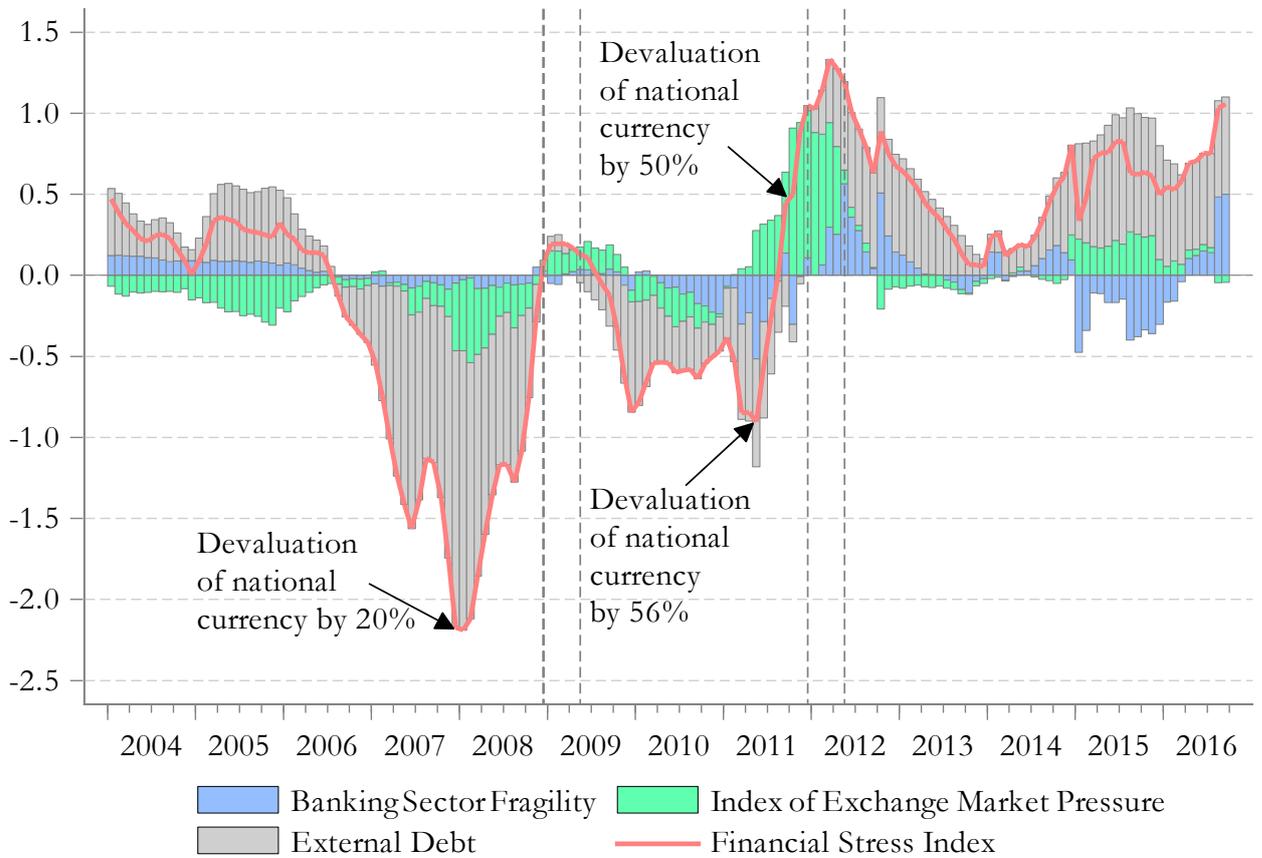
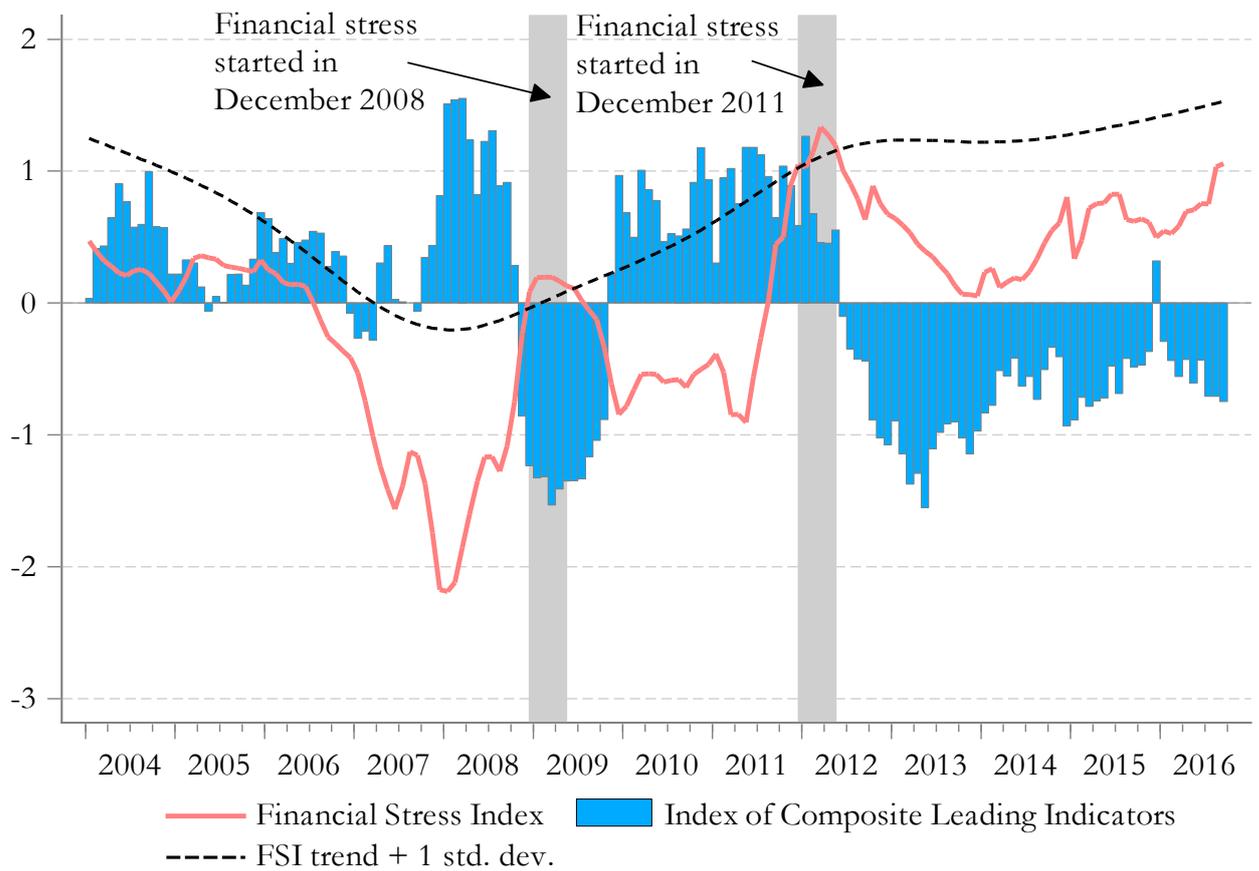


