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# FISCAL POLICY REACTION FUNCTION AND SUSTAINABILITY OF FISCAL POLICY IN UKRAINE

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## Abstract

This article analyzes fiscal policy reaction function with switching regimes for Ukraine. We demonstrate that the fiscal policy reaction function in Ukraine has a nonlinear nature. The analysis revealed that the fiscal policy of Ukraine has been in a passive regime for a long time and a switch to this mode took place in late 2006 with the beginning of rapid economic growth. By means of the LSTR models, it is shown that at high levels of debt and the GDP gap the fiscal policy switches to an active regime. However, such switching is rare and short, and therefore does not have an impact on the overall picture. We also found an asymmetry in the response of fiscal policy on the GDP gap depending on the phase of the economic cycle. In our opinion, this asymmetry is the main obstacle to switching the fiscal policy in active regime.

**JEL classifications: E62, H62, H63**

**Keywords: Fiscal policy, fiscal sustainability, active/passive fiscal policy, Ukraine**

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## 1. Introduction

The construction of fiscal policy reaction function (FPRF) on the national level and for a set of countries provides an opportunity to assess the sustainability of fiscal policy and the changes caused by the introduction of specific fiscal rules. The study of fiscal policy response to the changes in the macroeconomic environment by means of FPRF construction or statistical evaluation of the fiscal rules is a theme that is increasingly being discussed in academic circles. The variety of theoretical and empirical work on the estimates of the FPRF cannot yet be compared with the amount of works on monetary policy rules. As noted by Favero and Monacelli (2005), there are several reasons for this fact. First, the lack of quick access to high-quality statistical data for fiscal indicators. Second, the unsatisfactory empirical results, especially in comparison with the monetary policy models based on Taylor rule. Third, instability of the FPRF parameters that can vary dramatically depending on fiscal policy regimes. The identification of exogenous fiscal policy actions is a different problem. The dynamics of fiscal indicators contain automatic and discretionary reactions of budget parameters on macroeconomic variables; consequently, it's rather difficult for economists to characterize these two components of the fiscal reaction. Another issue is the role of expectations in the interaction of fiscal policy and economy because according to the Lucas critique only unexpected fiscal changes can have an effect. Since the changes in expectations concerning the fiscal policy occur earlier than the fiscal policy actions take place, the study of fiscal shock impact on the economy is a difficult challenge. However, when modeling the FPRF, economists are primarily interested in identifying the systematic relationships between economy and the fiscal parameters, while recognizing that the estimated coefficients contain a mix of automatic and discretionary fiscal reaction and formed the expectations of economic agents.

A promising topic for discussion is the nonlinearity of the FPRF and fiscal policy regime switching. In this context, economists mainly pay attention to advanced economies or small open economies with developed democracies. At the same time, small open economies with emerging markets remain less examined. The purpose of this study is to analyze the fiscal policy regime

switching in Ukraine, which is a classic example of a small open economy with an emerging market. In particular, we construct the FPRF for Ukraine on quarterly data in the manner of Burger and Marinkov (2012) and analyze the fiscal policy regimes employing the regressions with breaks in time series and splines for the level of public debt and the phase of business cycle. Then we use an approach similar to the method of Legrenzi and Milas (2013) and estimate the LSTR models with a set of different transition variables to better understand the causes of fiscal policy regime switching.

The issue of determination fiscal policy regimes is not only of academic interest, but it also has policy context. For the last eight years, Ukraine has been experiencing a period of rapid public debt growth, so the issue of debt stabilization is important for fiscal policy. The study of fiscal policy regimes evolution allows to shed light on the reasons for the exponential growth of the public debt in the recent years and to generate the recommendations for its stabilization.

The paper is structured as follows. The second section deals with the literature review on the relationship between the concept of fiscal sustainability and the fit of FPRF; we also discuss the empirical results concerning the fiscal policy regimes in emerging markets. The third section describes the methods of FPRF estimates that we prefer to apply assuming switching regimes in Ukraine. The fourth section is devoted to the dataset description and stationarity issues. In the fifth section, we present the results of estimations. The last section gives a summary of findings and some implications for fiscal policy.

## 2. Literature review

*2.1 The fit of fiscal policy reaction function and fiscal sustainability*

The main purpose of modeling the FPRF is to describe the automatic and discretionary reaction of fiscal authorities in respect of their goals. The discussion on fiscal policy targets is long-standing. Based on prior theory and standard assumptions, researchers argue that the objective of fiscal policy is to regulate the cyclical fluctuations of an economy or to maintain fiscal sustainability. The FPRFs are designed to determine the achievement of the fiscal policy aims in different countries or in different time periods. The fit of the FPRF itself can be quite different, but must include an indicator of public debt and economic dynamics. The primary interest is the coefficient of the variable that indicates the public debt, because, along with co-integration of a number of fiscal variables, a statistically significant positive reaction of the primary deficit on the changes in the level of debt is a sign of sustainable fiscal policy (Bohn, 1998). A positive sign of the debt level coefficient in the FPRF means that a government reduces the budget deficit in response to the debt growth and increases it when the debt decreases. An unbiased estimate of the FPRF helps to draw conclusions about the sustainability of fiscal policy. Referring to the review of empirical literature which analyzes the FPRFs, it can be identified the conventional modifications used by researchers to better describe the dynamics of fiscal indicators. Along with standard variables mentioned above, the monetary indicators are often included into the FPRF. According to de Mello (2005), the general fit of the FPRF can be represented as follows:

$$b_{i,t} = a_0 + a_1 b_{i,t-1} + a_2 d_{i,t-1} + a_3 C_{i,t} + u_{it} \,, \qquad (1)$$

where $b_{i,t}$ – primary budget balance to nominal GDP ratio, $d_{i,t}$ – public debt to nominal GDP ratio, $C_{i,t}$ – a set of control variables for the different levels of budgets *i* in time period *t*. To determine the control variables de Mello utilized the next intertemporal budget constraint:

$$b_t + (r_t - g_t) d_{t-1} = \Delta d_t + \Delta m_t + (\pi_t + g_t) m_{t-1} \,, \qquad (2)$$

where $\pi_t$ – inflation, $m_t$ – monetary base to GDP ratio; $g_t$ – real GDP growth rate. Using this relationship, the author shows that the cyclical output and inflation should be included as control

variables in equation (2) to account for revenues from seigniorage. In the study of Budina and Wijnbergen (2008), the budget constraint directly includes the income from seigniorage, as a result, debt sustainability is ensured by equality between the initial level of debt plus the present value of all future expenditures and the present value of all future budget revenues plus the incomes from seigniorage.

In some studies, the authors try to take into account the peculiarities of small open economies and include specific variables in the FPRF. Penalver and Thwaites (2006) make the assumption that public debt consists of foreign and domestic parts and, consequently, the cost and the dynamics of these components will be influenced by such variables as the real exchange rate, foreign and domestic interest rates. As a result, the authors concluded that uncertainty of macroeconomic forecasts and a response of such variables as public debt to GDP ratio and interest rates make the reaction of the fiscal rule on public debt changes significantly stronger.

Including dummies for extracting fiscal policy features that were a characteristic for a particular political regime in the FPRF is also a quite widespread practice (Burger and Marinkov, 2012). In some studies, economists analyze the fiscal policy reactions not in the form of total primary deficit response, but as a response of specific income and expenditures components (Claeys, 2008). Such studies allow conclusions to be drawn concerning exact budget components adjusting the overall budget balance in response to fluctuations in the level of debt and macroeconomic indicators.

Switching fiscal policy regimes complicate the estimation of the FPRF because the simple linear model reflects the averaged coefficients of different regimes. In the empirical literature, the solution to this problem was found in the employment of models with switching regimes. Fiscal policy regimes can be introduced into the models exogenously or endogenously. Exogenous regimes introduction occurs when the researcher has an a priori notion in what period the fiscal policy could change its properties. Technically, this is done by evaluating the FPRF for different periods of time (Gali and Perotti, 2003) or by introducing dummy variables, for instance, for extracting specific political events (Burger and Marinkov, 2012). Another approach is to identify regime switching basing on endogenous information when under the influence of transition variable the FPRF

coefficients change, and this change is estimated based on the information contained in the data itself. In Legrenzi and Milas (2013), the Smooth Transition Regression (STR) was applied to estimate the simple FPRF, which assumed to switch the coefficients of the business cycle and short-run relationship between the primary budget deficit and public debt. Transition variables in this study are the level of public debt in the previous year, the magnitude of the business cycle in the previous year and the difference between the level of public debt and state-varying threshold. State-varying threshold is in turn determined by the index of financial pressure on the belief that in times of financial turmoil the government allows changes to debt constraints. According to the results, the studied countries (Greece, Ireland, Portugal and Spain) have demonstrated the sustainable fiscal policy from the 60-ies to the present time. At the same time, in the periods of increasing financial pressure, these countries reduced the marginal debt levels, after reaching those levels correction towards establishing fiscal sustainability took place. Burger et al. (2011), along with other approaches use Threshold Autoregressive model (TAR), where the output gap serves as a transition variable and the threshold is set at zero level. The result of this estimation is that fiscal policy becomes countercyclical in the periods of recession. In the studies of Favero and Monacelli (2005), Claeys (2008), Burger and Marinkov (2012) are employed the regressions with Markov switching regimes where the regimes are determined endogenously. Burger and Marinkov (2012) use this approach in order to reflect the transition of fiscal policy regimes from passive to active and vice versa in South Africa. In Claeys (2008), the characteristics of fiscal policy in different regimes were analyzed with this approach. Not only was the reaction of primary deficit studied, but the different components of budget expenditure and income were studied as well. Favero and Monacelli (2005), in addition to the extraction of fiscal policy regimes in the US, also study their synchronization with monetary policy regimes, thereby enriching the analysis of macroeconomic conditions of government and central bank actions.

*2.2 Active vs. passive fiscal policy*

Another important purpose of constructing and estimating the FPRF is to characterize the fiscal policy as active or passive. In recent empirical studies, it is conventional to distinguish different fiscal regimes based on fiscal policy activity or passivity. The classification of fiscal policy

characteristics follows the logic proposed in Leeper (1991). According to this classification, the active fiscal policy is the fiscal actions that are not related to the dynamics of public debt, i. e. via fiscal instruments the government tries to influence other macroeconomic parameters (level of output, employment, etc.). The passive one is the fiscal policy which is limited by the dynamics of public debt and intertemporal budget consideration. In this regime, the main objective of fiscal policy is to maintain or achieve a sustainable level of public debt. In the empirical context, this means that in the case of passive fiscal policy, the coefficient of public debt is positive and statistically significant. Instead, the active fiscal policy can be identified by the statistically significant coefficients of a number of other control variables, especially the GDP gap.