Figure 1. Episodes of financial stress in Belarus during 2004-2016

Next, using constructed CLI index two recessions were identified for Belarus for the period 2004-2016 (see Figure 2). In the first case (October 2008 – October 2009) the recession was started earlier than financial stress episode indicating that the financial stress was a consequence of economic slowdown during this time period. In the second case (June 2012 – September 2016) the recession was started with a lag of six month between the onset of financial stress and the slowdown and lasted substantially longer. Therefore, all these may indicate, first, that second recession was caused not only by structural problems in the economy, but also by financial stress; second, its large duration was magnified by severe losses of financial system induced by problems in banking system, foreign exchange market and due to lack of external finance, and, third, it indicates the longer duration of recession when preceded by the financial stress.

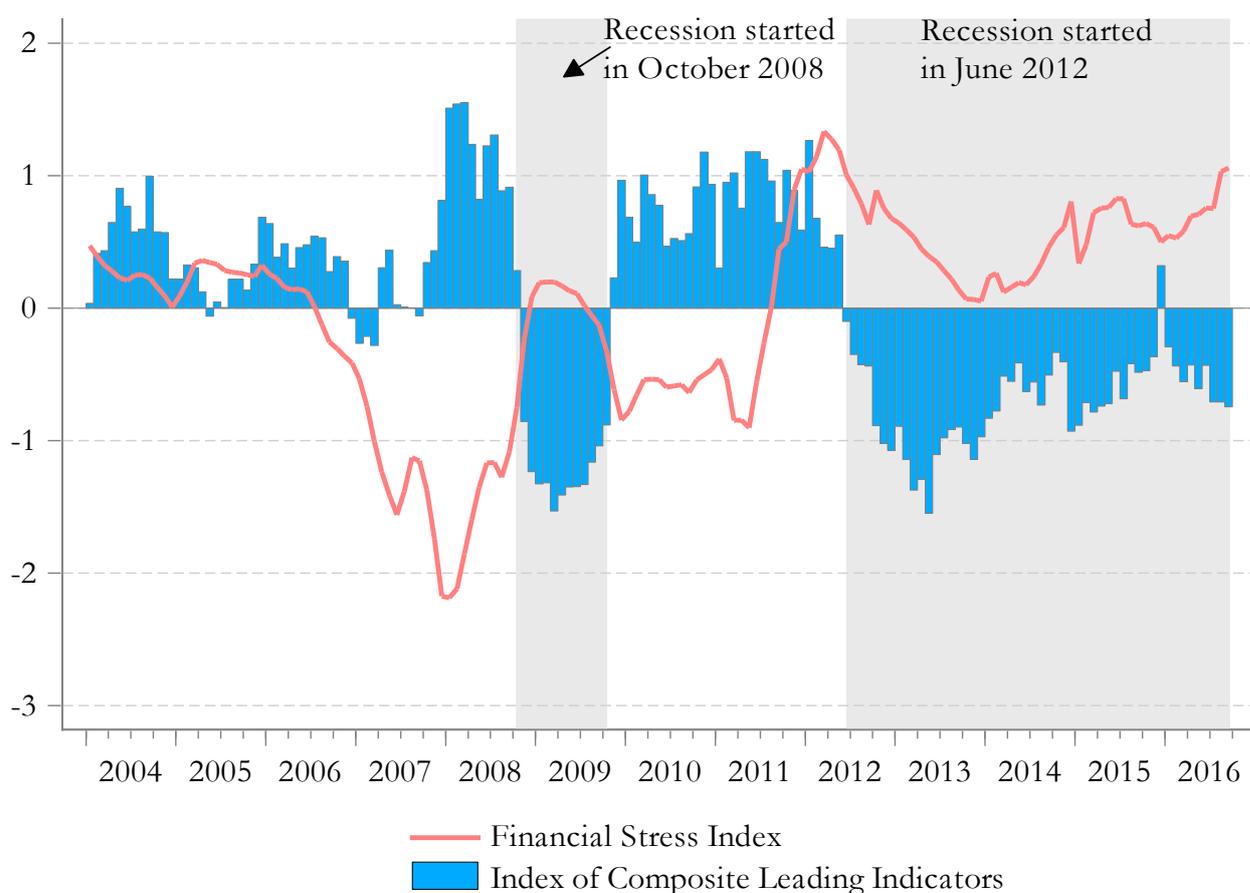


Figure 2. Recessions in Belarus during 2004-2016

The last conclusion can be also confirmed by estimating the cross correlations of the CLI index and the FSI – in order to see their dynamic relationship, because the CLI index was constructed using economic time series that indicate leading relationship to the business cycle at the turning points. Table 5 shows the results of calculated cross correlations.

Table 5. The cross correlogram of the FSI and the CLI index

i	$FSI, CLI(-i)$	$FSI, CLI(+i)$	lag	lead
0			-0.467***	-0.467***
1			-0.417***	-0.490***
2			-0.352***	-0.497***
3			-0.285***	-0.496***
4			-0.222***	-0.488***
5			-0.168**	-0.482***
6			-0.126	-0.472***
7			-0.086	-0.459***
8			-0.042	-0.430***
9			0.004	-0.393***
10			0.026	-0.350***
11			0.046	-0.300***
12			0.053	-0.250***
13			0.039	-0.217**
14			0.012	-0.192**
15			-0.018	-0.170**
16			-0.043	-0.140
17			-0.054	-0.101
18			-0.058	-0.079

Note: $CLI(-i)$ shows the correlation coefficients between lags of the composite leading indicator index and the financial stress index. $CLI(+i)$ shows the correlation coefficients between leads of the composite leading indicator and the financial stress index. *** – significance of the correlation at 1% level, ** – significance of the correlation at 5% level.