Regarding the classification of fiscal policy regimes and the signs of coefficients in the FPRF, it is worth noting some important points (see Table 1 for clarification). The classification of fiscal policy as a countercyclical (positive coefficient), neutral (statistically insignificant coefficient), procyclical (negative coefficient) is based only on the changes of business cycle coefficient in the FPRF. The same thing happens with the identification of sustainable (unsustainable) fiscal policy, which is based on the positive (negative) coefficient of a debt burden variable. The determination of active or passive fiscal policy requires that two FPRF coefficients (GDP gap and debt ratio) have the opposite signs. The positive coefficient of debt burden (sustainable fiscal policy) and the negative coefficient of the GDP gap (procyclical fiscal policy) identify a passive fiscal policy; the opposite signs of coefficients (unsustainable and countercyclical fiscal policy) indicate an active fiscal policy. However, such order of coefficients is only possible when given the negative correlation between the debt level and the phases of the business cycle. The situation when with the economy growth the level of debt decreases and vice versa is quite likely, but not mandatory. The weakening of the negative relationship between debt and the GDP cycle leads to different combinations of signs of these variables in the FPRF. In our study, we weaken the assumptions on mandatory opposite signs of debt and the GDP gap coefficients in the FPRF because, as will be shown below, the negative correlation between the level of debt and the business cycle is not always taken place in Ukraine. We assume the possibility of statistical insignificance of one of the variables, in this case, the classification of fiscal

policy will be undertaken according to the sign of a statistically significant coefficient. The statistical insignificance of debt ratio and the business cycle is treated by us as a sign of a neutral fiscal policy.

**Table 1**

**Possible combinations of coefficients in the FPRF**

| **Coefficients** | **Passive** | | | **Active** | | | **Neutral** | **Active-sustainable** | **Passive-unsustainable** |
|---|---|---|---|---|---|---|---|---|---|
| **GDP gap** | - | 0 | - | + | 0 | + | 0 | + | - |
| **Debt** | + | + | 0 | - | - | 0 | 0 | + | - |

The case of existence in the FPRF identical in signs, statistically significant coefficients of debt ratio and the GDP gap is only possible with the mutual positive correlation between these variables. In this case, two positive, statistically significant coefficients indicate the following: when the economy is growing up (and therefore the debt level goes up), the government reduces budget deficit thus ensuring both sustainable and countercyclical fiscal policy; when the economy is in recession (and therefore the level of debt goes down), the government increases the budget deficit, again providing countercyclical and sustainable fiscal policy. We will call such type of fiscal policy regime as active-sustainable. Two statistically significant negative coefficients indicate that in the periods when both economy and debt level grow up, and when they fall a government provides the procyclical unsustainable fiscal policy that is suicidal for the economy and public finance. The option with two negative coefficients does not match the economic logic and is unlikely to happen. At the same time, the positive coefficients of the business cycle and the level of debt in the FPRF is the optimal solution. In this regard, the question is whether the positive or close to the positive correlation between debt and the GDP gap is possible. As it follows from the example of Ukraine, such a situation is possible, provided the fairly low initial level of debt and underdevelopment of the economy with high growth potential. In that case to accelerate the growth of economy, a government increases borrowing and at the same time can control the level of debt, because it is not high, and conduct countercyclical fiscal policy.

*2.3 The regimes of fiscal policy in emerging markets*

Empirical work on the sustainability of fiscal policy for different categories of countries has numerous publications. The generalized conclusion is that on average fiscal policy in emerging market countries responds to the parameters of sustainability. In the study of Abiad and Ostry (2005), the authors emphasize that along with the general sustainability of fiscal policy, increase above the threshold levels of the debt diminish the responsiveness to debt for emerging market countries. This fact says about certain nonlinearity in the reaction of fiscal policy depending on the economic conditions. In fact, the authors argue that there are two regimes of fiscal policy in developing countries as they state that the ability of policy makers to maintain fiscal solvency through higher primary balances in the countries with mean and median debt ratios above 50-60 % range appears to wane.

In the paper, Mendoza and Ostry (2008) the authors study the problem of fiscal solvency in the context of industrialized countries, emerging markets, and the countries with high and low levels of debt. The general conclusion is that the fiscal sustainability criteria are satisfied in general by all groups of countries, but with the growth of debt level, the government's ability to meet the criteria of fiscal stability is greatly reduced. In contrast to the previous literature, they did not find that the responsiveness to debt increases, when the debt exceeds threshold levels in panel regressions for advanced countries, but it does diminish for emerging market countries.

In the article of Ghosh et al. (2013) was examined the phenomenon of “fiscal fatigue”, which is called the switching of fiscal policy in an unsustainable regime at high debt ratio. The authors argue that the statement of Bohn (1998), who claims that to satisfy its intertemporal budget constraint the primary balance always has to react positively to lagged debt, can be thought of as a weak sustainability criterion that does not, for example, rule out an ever increasing debt-to-GDP ratio (and thus the need for a primary surplus that eventually exceeds GDP). On the sample of the developed countries, the authors empirically prove the existence of the "fiscal fatigue" phenomenon by constructing the cubic FRFP. This function is a specific modification of the model with three regimes of fiscal policy. The authors showed that at low levels of debt the relationship between a budget deficit and the level of debt is not significant or even negative. As debt increases, the responsiveness of fiscal policy also increases, but at a high level of debt, this reaction starts to weaken and eventually

decreases at extremely high debt levels. The results of estimations suggest that the responsiveness of fiscal policy begins to decrease at the debt level of 90-100% of GDP and becomes negative when the debt level approaches the threshold of 150% of GDP. This conclusion is contrary to the results of Bohn (1998) for the US, according to which the fiscal reaction increases with increasing debt. The authors explain the phenomenon of "fiscal fatigue" by the disability of the government to increase primary balances with the same pace as debt goes up.

Another side of fiscal policy regime is its reaction on the GDP fluctuations. The response of the fiscal policy on the business cycle is a fairly well-researched issue. The general conclusion is that in the emerging markets, fiscal policy is procyclical or neutral. An important issue in the context of fiscal sustainability is the symmetry of fiscal policy response in the different phases of the economic cycle. In the report of the IMF (April, 2015), it is stated that the symmetry in the fiscal response between good and bad times is important for three main reasons: rebuilding buffers ahead of the next cyclical downturn; reducing the risk of overheating; and avoiding a ratcheting up of public debt over successive cycles. According to the report, emerging markets are characterized by asymmetry in the fiscal policy response to the economic cycle. In periods of recession the fiscal policy is countercyclical while in times of economic growth - procyclical. Procyclicality of fiscal policy in the phases of economic growth may be dictated by a number of factors: a rapidly growing pool of revenues complicates the efforts to keep a tight lid on total expenditure, as the individual ministries compete for resources; potential output is unobservable, that's why the policymakers might be tempted to interpret temporary revenue gains as permanent, leading to higher spending or tax cuts that further fuel booming aggregate demand; a countercyclical fiscal policy may simply be inappropriate. For emerging markets and developing economies, good times often translate into easier access to financing and therefore provide an opportunity to deliver on the key priorities for growth and poverty reduction. These arguments imply that the asymmetric response of fiscal policy at different phases of the economic cycle bears threats for debt sustainability. The IMF (April, 2015) demonstrates that a systematic asymmetric response is associated with a nonnegligible upward drift

in the debt-to-GDP ratio. Under fairly benign macroeconomic assumptions, asymmetric stabilization could, after 20 years, lead to a debt-to-GDP ratio much higher than with symmetric stabilization.

In terms of switching passive and active regimes of fiscal policy, the asymmetry of fiscal response regarding the phases of business cycle could mean hidden threat to debt. If the government conducts the passive fiscal policy (procyclical and sustainable) in the periods of positive GDP gap, that means it increases the budget deficit, while the debt ratio decreases. Besides the fact that the government thus contributes to overheating of the economy, it also creates the conditions for increasing debt and fiscal space narrowing in the following periods. Such policy is hardly prudential. The better choice in such circumstances is an active fiscal policy, which has to cool down economy in the growth phase and contribute to the accumulation of fiscal resources for countercyclical actions in the future periods of economic downturn. In this study, we show that it is a passive fiscal policy in the phases of economic boom led to the uncontrolled growth of public debt in Ukraine.

## 3. The method of estimating fiscal policy reaction function for Ukraine

In the estimation of the FPRF for Ukraine we start with the standard model:

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

where $prsurpl$ – ratio of primary budget deficit to GDP, $debt$ – ratio of total government and guaranteed debt to GDP, $gap$ – cyclical deviations of nominal GDP from potential GDP, $pol$ – political dummy, which denotes the two quarters period before the president or parliamentary elections, $D$ – dummy to control for outliers in data. To estimate the function were used the quarterly data, forcing us to enter the fourth lag of explanatory variables in the model. The natural way to study the reaction of fiscal policy is to use the annual data, since the budget is adopted on an annual basis and the government likely exerts its response to changes in the economic environment with a lag of one year. However, the use of annual data critically reduces the number of observations for Ukraine, since the calculations are carried out for the period 1998-2015 years. In addition, the quarterly data

are more appropriate for the regime extraction. Therefore, using the logic contained in Burger and Marinkov (2012), we use the quarterly data with the fourth lag as a substitute for the annual data with one lag. In studies with fiscal rules estimates, the quarterly data are often used while explaining the variables included into the model without lags. That leads mainly to the estimation of the automatic reaction of fiscal parameters on the economic conditions. At the same time, the discretionary reaction is largely ignored as implementation lags of fiscal decisions are unlikely to allow them to be accepted and put into operation within one quarter. Therefore, we note that the inclusion of variables lagged by four quarters in our study largely draws attention to discretionary government response. The model (3) is estimated via OLS, GMM and LIML. The endogeneity risk is reduced due to the use of explanatory variables lags, but the model also includes a lag of the dependent variable, which saves the probability of endogeneity and bias of all coefficients. As endogenous variables considered *prsurpl*, *debt*, *gap*, as instruments, we employed the set of variables, which reflect the external economic conditions. In particular, we used the variables that reflect the state of the world economy (the average growth rate of the OECD countries), the state of the world commodity markets which influence the Ukrainian economy (agricultural raw materials index, metals price index, non-fuel price index, sunflower oil, wheat price index, fertilizers price index) and a real effective exchange rate as an indicator that reflects the relative prices between Ukraine and its major trading partners. The argumentation for using these variables is that the Ukrainian economy is small and open, Ukraine is a price-taker in the international commodity markets so the international economic trends are weakly dependent on the events and political decisions in Ukraine (exogeneity), but strongly influence the economic situation in Ukraine itself (should be strong instruments).

We also introduce in the FPRF a political variable that seems reasonable given the increasing empirical literature on political business cycles. If fiscal manipulations of the incumbent politicians in election periods explain the dynamics of budget parameters, their inclusion in the model has to increase the objectivity of all coefficients.

Since we assume the FRFP nonlinearity, we test the presence of structural breaks in the coefficients of the model (3). The presence of significant changes in the coefficients of the business cycle and debt shall identify the periods of switching the regimes of fiscal policy in Ukraine.

To determine the fiscal regimes depending on the phases of the economic cycle and debt levels were run a set of models with splines, which distinguished the coefficients of FPFF depending on the data being above or below the spline. As splines we used zero level of the business cycle, sample mean of the debt ratio, the positive/negative changes in public debt.

Determination of splines in an exogenous manner can lead to an incomplete understanding of the process of fiscal policy regime switching because of the subjectivity of this approach. To identify the switching thresholds based on the statistical results, we applied the logistic smooth transition regression (LSTR) of the following form:

$$prsurpl_t = \phi' \mathbf{x}_t + \theta' \mathbf{x}_t G(\gamma, c, s_{t-n}) + u_t, \;\; t = 1, \dots, T, \tag{4}$$

where $\mathbf{x}_t$ – vector of exogenous explanatory variables, $\phi = (\phi_0, \phi_1, \dots, \phi_m)'$ and $\theta = (\theta_0, \theta_1, \dots, \theta_m)'$ – parameter vectors of size $((m+1) \times 1)$, $u_t \sim i.i.d.(0, \sigma^2)$. For that type of models assumed the next transition function:

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

where $s_{t-n}$ – transition variable, which in our study included with some lag *n*, $c_k$ – one of the location parameters from vector $\mathrm{c} = (\mathrm{c}_1, \dots, c_K)'$ with restrictions $\mathrm{c}_1 \leq \cdots \leq c_K$, $\gamma$ – slope parameter. According to our approach:

- the same variables as in the model (3) were used as exogenous;
- the coefficients of public debt ratio and the GDP gap are assumed switching;
- fiscal policy demonstrates the regime switching that depends on the magnitude of transition variable ($s_{t-n}$) relative to variable $c_k$, which is the threshold for switching;
- the weighting coefficient of a particular regime is $\theta_m$, parameter $\gamma > 0$ defines a smoothness of transition between the regimes.

This type of model and the stages of construction are well described in Teräsvirta (2004), the idea of such FPRF specification implemented in Legrenzi and Milas (2013). In this study, unlike the previous works we test the LSTR model for the size of vector $\mathrm{c} = (\mathrm{c}_1, \ldots, c_K)'$. The most common cases are regressions with *K*=1 and *K*=2. In the case of *K*=1, the model parameters vary monotonically according to the functional relation with $s_{t-n}$ until the final switch to another regime. These models describe the asymmetric behavior of variables at high and low values of transition variable. The transition between the regimes can be smooth. The LSTR model with *K*=2 (LSTR2) assumes that the coefficients vary symmetrically around the point $(\mathrm{c}_1 + \mathrm{c}_2)/2$, which is within the range of transition variable. Such models are used when the variables behave in the same manner at high and low magnitudes of $s_{t-n}$, but switch to another regime while $s_{t-n}$ is intermediate.

LSTR2 regression is a three-regime model, two of which are symmetrical. The evidence for the possibility of existence of such type of nonlinearity in fiscal policy is the work of Ghosh et al. (2013), where the authors, although using a cubic regression empirically, show that fiscal policy reduces its responsiveness to the debt at extremely low and high values of debt pressure, but strongly positively reacts on the increasing debt at a moderate debt burden.

Before the model construction, a series of tests for nonlinearity in relationships caused by the transition variables should be run. As transition variables, we test the level of debt ratio conditional on financial pressure index, the ratio of total public debt to GDP, and the GDP gap. The variables with lags from *t*-4 to *t*-8 were chosen for testing. The choice of these potential transition variables related to the assumption that switching of fiscal policy to another regime is caused by the phase of the economic cycle and the overall level of public debt. Testing as a transition variable the level of debt ratio conditional on financial pressure index is inspired by the experiment in Legrenzi and Milas (2013), who argued that under high financial pressure the governments decrease marginal debt level, which is a threshold for switching the fiscal policy regime. To use this state-varying threshold we ran a regression of debt ratio on financial pressure index and used the residuals of regression as a transition variable.

The choice of lags of transition variables is due to the assumption that when determining the parameters of next year's budget, the government is guided by the information on the public debt and the stability of the financial system, which it received in the previous year.

Financial pressure index (FPI) was estimated with rather a simple scheme, which is basically the same as the method presented in Park and Mercado (2013). The FPI indicates the level of volatility in the major markets that are responsible for the circulation of finance in the economy: the banking sector, the foreign exchange market, the stock market, the market for government debt. As an indicator of the banking sector state, the differences of logarithms of household deposits multiplied by (-1)[1] were used. The foreign exchange market conditions were determined based on a standard exchange market pressure index (EMPI). Volatility on the stock market was modeled with GARCH (1,1), where the dependent variable was the first difference of PFTS [2] index logarithms. EMBI+Ukraine index – yield spread of the external debt of Ukraine in relation to the US Treasuries was employed to take into account the state of the Ukrainian government bonds market. Weighting and integration scheme of these indicators as follows: all indicators were demeaned, standardized and summed up with equal weights.

As an alternative variable to test the robustness of our results, we use the ratio of cyclically adjusted primary deficit to potential GDP (*cab*), instead of the primary deficit ratio to GDP. The *cab* is an indicator that better identifies discretionary fiscal policy, and thus makes it possible to affirm confidently that the results are not biased due to the presence of an automatic reaction.

## 4. Data

### *4.1 Data format and sources*

[1] Data for calculation of standard indicators of the banking sector, β-coefficient of banks' shares on the stock market, the share of nonperforming loans, are not available in the required frequency and for the required period. The multiplication by (-1) was conducted to synchronize the dynamics of this sub-index with other indicators of the index: values increase – increase of financial pressure and vice versa.

[2] PFTS – one of the largest stock exchanges in Ukraine, which has the longest history of operation and publishes the data required for the estimates.

We use the quarterly data for a maximum period of 1998–2015 years. The data on public debt is taken from the Ministry of Finance database contained on its website, the budget parameters are taken from the website of the State Treasury of Ukraine, and the macroeconomic parameters are taken from the database of the National Bank of Ukraine (NBU). In the process of estimating FPI, the level of households' deposits and data for calculation of EMPI have been taken from the official statistics of the NBU, the daily dynamics of PFTS index was formed on the basis of the data from its official website, EMBI+Ukraine was taken from the DATASTREAM statistical base. The data which were not available on a quarterly basis (conditional heteroskedasticity of PFTS Index, EMBI+Ukraine spread) were averaged to the level of quarters. The variable *prsurpl* was preliminary seasonally adjusted, because it contained quite strong seasonality while the introduction of seasonal dummies exacerbated the problem of degrees of freedom adequacy. The *debt* was estimated as the logarithm of the ratio of total government and guaranteed debt to seasonally adjusted GDP[3]. Before estimation of the GDP gap (*gap*) with the application of Hodrick-Prescott filter, the nominal GDP was transformed into logarithms and seasonally adjusted. As *cab* proxy were used residuals from the regression of the form:

$$PR_{DEF}{}_t = c_0 + c_1 GDP_{cycle}{}_t + e_t, \quad (6)$$

where $PR_{DEF}$ – seasonally adjusted primary deficit, $GDP_{cycle}$ – seasonally adjusted GDP gap in absolute terms, $e_t$ – model residuals that do not include the automatic response of fiscal policy on the cyclical fluctuations of GDP. Thus, we assume that the automatic response of fiscal parameters reveals itself during the quarter, the discretionary government actions have internal implementation minimal lag of one quarter.

*4.2 The stationarity of time series*

[3] The level of public debt is the stock measure, at the same time quarterly GDP – flow measure. That is why on the graphs and in the tables, *debt* which equals *log(total government and guaranteed debt / seasonally adjusted GDP*) takes very high values. Taking the exponent and dividing this figure by 4 allows getting approximation of the average yearly ratio of debt to GDP.

The stationarity of time series, which we include in the model, is an important point for consistent estimation of the FPRF parameters. The GDP gap is stationary by definition, but the unit root tests of public debt and primary deficit to GDP ratios usually produce very mixed results. This is especially true for Ukraine, where public debt dynamics were distorted by a powerful structural shock in 2008, which makes standard tests invalid. However, in Bohn (1998) and Bohn (2007), it was noted that such time series are characterized by considerable inertia, so the determination of their stationarity is challenging. Accordingly, stationarity should be based not on the statistical tests that are losing their power in a relatively small sample and with the presence of structural breaks, but on economic logic. This view is shared by Favero and Marcellino (2005), who suggest that there is a strong economic foundation to assume the stationary of debt and deficit to GDP ratio and this hypothesis should be accepted regardless of the test results. So it makes sense to model the FPRF with a fit like (3), which takes into account the short-term relationships and long-term trends.

The time series charts of variables included in our analysis and respective descriptive statistics are presented in Appendix 1. The visual analysis of the data suggests that except the debt ratio variables are close to a stationary process with transitive shocks. The *debt* variable demonstrates nonstationary behavior with the structural break in the third quarter of 2008, after which we can observe not only a level shift but also a trend change. The first differences of a debt variable (*d_debt*) are much closer to a stationary time series form, but the effects of the structural break are noticeable. For formal conclusions on the stationarity of time series were conducted ADF, KPSS and Elliot-Rothenberg-Stock (ERS) Point optimal tests presented in Table 2. The order of lags in ADF was selected according to the AIC information criterion, all tests were conducted with the assumption of intercept stationarity.

**Table 2**

**The results of stationarity testing for the FPRF variables**

| Variable (period) | ADF (H0: ρ=1) t-statistics | KPSS (H0: ρ≠1) LM- statistics | ERS (H0: ρ=1) t-statistics |
|---|---|---|---|
| *prsurpl (1998q1-2015q4)* | -5,3 (p<0,01) | 0,36 (p≈0,1) | 2,25 (p<0,05) |
| *cab(1998q1-2015q4)* | -4,73 (p<0,01) | 0,73(p<0,05) | 1,64 (p<0,01) |
| *gap (1998q1-2015q4)* | -3,53 (p<0,01) | 0,05(p>0,1) | 1,09 (p<0,01) |
| *debt (1998q1-2015q4)* | -0,56 (p>0,1) | 0,25(p>0,1) | 12,2 (p>0,1) |
| *d_debt (1998q2-2015q4)* | -7,59 (p<0,01) | 0,24(p>0,1) | 0,69 (p<0,01) |

The stationarity tests show that the cycle of GDP and primary surplus, with very high probability, are stationary processes. At the same time, according to the ADF test, cyclically adjusted budget balance and the first differences of debt ratio are stationary, but confirm their stationary according to the KPSS test only at the level of about 5%. As the disadvantages of ADF and KPSS tests are known and consist in the fact that they are severely size distorted and can't distinguish highly persistent stationary processes from nonstationary processes very well, the ERS test was conducted for the final conclusion.

## 5. The estimation results

### *5.1 Linear fiscal policy reaction function for Ukraine*

According to the proposed approach, we estimated the model of type (3) for variables *prsurpl* and *cab* with OLS, GMM, and LIML, with results presented in Table 3. A dummy variable (*d_10:03*) denotes the third quarter of 2010 when the government of Ukraine issued and sold VAT-bonds approximately on 16.5 billion of UAH., artificially increasing the revenues from VAT and distorting budgetary statistics. Along with the coefficients, in the table there are some statistics to judge the accuracy of standard errors estimation and bias. Note that when identifying the problems with autocorrelation or heteroskedasticity of errors, we applied the HAC variance-covariance matrix to mitigate the problems with standard errors. For the models where were used the instruments, we provide the statistics, characterizing the degree of instruments exogeneity and their explanation power. The test results indicate that the selected instruments are exogenous, but may suffer from weakness. The underidentification test does not indicate a problem, but the F statistics in Weak

identification test indicates that maximal IV bias relative OLS can reach 20%. That is why, along with the GMM we used LIML, which is less sensitive to the problems of weak instruments.