There is a statistically significant negative relationship between the FSI and CLI index before 4 lags and after 15 leads. These results indicate that the FSI is correlated negatively with the CLI index signifying that financial stress is related with the substantial longevity of the decrease in economic activity in Belarus.

Finally, the descriptive statistics of two episodes of financial stress and recessions are presented in Table 6. The cumulative output losses (relative to trend) in downturns were 5.85% of GDP for first recession that was not preceded by financial stress and 12.89% of GDP for second recession that was followed by financial stress (which by more than two times higher than for first recession). These results are the consequence of longer duration of second recession. In turn, these findings also indicate that banking system stress (second episode of financial stress) tend to be related with larger output consequences and longer recession than episode of pure exchange market stress (first episode of financial stress), where the banking system was mostly unaffected.

Other interesting result is the difference in the increase in FSI prior to start of recessions. In second case the increase is by 2.4 times higher than in first case, indicating, first, magnitude of shock may also be a trigger of substantial longevity of following recession (see Table 6).

Table 6. Descriptive statistics on financial stress and recessions in Belarus

Episodes of financial stress	Duration (months)		Output loss ^a (% of GDP)		Number of months after start of financial stress to recession	Increase in <i>FSI</i> six months prior to financial stress (%)
	Financial stress	Recession	Cumulative ^b	Average ^b		
December 2008 – May 2009	6	12	-5.85	-0.53	0	82.47
December 2011 – May 2012	6	52	-12.89	-0.52	6	198.34

Note: ^a output loss is measured as GDP below trend during recession. ^b output loss is calculated on yearly base.

Thus, taking the above results the *FSI* of Belarus may be considered as a comprehensive indicator that successfully determines the main episodes of financial stress in Belarus during studied period and can afford the basis to study their macroeconomic consequences.

5.3. Estimation results of ARDL models

A preliminary step before conducting cointegration and causality analyses is to examine the integrated properties of the studied variables (*CLI*, *FSI*, *PR* and *CPI*). Four unit root tests are used: *ADF*, *PP*, *ERS DF-GLS* and *ERS point optimal*. The last two tests are developed by Elliott et al. (1996) and have better power properties and lower size distortions in comparison to the standard *ADF* unit root tests. The results at level and first differences are shown in Table 7, indicating that variables are all stationary at first differences²¹, but inconclusively stationary at level. Therefore, there is a possibility that *FSI* and *CLI* may suffer from endogenous structural breaks since they comprise of monthly figures of almost thirteen years. Therefore, the *ARDL* methodology to cointegration (with dummy variables capturing structural breaks in the series) is suitable here, because can handle the possibility of different types of stationarity in the data.

²¹ Integrated of order one, i.e. *I*(1).

Table 7. Results of unit root tests

Null Hypothesis	At level		At 1st difference	
	intercept	intercept and trend	intercept	intercept and trend
<i>ADF unit root test</i>				
<i>FSI</i>	-1.972	-2.512	-7.096***	-7.125***
<i>CLI</i>	-2.253	-2.729	-11.538***	-11.499***
<i>PR</i>	-2.188	-2.799	-6.037***	-6.0144***
<i>CPI</i>	-4.205***	-4.287***	-5.600***	-5.587***
<i>PP unit root test</i>				
<i>FSI</i>	-1.663	-2.196	-6.957***	-7.046***
<i>CLI</i>	-2.615*	-3.151*	-11.543***	-11.505***
<i>PR</i>	-2.034	-2.728	-6.110***	-6.091***
<i>CPI</i>	-2.387	-2.416	-4.842***	-4.829***
<i>ERS DF-GLS unit root test</i>				
<i>FSI</i>	-1.859*	-1.995	-6.469***	-7.085***
<i>CLI</i>	-2.262**	-2.534	-3.009***	-9.674***
<i>PR</i>	-1.683	-1.919	-3.034***	-5.278***
<i>CPI</i>	-4.207***	-4.227***	-5.618***	-5.629***
<i>ERS point optimal unit root test</i>				
<i>FSI</i>	3.469*	12.053	0.537***	1.608***
<i>CLI</i>	2.620**	7.912	0.777***	1.571***
<i>PR</i>	4.825	14.299	1.327***	2.549***
<i>CPI</i>	0.419***	1.436***	0.012***	0.047***

Note: *** – significance at 1% level, ** – significance at 5% level.

Table 8 presents the computed F-values for testing the existence of long-run relationships presented in Eqns. (4) and (5) during studied period under the null hypothesis of no relationship between the regressors. The F-statistic in Table 8 is compared with the critical bounds presented in Pesaran et al. (2001). The outcome of the bounds test is conditioned by the choice of the lag order, p . Therefore, the conditional models (see Eqns. (4) and (5)) are estimated by imposing optimal lag length selection using Akaike Information Criterion (AIC). Estimated results of the bound F-test show that with CLI as the dependent variable, the computed F-statistic exceeds the upper critical bound of 1%. Therefore, the null hypothesis ($H_0: \lambda_1 = \lambda_2 = \lambda_3 = \lambda_4 = 0$) that no long-run relationship (no cointegration) between economic activity, financial stress, policy rate and inflation in Eqn. (4) is rejected. The same holds for model with PR as a dependent variable (see Eqn. (5)) – the computed F-statistic exceeds the upper critical bound of 1% rejecting the null hypothesis ($H_0: \beta_1 = \beta_2 = \beta_3 = \beta_4 = 0$) that no cointegration exists between underlying variables.

Table 8. ARDL bounds test results for the existence of a long-run relationship

Model	Calculated F-statistic	Optimal lag order	Significance level	Critical bounds	
				F-statistic*	
				I(0)	I(1)
$F_{CLI}(CLI FSI, PR, CPI)$	8.39 ^a	(12, 1, 2, 0)	1%	3.65	4.66
			5%	2.79	3.67
			10%	2.37	3.20
$F_{PR}(PR CPI, FSI, CLI)$	13.07 ^a	(5, 7, 5, 6)	1%	4.30	5.23
			5%	3.38	4.23
			10%	2.97	3.74

Note: The superscripts a and b indicate that the statistic lies above or below the upper or lower bound, correspondingly. * - critical values from Pesaran et al. (2001).

The serial correlation-free residuals were obtained under optimal lag order of twelve ($p=12$) for CLI for the model of Eqn. (4) and lag order of five ($p=5$) for PR for the model of Eqn. (5), as suggested by AIC. Additionally, several diagnostic tests such as Breusch-Godfrey serial correlation LM test, Jacque-Bera normality test, Breusch-Pagan-Godfrey heteroscedasticity test and Ramsey RESET specification tests are applied to check the stability of the ARDL models (see Tables 9 and 11). All the tests indicate that the models have correct functional form, residuals are normally distributed (except for model in Eqn. (5)), serially uncorrelated and homoscedastic.