**Table 3**

**The results of estimation linear FPRF for Ukraine, 1998-2015**

| | OLS | | GMM | | LIML | |
|---|---|---|---|---|---|---|
| | $prsurpl$ | $cab$ | $prsurpl$ | $cab$ | $prsurpl$ | $cab$ |
| Constant | 0,008 | 0,01** | 0,004 | 0,008 | 0,008 | 0,007 |
| $prsurpl_{t-4}, cab_{t-4}$ | 0,24* | 0,38*** | 0,68** | 0,69*** | 0,74** | 0,88*** |
| $gap_{t-4}$ | -0,09 | -0,07 | -0,19** | -0,13* | -0,21*** | -0,009 |
| $d\_debt_{t-4}$ | 0,04** | 0,04* | 0,001 | -0,0003 | -0,006 | 0,09 |
| d_10:03 | -0,08*** | -0,08*** | -0,06* | -0,067* | -0,06* | -0,075** |
| $pol_t$ | -0,01*** | -0,01** | -0,018** | -0,016* | -0,018** | -0,018* |
| obs. | 67 | 67 | 61 | 61 | 61 | 61 |
| Adj. R-squared | 0,27 | 0,29 | | | | |
| Autocorrelation in residuals test | p=0,03 | p=0,42 | p=0,19 | p=0,13 | p=0,17 | p=0,17 |
| Heteroscedasticity test | p=0,42 | p=0,34 | p=0,26 | p=0,31 | p=0,35 | p=0,25 |
| Sargan statistics | | | p=0,46 | p=0,61 | p=0,51 | p=0,34 |
| Endogeneity test | | | p=0,002 | p=0,001 | p=0,0021 | p=0,008 |
| Underidentification test | | | p=0,01 | 0,0003 | p=0,012 | p=0,028 |
| Weak identification test | | | 5,86 | 6,76 | 5,86 | 3,74 |

Note: *, ** and *** denote statistical significance at the 10%, 5%, and 1% levels respectively. Autocorrelation in residuals test - Breusch-Godfrey Serial Correlation LM Test (4 lags) for OLS estimates and Cumby-Huizinga test for GMM and LIML. Heteroscedasticity test - Breusch-Pagan-Godfrey test for OLS estimates and Pagan-Hall general test for GMM and LIML. In Weak identification test is reflected Cragg-Donald Wald F statistic or Kleibergen-Paap rk Wald F statistic if heteroskedasticity or serial correlation was detected.

The coefficients in Table 3 indicate that Ukraine is characterized by the opportunistic political cycles. Looking at the results, we can conclude that the fiscal policy was in the passive state during the reported period. The models indicate a positive and statistically significant, in the case of OLS, response of primary deficit and cyclically adjusted primary deficit on public debt. Meanwhile, the coefficients of GDP gap demonstrate the procyclical behavior of fiscal policy, although with the lack of statistical significance. Judging by the signs of the coefficients, OLS and the methods of instrumental variables indicate the identical characteristics of the fiscal policy in Ukraine. The fall of the statistical significance of the coefficients in the models estimated by GMM and LIML can be explained by the loss of efficiency inherent to these estimators.

*5.2 Fiscal policy reaction function with structural breaks: when things went wrong*

The linear FPRF in the (3) specification demonstrates the instability of the coefficients. To demonstrate this fact, we conducted a series of tests for regression coefficients change, caused by structural breaks in the data. The conducted tests for unknown dates of structural breaks included the coefficients of the variables that we are most interested in (Table 4).

**Table 4**

**The results of Wald test for a structural break**

| **Coefficients included in the test** | **Break date** | **Prob. > chi²** |
|---|---|---|
| Dependent variable: $prsurpl_t$ | | |
| $gap_{t-4}, d\_debt_{t-4}$ | 2006q3 | p=0,03 |
| $gap_{t-4},$ | 2006q3 | p=0,02 |
| $d\_debt_{t-4}$ | 2011q1 | p=0,08 |
| Dependent variable: $cab_t$ | | |
| $gap_{t-4}, d\_debt_{t-4}$ | 2006q3 | p=0,56 |
| $gap_{t-4},$ | 2006q3 | p=0,26 |
| $d\_debt_{t-4}$ | 2008q1 | p=0,47 |

The results in Table 4 let us make several conclusions. First, the structural breaks in the data, leading to coefficients instability are much better identified in a model of the primary surplus. Second, the changes in the coefficients demonstrate both debt ratio and the GDP gap, what enables us to detect the common structural break date for these variables - the third quarter of 2006. In accordance with the date of structural breaks, the regressions of type (3) with the application of Least Squares with Breaks were estimated. When the model demonstrated the serial correlation and heteroskedasticity in errors, we used the HAC matrix to estimate the standard errors. We also estimated the FPRF with structural break in the fourth quarter of 2008, which is considered the starting date of the most powerful downturn in the Ukrainian economy and the financial sector. This episode in the history of the Ukraine's economy is memorable by the rapid devaluation, falling stock indexes, the explosion of CDS spreads on Ukrainian bonds, accepting of special fiscal programs as a response to the crisis of

debt and recession. Considering these events, crisis in 2008 q4 may be the point of changing the fiscal policy direction[4].The estimation results are presented in Table 5.

**Table 5**

**Lest square with breaks estimation of the FPRF**

| **Variables** | $prsurpl$ | $cab$ | $prsurpl$ | $cab$ |
|---|---|---|---|---|
| | **1999q2 – 2006q3** | | **1999q2 – 2008q4** | |
| $gap_{t-4}$ | 0,15** | 0,12 | 0,54 | 0,008 |
| $d\_debt_{t-4}$ | 0,03** | 0,02 | 0,01 | 0,01 |
| | **2006q4 – 2015q4** | | **2009q1 – 2015q4** | |
| $gap_{t-4}$ | -0,22** | -0,1*** | -0,2*** | -0,1** |
| $d\_debt_{t-4}$ | 0,03*** | 0,04*** | 0,04*** | 0,05*** |
| | **Non-Breaking Variables** | | | |
| Constant | 0,01** | 0,01** | 0,007 | 0,01* |
| $prsurpl_{t-4}, cab_{t-4}$ | 0,25** | 0,39*** | 0,26** | 0,41** |
| d_10:03 | -0,09*** | -0,09*** | -0,09*** | -0,09*** |
| $pol_t$ | -0,018*** | -0,01** | -0,01*** | -0,01** |
| obs. | 67 | 67 | 67 | 67 |
| Adj. R-squared | 0,33 | 0,28 | 0,26 | 0,23 |
| Breusch-Godfrey Serial Correlation LM Test (lag4) | p=0,91 | p=0,74 | p=0,49 | p=0,53 |
| Breusch-Pagan-Godfrey test | p=0,08 | p=0,06 | p=0,01 | p=0,05 |

The coefficients of the GDP gap and debt demonstrate switching and thus make it possible to assess the regime of fiscal policy. According to the results, before the breaking points the fiscal policy in Ukraine has been close to the active-sustainable or neutral state. After the identified points, the fiscal policy became passive relative to the economic dynamics[5]. The results raise two questions: how to the end of 2006 the government of Ukraine managed to balance between the procyclicality of fiscal policy and a sustainable reaction on the debt changes; what are the factors that caused the change at the end of 2006.

[4] Chow test confirms the presence of a structural break for the point 2006 q3, and with slightly less probability for the 2008 q4.

[5] We also calculated the recursive coefficients of FPRF to reflect the evolution of fiscal policy reactions to changes in the business cycle and the debt burden. These results confirm the gradual reduction of business cycle coefficient and increasing the coefficient of debt ratio (Appendix 2).

As noted above, the negative correlation between the dynamics of the economic cycle and the level of debt leads to the switch of their coefficients in the opposite directions. That is the situation we are observing after the third quarter of 2006, however, before these coefficients had the same sign. Leaving aside the statistical significance of the coefficients, the results of the estimates point to a combination of countercyclical fiscal policy in compliance with the fiscal sustainability before the third quarter of 2006. In our earlier discussion of the fiscal regimes classification, we called such regime as active-sustainable and described the conditions of its existence. Such regimes are possible only when the assumption of the negative correlation between the debt and the business cycle is violated. In Appendix 3 we present the results of the regression of debt on the business cycle with the application of Least Squares with Breaks, where the break date is set in the third quarter of 2006 and the Chow test that indicates the presence of a structural break at this point. This regression indicates that before the break date the debt level had decreased gradually (constant in regression), and the relationship between the changes in debt and business cycle had been quite weak. However, after the third quarter of 2006, the debt has begun to grow rapidly and has been established the significant negative relationship between fluctuations in the debt and the business cycle. The lack of significant negative correlation between the debt and the business cycle may have several causes. Perhaps the government of Ukraine at the time did not have enough opportunities to enter the international capital market for the increasing debt, indirect evidence of that is the steady decline in public debt during 2000-2008 years (Figure 1). An important factor was also the support of the fixed exchange rate regime by the central bank (Appendix 4), which also lasted during 2000-2008 and created the favorable conditions for servicing and repayment of foreign debts. Thus was born the illusion of public debt control, according to which the government could manipulate the level of debt without considering the business cycle dynamics. This illusion is reflected in the actions of the government in late 2006 when the paradigm shift happened in the relationship between the debt and the business cycle that led to fiscal policy regime switching.

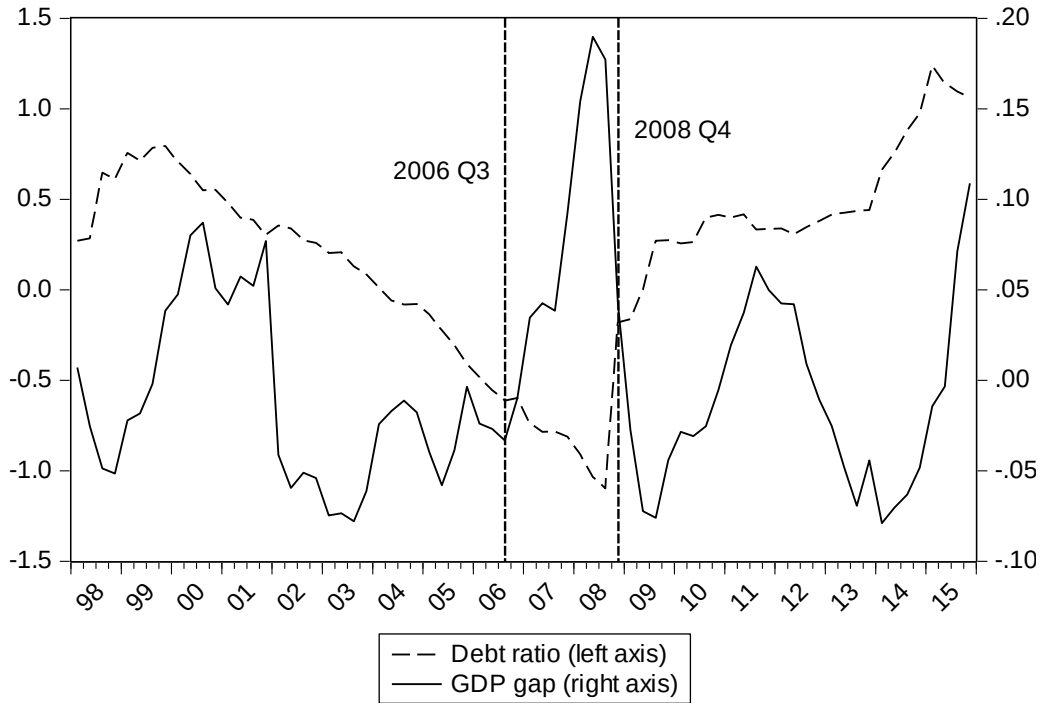



**Figure 1. The dynamics of Debt ratio and the GDP gap in Ukraine**

The peculiarity of the third quarter of 2006 is that this period is the starting point of the most powerful cyclical economic growth in the history of Ukraine (Figure 1). This strong economic growth in Ukraine was due to the strong growth of the world economy and, consequently, the incredible rise in prices on the world commodity markets. This growth was especially visible on the commodities markets, which are the major export positions of Ukraine (Appendix 5).