Next, since the bound tests confirm the presence of cointegration between economic activity, financial stress, policy rate and inflation in Belarus during studied period, the short-run and long-run coefficients for both models (presented in Eqns. (4) and (5)) may be calculated (see Tables (9)-(12))

Table 9 shows the results of long-run coefficients of the ARDL model of CLI presented in Eqn. (4). The coefficient of financial stress index is negative and significant. An increase in financial stress by 1 standard deviation (or approximately by 0.75 points) ceteris paribus, will decrease economic activity in Belarus by 0.35 points. This shows that high level of financial instability causes the substantial downturn in economic activity in Belarus, mostly because the underdeveloped financial system²² is not supportive to economic activity and usually associates with financial instability (Li et al., 2015).

Next, the influence of policy rate (PR) is also negative and significant. An increase in policy rate by 10 percentage point ceteris paribus, will decrease economic activity in Belarus by 0.63 points. The increase in inflation in Belarus by 10 percentage points increases economic activity in Belarus by 0.18 points, ceteris paribus. Finally, the influence of structural breaks on economic activity occurred in FSI in 2006 and in CLI in 2008 is negative and significant, while structural break in financial stress occurred in 2011 caused statistically significant positive changes in economic activity.

²² For example, lacking the developed and effectively functioning stock market.

Table 9. Long-run estimation results of the ARDL model for economic activity – CLI model

Variable	ARDL _{CLI} (12, 1, 2, 0)	t-values
<i>Long-run coefficients</i>		
<i>FSI</i>	-0.463**	-2.451
<i>PR</i>	-6.265***	-3.472
<i>CPI</i>	1.804**	2.422
<i>Dummy</i> _{FSI_2006}	-0.640**	-2.178
<i>Dummy</i> _{FSI_2011}	0.988*	1.668
<i>Dummy</i> _{CLI_2008}	-1.357***	-2.943
Constant	-0.463***	-2.451
<i>Diagnostic test statistics</i>		
χ^2_{LM}	1.140 [0.337]	
χ^2_{BPG}	0.922 [0.564]	
χ^2_{RESET}	1.628 [0.205]	
$\chi^2_{NORMALITY}$	1.183 [0.553]	

Note: F-statistics in the parentheses. *** – significance at 1% level, ** – significance at 5% level, * – significance at 10% level. *Dummy*_{FSI_2006} – structural break occurred in FSI in 2006, *Dummy*_{FSI_2011} – structural break occurred in FSI in 2011, *Dummy*_{CLI_2008} – structural break occurred in CLI in 2008.

The results of short-run error correction estimates for Eqn. (4) are presented in Table 10. The significant and smaller than unity lagged error correction term (ECM_{t-1}) indicates the existence of long-run cointegration between CLI, FSI, PR and CPI. These results also confirm the existence of long-run relationship among economic activity and financial stress in Belarus calculated using bound F-test (see Table 8). More importantly, the negative sign of error correction term shows that 32% of long-run disequilibrium in economic activity caused by other three variables will be corrected in the each short-run period (month as in present paper) in Belarus. The value of R^2 , which measures the overall goodness of the fit of model, indicates that it is well defined.

Table 10. Short-run estimation results of the ARDL model for economic activity – CLI model

Variable	ARDL _{CLI} (12, 1, 2, 0)	t-values
<i>Short-run coefficients</i>		
ΔCLI_{t-1}	0.092	1.281
ΔCLI_{t-2}	-0.070	-0.999
ΔCLI_{t-3}	0.087	1.250
ΔCLI_{t-4}	0.122*	1.763
ΔCLI_{t-5}	-0.035	-0.498
ΔCLI_{t-6}	0.237***	3.187
ΔCLI_{t-7}	0.070	0.973
ΔCLI_{t-8}	0.147**	2.039
ΔCLI_{t-9}	0.113	1.510
ΔCLI_{t-10}	0.067	0.910
ΔCLI_{t-11}	0.247***	3.336
ΔFSI_t	-0.798***	-5.456
ΔPR_t	-5.410***	-2.652
ΔPR_{t-1}	4.679**	2.404
ΔCPI_t	0.357	0.497
$\Delta Dummy_{FSI_{2006,t}}$	-0.137	-0.797
$\Delta Dummy_{FSI_{2011,t}}$	0.276	1.505
$\Delta Dummy_{CLI_{2008,t}}$	-0.219	-1.201
ECM_{t-1}	-0.323***	-6.529
<i>Diagnostic test statistics</i>		
R ²	0.925	
DW	1.945	

Note: *** – significance at 1% level, ** – significance at 5% level, * – significance at 10% level. $Dummy_{FSI_{2006}}$ – structural break occurred in FSI in 2006, $Dummy_{FSI_{2011}}$ – structural break occurred in FSI in 2011, $Dummy_{CLI_{2008}}$ – structural break occurred in CLI in 2008.

Table 11 shows the results of long-run coefficients of the ARDL model of PR presented in Eqn. (5). The coefficient of financial stress (FSI) is positive and significant. An increase in financial stress by 1 standard deviation (or approximately by 0.75 points) ceteris paribus, will increase policy rate in Belarus by 1.9 percentage points.