This episode of cyclical economic growth was characterized by the overheating of the world economy and finished with the global liquidity crisis and the strong decline in global output. Getting good times for the economy of Ukraine at the end of 2006 led to the fact that the fiscal policy switched into the passive regime and almost all time operates in it. For the period of the third quarter 2006 – the fourth quarter 2008, in conditions of economic growth and decreasing debt, this meant increasing the budget deficit[6]. However, the collapse of the world economy and the international capital markets and the resulting lack of external financing for the government led to the uncontrolled growth of public debt, what conserved the passive regime of fiscal policy for a long time. The exponential

[6] The mean for *CAB (PRSURPL)* for the period of 1998q1-2006q2 is equal to 0,02 (0,009), for the period of 2006q3-2008q3 - 0,005 (0,006).

growth of the public debt of Ukraine was caused by two major endogenous factors: the passive fiscal policy in 2006-2008, which made it impossible to form the reserves for future economic downturns (narrowed fiscal space) and contributed to the accumulation of debt; cheap financial resources on the overheated international capital markets encouraged the government to increase Ukraine's foreign debt (Appendix 6), what had the negative effects on a total debt level after the devaluation of the hryvnia in 2008-2009.

Thus, switching of fiscal policy, according to which the budget deficit is tied to the level of debt and can not be used to provide the countercyclical actions, took place not in the bad times of crisis that began in late 2008, but in the good times of economic growth. Such switch was caused by the nonprudential government policy that pinned hopes for steady economic growth and a fixed exchange rate.

*5.3 Fiscal policy reaction function with splines: asymmetry in response to the GDP gap*

Least Squares with Breaks allows to fit the dynamics of the processes with breaks in time but does not allow for analysis of the economic factors that cause the switching of policy regime. For the analysis of fiscal policy regimes switching depending on the debt dynamics and the phase of the business cycle, we have run a number of regressions with splines. For the GDP gap, the spline was set at zero level in order to observe the behavior of the FPRF coefficients in the periods of economic overheating and recessions. In a similar way, we established a spline for the growth of the debt burden. For the level of public debt, the spline was set at the mean value for the period of 1998-2015. The results of estimates (Table 6) indicate that relative to the phase of the business cycle, fiscal policy switches to the passive regime in the periods of positive GDP gap. In the periods of economic recession, the fiscal policy follows a neutral state - there is no countercyclical reaction, no definitive correction of the budget deficit in line with changes in the debt burden. This result explains why in the previous models with structural breaks the fiscal policy of Ukraine was in a neutral state in the period of 1998-2006 q3 - most of this period Ukraine was in a state of negative GDP gap. Regressions

with the splines on the debt measures indicate that the fiscal policy is generally sustainable and increase its responsiveness to the debt changes with the debt burden growth. At the same time, the dynamics of debt does not result in a statistically significant relationship between the budget deficit and the business cycle. Regardless of the level of debt, the fiscal policy is procyclical, although with the lack of statistical significance.

**Table 6**

**Fiscal policy reaction function with splines**

| **Spline** | **GDP gap lower zero (-), GDP gap over zero (+)** | | **Debt drop (-), Debt growth (+)** | | **Debt lower average level (-), Debt over average level (+)** | |
|---|---|---|---|---|---|---|
| **Dependent variable** | ***prsurpl*** | ***cab*** | ***prsurpl*** | ***cab*** | ***prsurpl*** | ***cab*** |
| *Constant* | 0,01*** | 0,02** | 0,01 | 0,01* | 0,008 | 0,01** |
| $prsurpl_{t-4}$/ $cab_{t-4}$ | 0,2* | 0,3*** | 0,2 | 0,3*** | 0,22* | 0,37*** |
| $pol_t$ | -0,01*** | -0,01*** | -0,02*** | -0,01** | -0,01*** | -0,01** |
| d_10:03 | -0,07*** | -0,07*** | -0,08*** | -0,08*** | -0,09*** | -0,09*** |
| $gap_{t-4}$ (-) | 0,19 | 0,16 | -0,11 | -0,1 | -0,12 | -0,1 |
| $gap_{t-4}$ (+) | -0,25*** | -0,19*** | -0,02 | 0,001 | -0,01 | -0,01 |
| $d\_debt_{t-4}$ (-) | 0,05 | 0,03 | 0,04 | 0,04 | 0,03** | 0,04 |
| $d\_debt_{t-4}$ (+) | 0,03*** | 0,04* | 0,03*** | 0,04*** | 0,07 | 0,06 |
| obs. | 68 | 68 | 68 | 68 | 67 | 67 |
| Adj. R-squared | 0,31 | 0,3 | 0,27 | 0,28 | 0,28 | 0,29 |
| Autocorrelation in residuals test | 0,11 | 0,37 | 0,01 | 0,17 | 0,08 | 0,5 |
| Heteroscedasticity test | 0,26 | 0,24 | 0,38 | 0,25 | 0,31 | 0,33 |

The models with splines indicate that the regime switching of fiscal policy takes place under the influence of the business cycle phase (from neutral to passive), the debt growth only increases the sustainability of fiscal policy. As it was mentioned in literature discussion, the asymmetry of fiscal policy regimes relative to the GDP gap holds risks for the fiscal sustainability. Procyclicality of the fiscal policy in times of economic growth and the absence of a procyclicality in downturn leads to a narrowing of fiscal space of the government and creating the conditions for the accumulation of debt in the future, which is not always accompanied by the positive economic dynamics. The sustainability of fiscal policy in the periods of positive GDP gap (reducing debt, increasing budget deficit) can not always compensate for the negative impact of the described asymmetry. It is necessary to point out

that the asymmetry in response to the budget deficits is not complete. In the periods of the negative output gap, fiscal policy is neutral. On the one hand, it can help to reduce debt, because in times of economic downturn the government does not increase the budget deficit, on the other hand, the lack of countercyclical policy extends the time of being the economy in a phase of depression that affects the state of public finances and can increase the level of debt.

*5.4 Logistic smooth transition regressions: is the fiscal policy of Ukraine always passive?*

While running the regressions with splines we, first, define the thresholds of regimes switching in our own discretion, and secondly, we believe that the coefficients of the FPRF are homogeneous in the sub-samples of the data that we have chosen. However, this approach is rather subjective and it makes sense to provide the data with an opportunity to point out the conditions of regime switching. For this, we apply the LSTR model (4), which allows testing a number of potential transition variables for the presence of non-linearities between the FPRF variables. Parameter $\gamma$ controls the slope of transition function according to Teräsvirta (2004), when $\gamma \to \infty$ an LSTR1 model approaches the Markov switching regression model with two regimes that have equal variances. The LSTR2 model, in this case, converges to switching the regression model with three regimes such that the outer regimes are identical and the midregime is different from the other two. Thus, constructing the LSTR model we can identify the variables that induce regime switching and assume not so rapid transition between the regimes as in Markov-switching models.

As noted in the methodology description, as the candidates for the transition variables we tested the public debt to GDP ratio (*debt*) and the GDP gap (*gap*). The testing methods are well described in Teräsvirta (1994, 1998)[7]. In our results, we present the estimations on the basis of those transition variables, which made it possible to identify the nonlinear relationships between the variables in FPRF.

[7] All tests and estimations for LSTR1 and LSTR2 conducted using JMulTi software.

**Table 7**

**LSTR1 models of FPRF**

| Dependent variable | $prsurpl_t$ | | $prsurpl_t$ | | $cab_t$ | | $cab_t$ | |
|---|---|---|---|---|---|---|---|---|
| Transition variable | $debt_{t-6}$ | | $gap_{t-8}$ | | $debt_{t-6}$ | | $gap_{t-8}$ | |
| | Linear part | Nonlinear part | Linear part | Nonlinear part | Linear part | Nonlinear part | Linear part | Nonlinear part |
| Const. | 0,004 | | 0,01*** | -0,01 | 0,01* | -0,08* | 0,01*** | |
| d_10:03 | -0,07*** | | -0,01 | | -0,09*** | | -0,02 | |
| $pol_t$ | -0,01** | | -0,01*** | | -0,01** | | -0,01** | |
| $prsurpl_{t-4}$ / $cab_{t-4}$ | 0,13 | | 0,2 | | 0,2* | | 0,36*** | |
| $d\_debt_{t-4}$ | 0,04** | 0,25 | 0,11* | -0,1 | 0,04* | 0,55 | 0,08 | -0,08 |
| $gap_{t-4}$ | -0,11** | 1,17*** | -0,1 | 0,7** | -0,1* | 1,9*** | -0,1 | 0,78** |
| γ | 2052,9 | | 7,4 | | 2425 | | 4,8 | |
| C1 | 0,71*** | | 0,07*** | | 0,71*** | | 0,08*** | |
| Obs. | 65 | | 63 | | 65 | | 63 | |
| adj. $R^2$ | 0,53 | | 0,43 | | 0,55 | | 0,38 | |
| Test of No Error Autocorrelation (p-value) | lag 1= 0,94 | lag 2= 0,98 | lag 1= 0,1 | lag 2= 0,14 | lag 1= 0,29 | lag 2= 0,44 | lag 1= 0,41 | lag 2= 0,58 |
| | lag 3= 0,99 | lag 4= 0,98 | lag 3= 0,3 | lag 4= 0,41 | lag 3= 0,59 | lag 4= 0,75 | lag 3= 0,63 | lag 4= 0,84 |

Table 7 contains the results of modeling the FPRF with the application of LSTR approach. The tests for nonlinearity with the use of transition variables described above constantly preferred the LSTR1 models. This means that fiscal policy has two regimes, one of which is formed after reaching a certain value by a transition variable (*nonlinear part*). A set of tests for nonlinearities allowed identifying two types of transition variables: public debt to GDP ratio with sixth lag; GDP with lag t-8. The models for primary (*prsurpl*) and cyclically adjusted budget deficit (*cab*) demonstrate about the same results – after crossing the transition variables with rather high thresholds (C(1) for gap = 0,08, max = 0,18; C(1) for debt ratio = 0,71, max = 1,23) fiscal policy switches to active regime. Gamma coefficients demonstrate rather a fast regime switching when the transition variable is $debt_{t-6}$, while $gap_{t-8}$ causes relatively slow transit. The statistical insignificance of γ is justified

by the fact that for large values of gamma and a small data sample it's difficult to determine the curvature of transition function because it requires a large number of observations near the C1 point. This fact increases the standard errors of γ. Another point is that the standard *t*-statistic can't be interpreted correctly since it is designed to test the hypothesis γ = 0, while in LSTR γ is restricted: $\gamma^s > 0$ (Teräsvirta 2004).

The thresholds of fiscal policy regimes switching and transition functions of LSTR1 regressions are presented in Appendix 7. These charts reflect the probability of the FPRF to be in the nonlinear part of the model, or in other words, allow identifying the periods of FPRF switching in the regime of active fiscal policy. Due to the fact that the thresholds of transition variables are relatively high, the switching episodes of fiscal policy in an active state are rare and short-lived.

The debt level threshold of fiscal policy switch in an active state (countercyclical and unsustainable) coincides with the results in Abiad and Ostry (2005), where demonstrated that on the emerging market the fiscal policy loses its sustainability after the debt to GDP ratio exceeds 50-60%. The threshold estimated by the LSTR1 model for Ukraine is: $\frac{(e^{0,71})}{4} = 0{,}5$.