Next, the influence of CPI is also positive and significant. An increase in inflation by 1 percentage point ceteris paribus, will increase policy rate in Belarus by 0.69 percentage points. The increase in economic activity does not statistically significant effect on policy rate in Belarus. Finally, the influence of structural breaks on policy rate occurred in FSI in 2011 and in CLI in 2012 is negative and significant.

Taking altogether the long-run estimation results of CLI model (see Table 9) and PR model (see Table 11) it is evident that, first, FSI influences economic activity substantially more than FSI affects policy rate; second, policy rate in Belarus substantially influences economic activity; third, FSI has low effect on policy rate. Thus, it is evident from above findings that financial crises in Belarus was also caused due to low pass through from financial stress to policy rate, that is policy rate does not fully absorb the market information on increasing financial imbalances in the economy – low policy rate was used

to stimulate economic activity (delivering significant amount of preferential credits, with credit rates significantly lower than policy rate, for state sector that dominates in Belarus's economy).

Table 11. Long-run estimation results of the ARDL model for policy rate – PR model

Variable	ARDL _{PR} (5, 7, 5, 6)	t-values
<i>Long-run coefficients</i>		
<i>CPI</i>	0.693 ^{***}	6.103
<i>FSI</i>	0.025 ^{***}	2.277
<i>CLI</i>	0.0003	0.032
<i>Dummy</i> _{FSI_2011}	-0.153 ^{***}	-2.944
<i>Dummy</i> _{CLI_2012}	-0.154 ^{***}	-2.908
Trend	0.001 ^{***}	4.326
<i>Diagnostic test statistics</i>		
χ^2_{LM}	1.266 [0.284]	
χ^2_{BPG}	1.016 [0.455]	
χ^2_{RESET}	0.242 [0.809]	
$\chi^2_{NORMALITY}$	221.716 [0.000]	

Note: *F*-statistics in the parentheses. *** – significance at 1% level, ** – significance at 5% level, * – significance at 10% level. *Dummy*_{FSI_2011} – structural break occurred in FSI in 2011, *Dummy*_{CLI_2012} – structural break occurred in CLI in 2012.

The results of short-run error correction estimates for Eqn. (5) are presented in Table 12. The significant and smaller than unity lagged error correction term (ECM_{t-1}) indicates the existence of long-run cointegration between CLI, FSI, PR and CPI in estimated Eqn. (5). These results also confirm the existence of long-run relationship among policy rate and financial stress in Belarus calculated using bound *F*-test (see Table 8). Moreover, the negative sign of error correction term shows that 14% of long-run disequilibrium in policy rate caused by other three variables will be corrected in the each short-run period (month as in present paper) in Belarus. The value of R^2 , which measures the overall goodness of the fit of model, indicates that it is well defined.

Table 12. Short-run estimation results of the ARDL model for policy rate – PR model

Variable	ARDL _{PR} (5, 7, 5, 6)	t-values
<i>Short-run coefficients</i>		
ΔPR_{t-1}	0.245 ^{***}	3.347
ΔPR_{t-2}	0.040	1.157
ΔPR_{t-3}	0.214 ^{***}	3.169
ΔPR_{t-3}	-0.159 ^{**}	-2.156
ΔCPI_t	0.222 ^{**}	7.399
ΔCPI_{t-1}	0.030	0.805
ΔCPI_{t-2}	0.041	0.257
ΔCPI_{t-3}	-0.033	-0.978
ΔCPI_{t-4}	-0.063 [*]	-1.889
ΔCPI_{t-5}	-0.125 ^{***}	-3.930
ΔCPI_{t-6}	-0.092 ^{**}	-2.634
ΔFSI_t	-0.018 ^{***}	-3.473
ΔFSI_{t-1}	0.003	0.518
ΔFSI_{t-2}	-0.002	-0.325
ΔFSI_{t-3}	0.008	1.359
ΔFSI_{t-4}	-0.021 ^{***}	-3.894
ΔCLI_t	-0.004 ^{**}	-2.147
ΔCLI_{t-1}	-0.0004	0.159
ΔCLI_{t-2}	-0.002	-1.057
ΔCLI_{t-3}	0.001	0.271
ΔCLI_{t-4}	0.005 [*]	1.938
ΔCLI_{t-5}	-0.005 ^{**}	-2.193
$\Delta Dummy_{FSI_{2011,t}}$	-0.025 ^{***}	-4.000
Δ	-0.001	-0.109
$Dummy_{CLI_{2012,t}}$		
Constant	0.004 ^{***}	4.822
ECM_{t-1}	-0.144 ^{***}	-7.923
<i>Diagnostic test statistics</i>		
R ²	0.993	
DW	2.132	

Note: *** – significance at 1% level, ** – significance at 5% level, * – significance at 10% level. $Dummy_{FSI_{2011,t}}$ – structural break occurred in FSI in 2011, $Dummy_{CLI_{2012,t}}$ – structural break occurred in CLI in 2012.