An important point is that the logic of the fiscal policy regime switching in Ukraine assumes the feasibility of the LSTR2 model for its description. According to our results, the regime switching takes place at the high business cycle and debt levels. If there is a constant negative correlation between the business cycle and debt, the periods of high debt must be accompanied by the low values of the GDP gap and vice versa. This would mean that fiscal policy switches to the active regime in two cases: high[8] debt ratio (low GDP gap), low debt ratio (high GDP gap). The try to describe the FPRF of Ukraine through the application of three-regime model (LSTR2) was not successful due to the low statistical significance of coefficients. We explain this fact by the lack of negative significant correlation between the debt level and the business cycle for the significant part of our sample (1998-2006 q3), as shown above.

[8] Under high and low, we mean above or below a certain threshold level that is statistically significant.

We also conducted the tests for the presence of nonlinear relationships in the Ukrainian FPRF provided that only one variable switch ($d\_debt_{t-4}$, or $gap_{t-4}$). According to the testing results, we have run a number of LSTR1 regressions listed in Appendix 8. These models point to the fact that more prone to switching are the coefficients of the business cycle while the coefficients of debt ratio are more or less monotonous. This finding confirms the results of the spline regressions (Table 6), which pointed to the radical switch of the GDP gap coefficients in different phases of economic dynamics. However, the LSTR1 models also point to the fact that the fiscal policy in Ukraine was not in the passive state for the whole range of positive values of the business cycle. At extremely high values of the GDP gap the switch to active regime happened.

In Legrenzi and Milas (2013), the time-varying threshold in the form of debt ratio modeled by regression on financial stress index (FPI) was used as a transition variable in the nonlinear FPRF. The authors argued that the governments are likely to reduce the debt level thresholds in times of high pressure on the financial systems. In other words, the coefficients of FPI in a regression on the level of debt assumed to be negative and statistically significant, suggesting that, during the periods of financial pressure, the governments reduce the debt threshold, possibly in response to the financial market concerns. We have built a similar model where as a transition variable were used the residuals of the regression of the debt level on the index of financial pressure. This model shows how the debt burden should deviate from the value set by the relationship between debt ratio and FPI to switch the fiscal regime. The model for the primary budget deficit presented in Appendix 9 and indicates that the high debt ratio makes the fiscal policy to switch into the active regime. This fact was established earlier. But the interesting point is that in contrast to the findings of Legrenzi and Milas (2013), Ukraine is characterized by a positive relationship between the level of debt and financial stress index. Appendix 10 contains the regression of debt ratio growth (*d_debt*) on FPI (*fpi*) and their cross correlogram that indicates that the FPI increase leads to the level of debt growth in Ukraine. The reduction of acceptable debt limits by a government in times of high financial stress may be caused by the inability to be financed on favorable terms, as the rates in the markets in these conditions increase dramatically, or increased probability of default, which makes the policymakers to lower

level of debt. However, in the case of Ukraine, the situation was the opposite, in conditions of high financial pressure the level of debt increased. That means that the government of Ukraine, regardless of market conditions, increased its debt in times of crisis and thus further involved itself in debt bondage. In such circumstances, the fiscal policy has little chance to switch into the active regime as debt service is a priority of the government.

The explanation of fiscal policy transition from passive to active regime at the high level of the GDP gap in our view is that the budget deficit can not be increased long in the conditions of economic growth. Eventually, the correction of the fiscal balance must take place that will have the features of countercyclicality. In addition, if the economic growth is indeed accompanied with the declining of debt level, the debt becomes a problem for which the government pays little attention. Switching the fiscal policy in active regime at high levels of debt ratio corresponds to the "fiscal fatigue" phenomenon described in Ghosh et al. (2013) and can be explained by the fact that after a certain threshold the government is no longer able to reduce the budget deficit and no longer responds to the high level of debt.

The facilitation of such reaction of the government on debt could also be caused by the intervention of the international financial organizations (including the IMF), which occurs every time Ukraine is on the edge of default. Refinancing of Ukrainian debt obligations in an environment where the potential lenders consider Ukrainian bonds too risky and funding of some budget programs allow the government to conduct occasionally countercyclical fiscal policy. This is confirmed by the dynamics of the share of Ukraine's debt to the international financial organizations (IFO) and the cross correlation function relatively FPI (Appendix 11). We also built the LSTR1 model of FPRF with the proportion of public debt to IFO as a transition variable (Appendix 12). This model shows that switching to active fiscal policy regime happened after achieving the threshold of 33-34%. Such shares of public debt to IFOs were observed during the periods of major financial crises in the history of Ukraine: 1998, 2008-2009, at the end of 2015 Ukraine was approaching this threshold.

## 6. Conclusions and policy implications

The analysis of fiscal policy reaction function of Ukraine shows that it has a non-linear nature. The coefficients of FPRFs for the primary budget deficit and cyclically adjusted budget balance are very much alike, to some extent confirming the robustness of the results. Our findings, in general, coincide with previous empirical works, which state that in emerging markets the fiscal policy is procyclical and sustainable (passive). However, we have also shown that the fiscal policy in Ukraine was not always passive and under certain conditions can switch into the active regime for a short time. The paradox is that the fiscal policy switched in the passive regime not during the rapid growth of debt, but during the strong economic growth. At the time dimension, regime switching took place in the third quarter of 2006 when the rapid growth of the global and Ukrainian economy began. During this period, the fiscal policy of Ukraine switched from the regime close to active-sustainable to passive, and still to function in such way. This switch was caused by the government's decision to increase the budget deficit while economic growth. The access to the foreign markets in the conditions of economic boom contributed to the accumulation of external debt. After the global financial crisis and the collapse of the hryvnia, this has led to the rapid growth of debt.

The main problem of Ukraine's fiscal policy that does not allow reducing the level of public debt and switching of fiscal regimes according to the macroeconomic environment is an asymmetry in response to the phase of the business cycle. During the periods of economic growth, the fiscal policy in Ukraine is procyclical, during the recessions - neutral. The procyclicality in the periods of economic growth does not allow creating sufficient fiscal space to maintain the active fiscal policy. On the other hand, this incomplete asymmetry can help to reduce debt, because in times of economic downturn the government does not increase the budget deficit. But it also can increase the level of debt because the lack of countercyclical policy extends the time of being the economy in a phase of depression that affects the state of public finances.

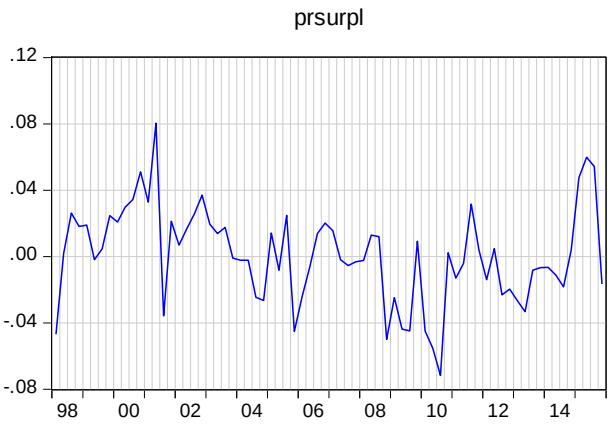
In line with Abiad and Ostry (2005), we found that the fiscal policy in Ukraine switches to the active regime after crossing the debt-GDP ratio threshold at the level of 50%. We have also shown that this switching occurs at the high threshold of the GDP gap. However, unlike Abiad and Ostry (2005) and in line with Bohn (1998), our results suggest strengthening of the fiscal policy response

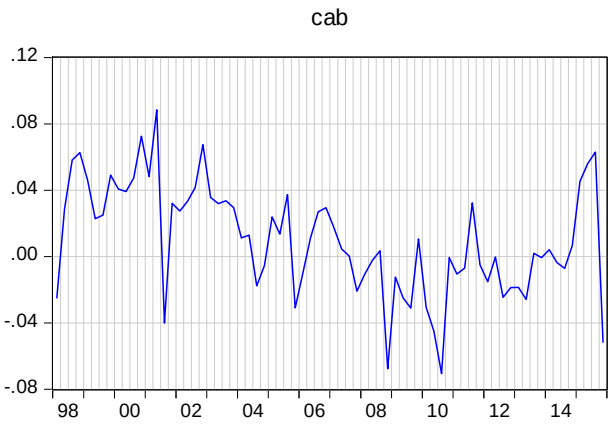
to the debt as it increases (before the limit of 50% of GDP). The identified nonlinear effects are similar to the phenomenon of "fiscal fatigue", which is described in Ghosh et al. (2013). At a low level of public debt, the government can afford to keep an unsustainable fiscal policy, while at the high level of debt after a certain threshold the government is no longer able to reduce the budget deficit and no longer responds to the high level of debt.

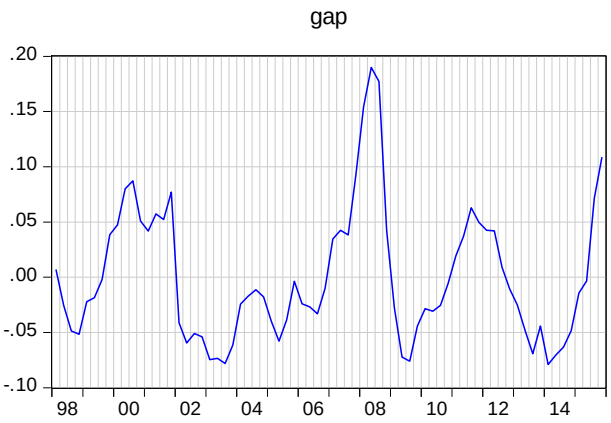
The analysis shows the need to address the issue of the asymmetry in the response of fiscal policy on the different phases of the economic cycle. Procyclical fiscal policy in the periods of a positive GDP gap does not allow reducing debt level and constantly threaten fiscal sustainability. Under such asymmetry the government, on the one hand, tries to ensure fiscal sustainability through a strong reaction of the budget to debt changes, and, on the other hand, it creates the prerequisites for further increasing of debt. Being constantly in the regime of passive fiscal policy, the government cannot use the fiscal instruments for countercyclical regulation of the economy. Thus, Ukraine found itself in a situation when the monetary policy has been deactivated for a long time because of maintaining the regime of fixed exchange rate, and the fiscal policy is focused on debt dynamics. The way out of this situation is to consolidate the budget to reduce and stabilize the level of debt and the development of fiscal rules that have to limit the ability to conduct the procyclical fiscal policy in the phases of positive GDP gap. The results also raise questions about the implementation of a modern system of financial stress forecasting, because its absence has led to disastrous consequences for fiscal policy. The sharp and unexpected change of the conjuncture of world economy and financial markets in 2008 has led to the conservation of passive fiscal policy regime in Ukraine. This shock could have been avoided if the system of early financial stress warning existed and the government could switch to the regime of prudential financial policy.