Stability of the estimated ARDL models' parameters is necessary for the empirical findings be valid over the sample period. To test for parameters' stability the CUSUM and CUSUMSQ test statistics are calculated to the recursive residuals of the models. Plots of the CUSUM and CUSUMSQ test statistics are presented on the Figure 3 and 4, revealing no evidence of parameter instability in the selected ARDL models at 5% critical level²³. Therefore, the stability of the estimated parameters indicate that the ARDL models can be considered stable enough for proper policy analysis.

²³ The cumulative sum of the recursive residuals and cumulative sum of squares of the recursive residuals within 5% significance lines suggest that the residual variance is stable.

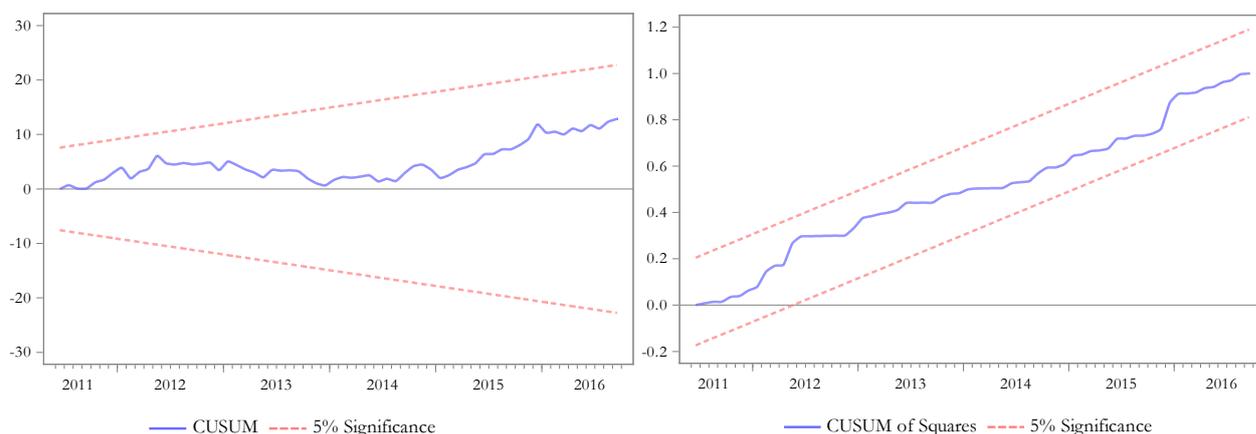


Figure 3. Stability tests for CLI model

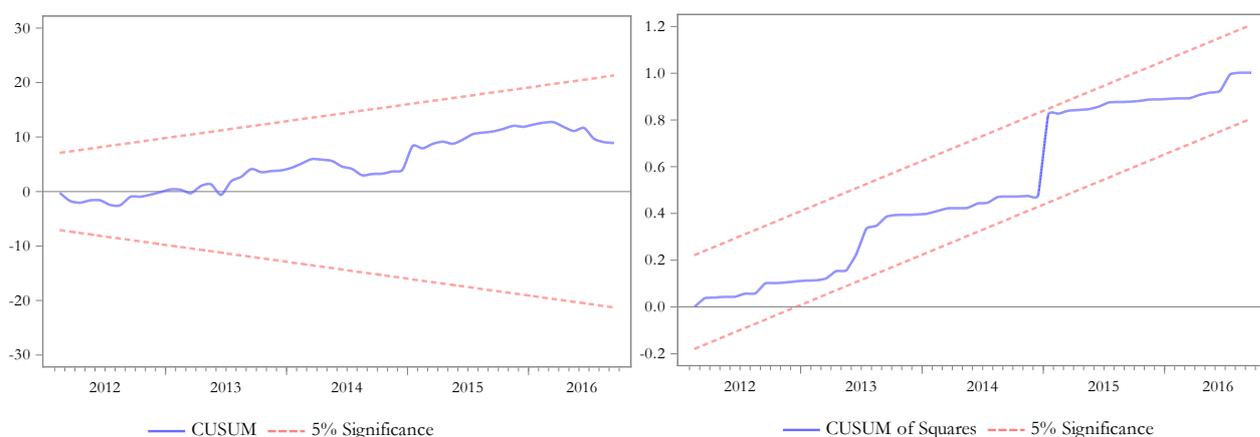


Figure 4. Stability tests for PR model

5.4. Toda and Yamamoto causality analysis

Table 13 show the results of Toda and Yamamoto causality analysis of relationships between FSI, CLI, PR and CPI indicating presence of the next causality relationships:

$$\mathbf{FSI} \rightarrow \mathbf{CLI} \rightarrow \mathbf{CPI} \leftrightarrow \mathbf{PR}$$

The findings show that FSI Granger causes economic activity. In turn, economic activity Granger causes inflation. Finally, there is a bidirectional causality running from inflation to monetary policy (through policy rate) and from monetary policy to inflation.

From theoretical point of view, results also signify that there is no evidence for the support of the conventional wisdom hypothesis in Belarus since 2004. The FSI does not Granger causes CPI and vice versa. Moreover, these results show that the price liberalization is important for sound monetary policy in Belarus. If it is supposed to reach objectives for inflation and output gap the NBB should have all the information about current macroeconomic situation in the country.