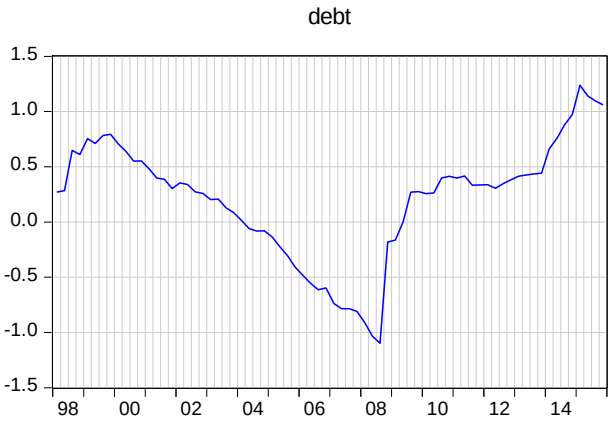
## Appendix 1

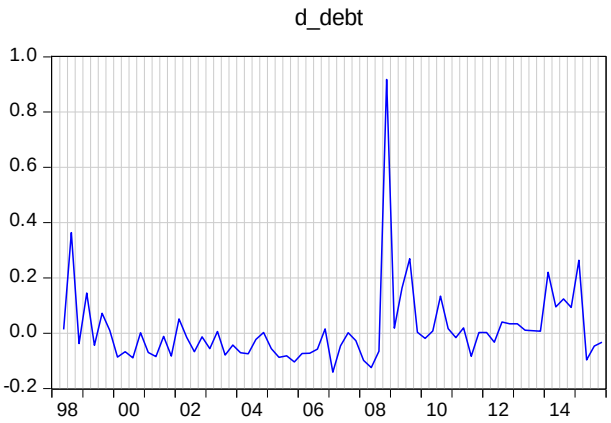
## The dynamics of the FPRF variables in Ukraine




**Descriptive statistics of the FPRF variables**

| | prsurpl | cab | gap | debt | d_debt |
|---|---|---|---|---|---|
| **Mean** | 0,000793 | 0,010216 | 7,49E-13 | 0,207417 | 0,011147 |
| **Median** | 0,000414 | 0,008549 | -0,017408 | 0,319389 | -0,015547 |
| **Maximum** | 0,080462 | 0,088352 | 0,189801 | 1,237494 | 0,917544 |
| **Minimum** | -0,071741 | -0,070701 | -0,078978 | -1,098813 | -0,141457 |
| **Std. Dev.** | 0,028845 | 0,033355 | 0,060625 | 0,534519 | 0,144158 |
| **Skewness** | -0,005737 | -0,091712 | 1,026394 | -0,596894 | 3,929644 |
| **Kurtosis** | 3,156884 | 2,682384 | 3,866565 | 2,928451 | 23,64371 |
| **Jarque-Bera** | 0,074233 | 0,403573 | 14,89462 | 4,290751 | 1443,464 |
| **Probability** | 0,963564 | 0,817270 | 0,000583 | 0,117024 | 0,000000 |
| **Sum** | 0,057115 | 0,735544 | 5,39E-11 | 14,93401 | 0,791408 |
| **Sum Sq. Dev.** | 0,059074 | 0,078991 | 0,260952 | 20,28542 | 1,454709 |
| **Observations** | 72 | 72 | 72 | 72 | 71 |

*prsurpl* – seasonally adjusted ratio of primary surplus to GDP;

*cab* – residuals from the regression $PR_{DEF}{}_t = c_0 + c_1 GDP_{cycle}{}_t + e_t$, where $PR_{DEF}$ – seasonally adjusted primary deficit, $GDP_{cycle}$ – seasonally adjusted GDP gap in absolute terms, $e_t$ – model residuals that do not include the automatic response of fiscal policy on the cyclical fluctuations of GDP;

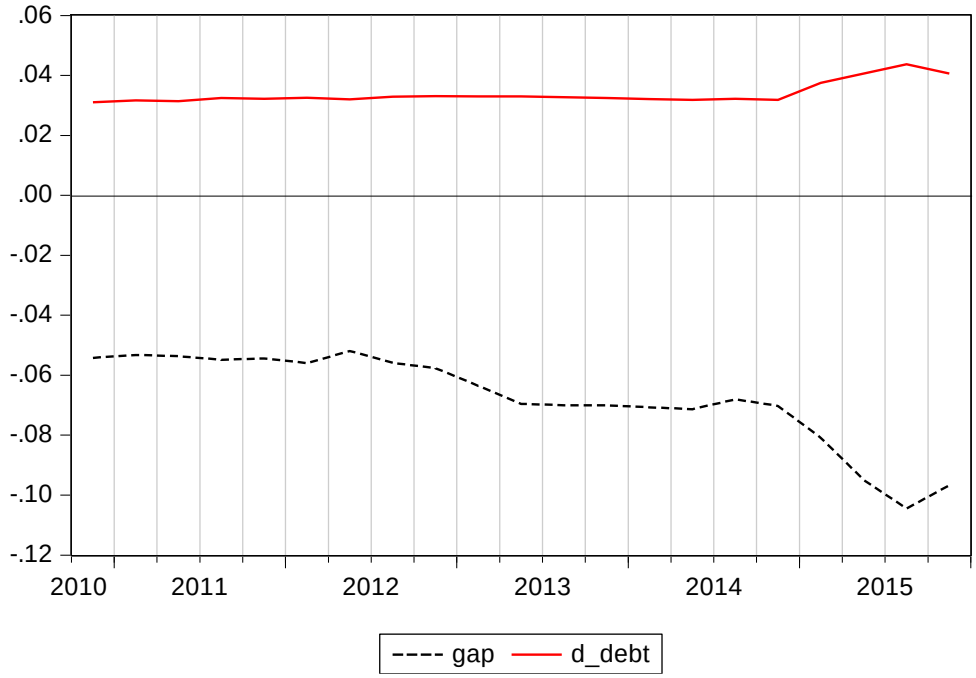
gap – business cycles extracted with application of Hodrick-Prescott filter to seasonally adjusted logarithms of GDP;

*debt* – logarithm of the ratio of total government and guaranteed debt to seasonally adjusted GDP;

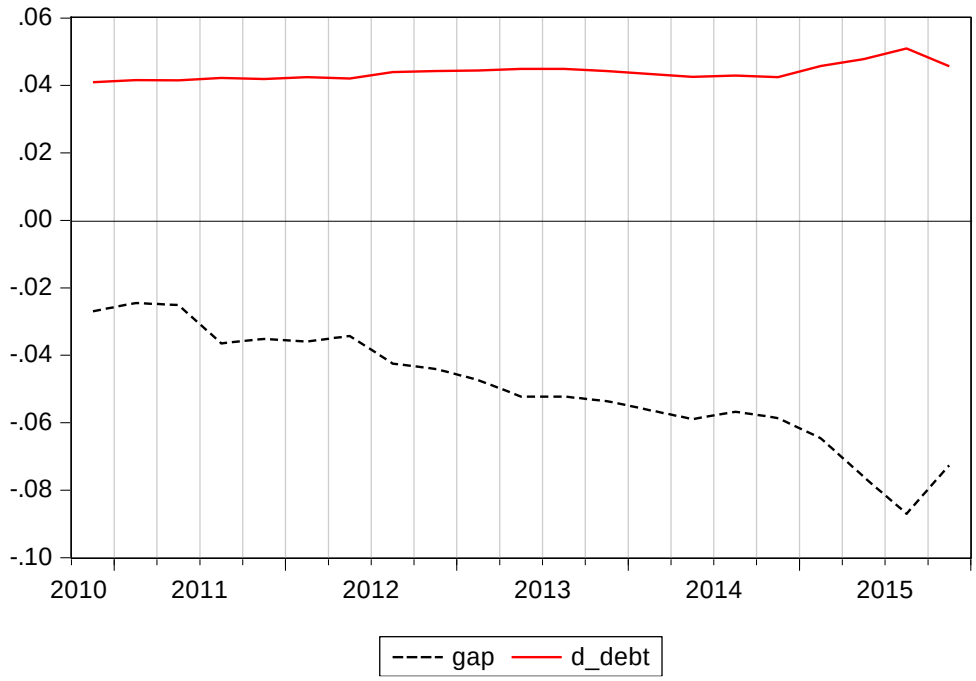
d_debt – first differences of *debt*.

**Appendix 2**

**Recursive coefficients of the FPRF for Ukraine (OLS, depending variable - *prsurpl*)**




**Recursive coefficients of the FPRF for Ukraine (OLS, depending variable - *cab*)**




**Appendix 3**

## Regression with structural break of debt ratio change on GDP gap

Dependent Variable: d_debt
Method: Least Squares with Breaks
Date: 04/28/16 Time: 18:22
Sample (adjusted): 1998Q2 2015Q4
Included observations: 71 after adjustments
Break type: Fixed number of user-specified breaks
Breaks: 2006Q4
White heteroskedasticity-consistent standard errors & covariances

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| 1998Q2 - 2006Q3 -- 34 obs | | | | |
| gap | -0.337814 | 0.234847 | -1.438445 | 0.1550 |
| C | -0.030206 | 0.013037 | -2.316882 | 0.0236 |
| 2006Q4 - 2015Q4 -- 37 obs | | | | |
| gap | -0.752965 | 0.222406 | -3.385545 | 0.0012 |
| C | 0.053767 | 0.026850 | 2.002504 | 0.0493 |

| | | | |
|---|---|---|---|
| R-squared | 0.135673 | Mean dependent var | 0.011147 |
| Adjusted R-squared | 0.096972 | S.D. dependent var | 0.144158 |
| S.E. of regression | 0.136990 | Akaike info criterion | -1.083125 |
| Sum squared resid | 1.257344 | Schwarz criterion | -0.955650 |
| Log likelihood | 42.45095 | Hannan-Quinn criter. | -1.032433 |
| F-statistic | 3.505664 | Durbin-Watson stat | 2.002486 |
| Prob(F-statistic) | 0.019972 | | |

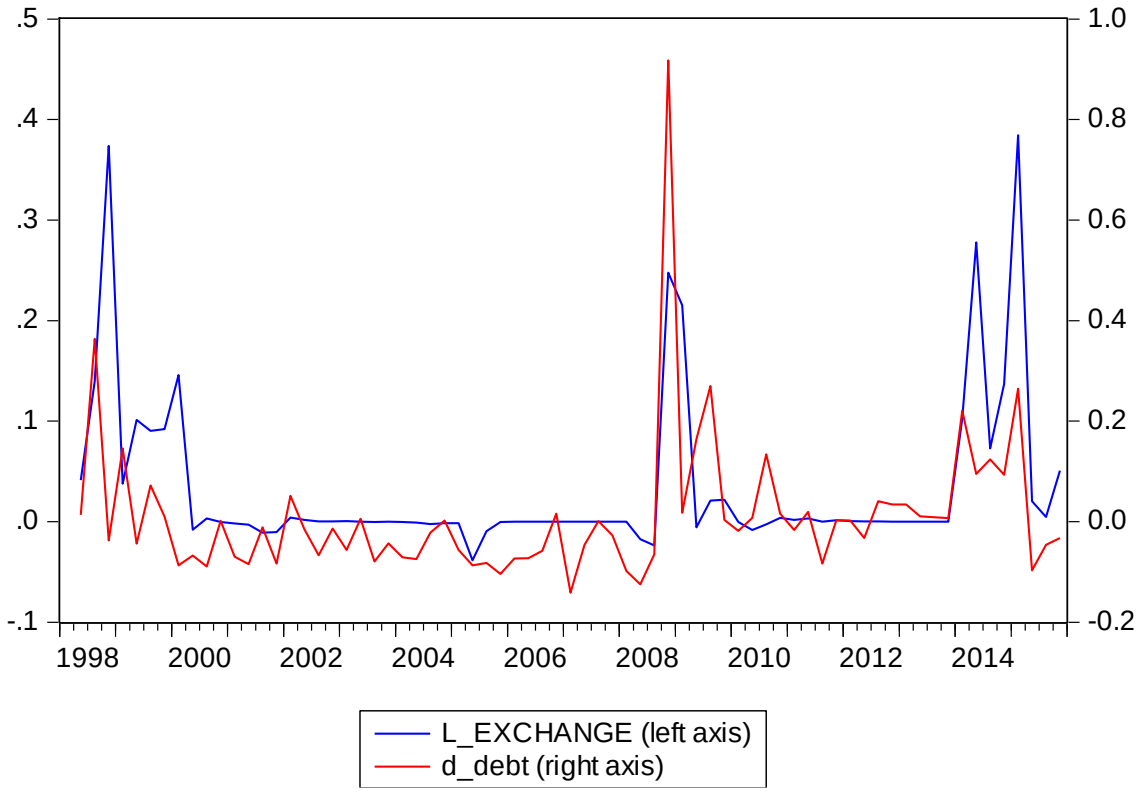
## Chow test for break in 3 quarter 2006