Finally, the above results suggest that higher financial stress in Belarus has led to lower economic activity that caused higher inflation (triggered by policy of preferential crediting or direct lending)²⁴,

²⁴ Under direct lending, banks are required to allocate certain percentages of their assets portfolios for loans to priority sectors at subsidized loan rates of interest. In order to insure against possible risks associated with directed loans, banks can offer higher interest rates or ration credit to non-favored borrowers (Kruk, 2011). As result, all these cause increase in

which in turn led to higher policy rate (tight monetary policy) introduced in order to constrain inflation in Belarus. Moreover, these findings also indicate that controlling for low level of financial stress in the economy help to predict higher economic activity in Belarus.

Table 13. Toda and Yamamoto causality tests results

Null Hypothesis	Chi-Sq. test	P-value	Inference
$FSI \rightarrow CLI$	18.963*	0.089	Yes
$FSI \rightarrow PR$	11.423	0.493	No
$FSI \rightarrow CPI$	17.613	0.128	No
$CLI \rightarrow FSI$	10.920	0.536	No
$CLI \rightarrow PR$	11.828	0.460	No
$CLI \rightarrow CPI$	19.426*	0.078	Yes
$PR \rightarrow FSI$	10.158	0.602	No
$PR \rightarrow CPI$	22.291**	0.034	Yes
$PR \rightarrow CLI$	17.315	0.138	No
$CPI \rightarrow FSI$	10.704	0.555	No
$CPI \rightarrow CLI$	6.720	0.876	No
$CPI \rightarrow PR$	30.950***	0.002	Yes

Note: *** – significance at 1% level, ** – significance at 5% level, * – significance at 10% level.

Therefore, taking into account that the probability of financial crises in Belarus is endogenous (due to structural imbalances) and related to the level of leverage in the economy (that can be captured, for example, by estimating potential real estate and deposit's bubbles) it is proposed to augment monetary policy of National Bank of Belarus of inflation targeting with additional financial stability target of level of financial stress.

First, in normal times, when the influence of financial stress probabilities on the realization of monetary policy is small it is proposed for the NBB to use more strict policy of inflation targeting in order to fulfill the output gap objective. Second, when financial stress starts to increase significantly, it might be optimal to undershoot the inflation objective and to increase short-term policy rate much higher, but the size of the increase in the interest rate should be dependent on the target of financial stress level.

6. Conclusion

The constructed in this paper financial stress index of Belarus includes next subcomponents: indicator of banking sector fragility, exchange market pressure index, and growth in external debt. Main tasks that presented in this paper FSI accomplish are: (1) to enhance the monitoring of financial stability in Belarus; (2) to determine and forecast potential sources and causes of financial stress in the economy of Belarus; and (3) to define the effects of financial stress.

The results indicate that the subcomponents of the FSI capture main features of financial stress in Belarus as the index tops at known financial stress episodes during 2004-2016 period. That is, the

inflation, first, through growth in prices by non-favored companies (in order to compensate for high interest rate payments) and, second, increase in prices by favored companies (due to loss in efficiency).

index identified two episodes of financial stress that exceeded one standard deviation threshold. The first episode started at the end of 2008 during the global financial crisis and ended in May 2009 and was mainly driven by stress in the foreign exchange market and due to lack of external finance. The second and most pronounced episode occurred in December 2011 and ended in May 2012 – started by stress in foreign exchange market, it was extended by stress in the banking sector and lack of external finance.

Next, using constructed CLI index two recessions were identified for Belarus for the period 2004-2016. In the first case (October 2008 – October 2009) the recession was started earlier than financial stress episode indicating that the financial stress was a consequence of economic slowdown during this time period. In the second case (June 2012 – September 2016) the recession was started with a lag of six month between the onset of financial stress and the slowdown and lasted substantially longer, which may indicate that it was caused not only by structural problems in the economy, but also by financial stress that magnified losses of financial system, where banking system stress tend to be related with larger output consequences and longer recession.

Further, the results of estimated ARDL models show that high level of financial causes the substantial downturn in economic activity in Belarus, generally because the underdeveloped financial system in Belarus is not fully supportive to economic activity and in recent years mostly associates with financial instability.

Additionally, the results of Toda and Yamamoto causality analysis show that FSI Granger causes economic activity. In turn, economic activity Granger causes inflation. Finally, there is a bidirectional causality running from inflation to monetary policy (through policy rate) and from monetary policy to inflation. These findings suggest that higher financial stress in Belarus has led to lower economic activity that caused higher inflation (triggered by policy of preferential crediting or direct lending), which in turn led to higher policy rate (tight monetary policy) introduced in order to constrain inflation in Belarus.

Finally, from theoretical point of view results also signify that there is no evidence for the support of the conventional wisdom hypothesis in Belarus since 2004. The FSI does not Granger causes CPI and vice versa. Therefore, price stability is not a sufficient condition to support financial stability. Subsequently, for the National Bank of Belarus it is suggested that financial instability through FSI should certainly be addressed independently with the objective of price stability.

7. Literature

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