Chow Breakpoint Test: 2006Q3
Null Hypothesis: No breaks at specified breakpoints
Varying regressors: gap
Equation Sample: 1998Q2 2015Q4

| | | | |
|---|---|---|---|
| F-statistic | 3.134246 | Prob. F(2,67) | 0.0500 |
| Log likelihood ratio | 6.350101 | Prob. Chi-Square(2) | 0.0418 |
| Wald Statistic | 8.818618 | Prob. Chi-Square(2) | 0.0122 |

**Appendix 4**

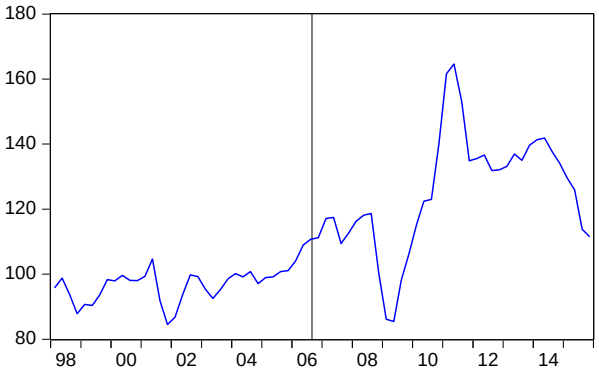
**The dynamics of exchange rate and debt ratio in Ukraine (log differences)**



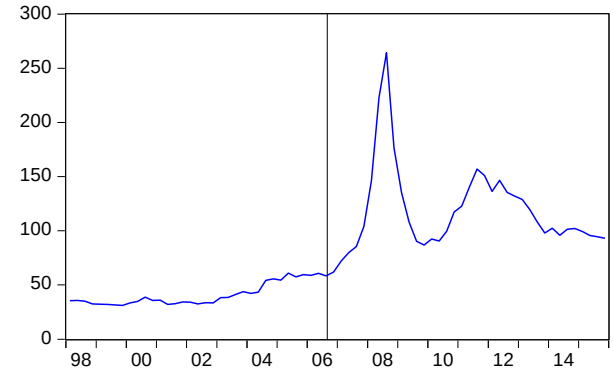

**Appendix 5**

**The dynamics of price indices on the world commodity markets**
**(line marks 2006 Q3)**

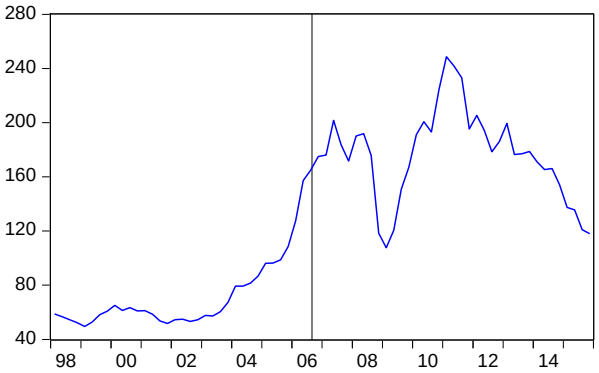
Agricultural Raw Materials Index



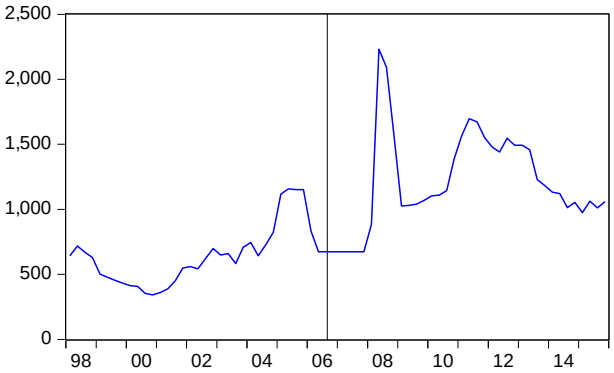

Fertilizers Price Index



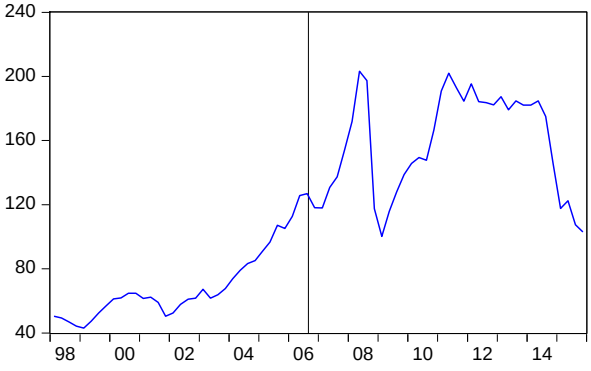

Metals Price Index



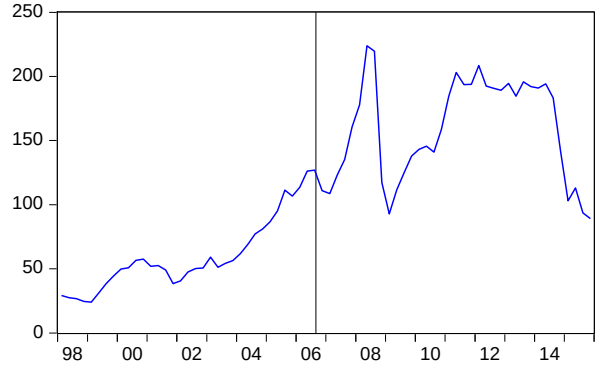

Sunflower oil Price Index



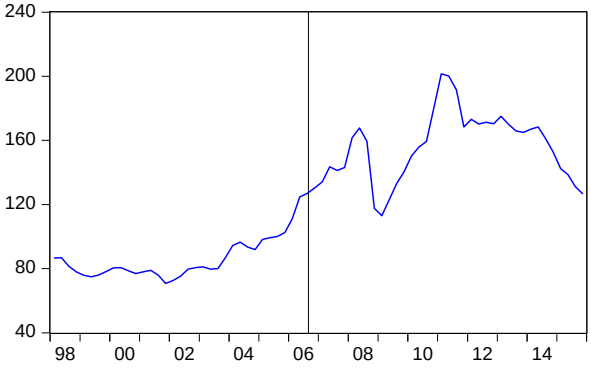

All Commodity Price Index



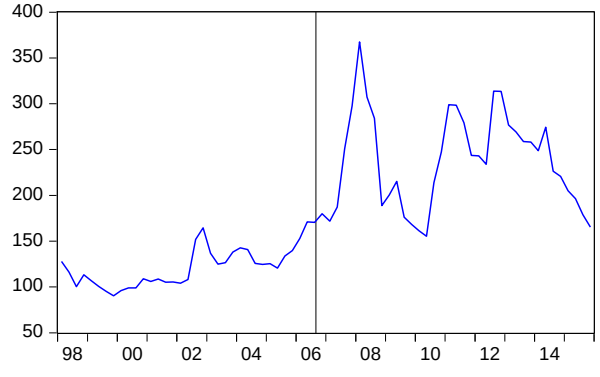

Fuel (Energy) Index




Non-Fuel Price Index

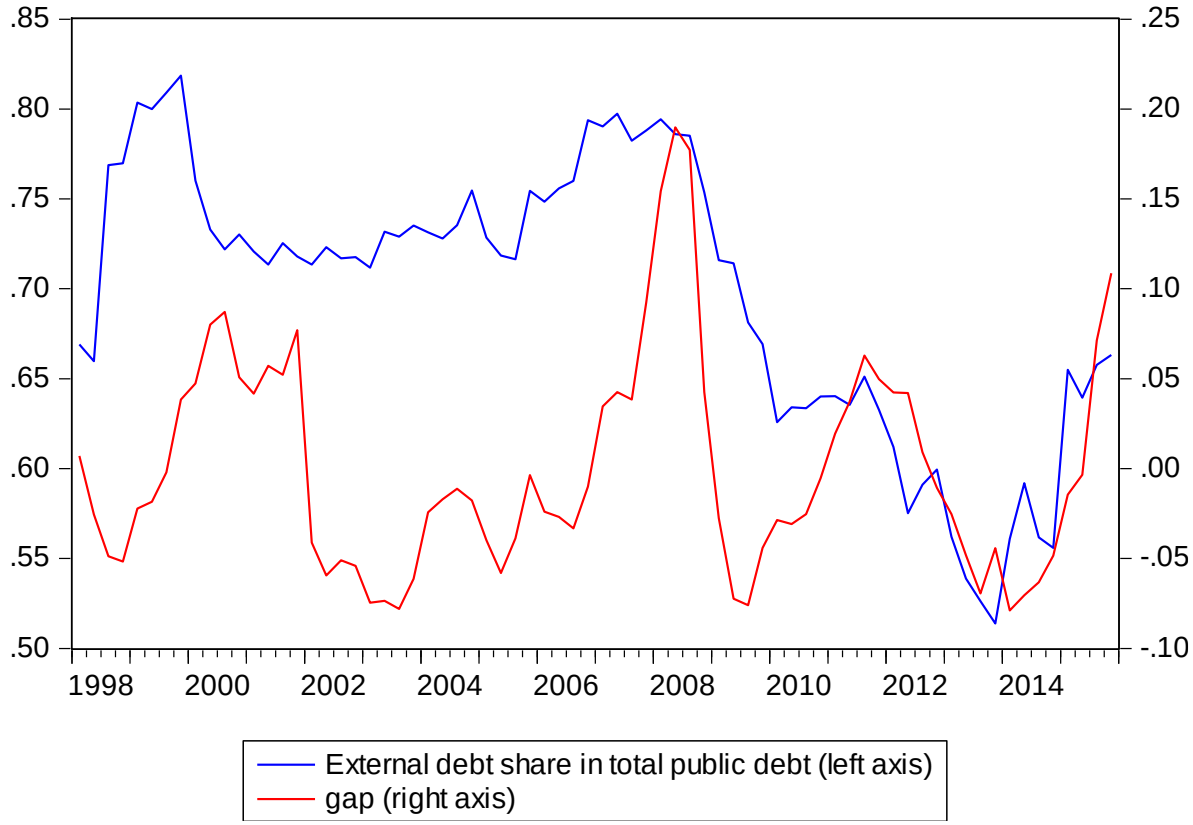



Wheat Price Index




**Appendix 6**

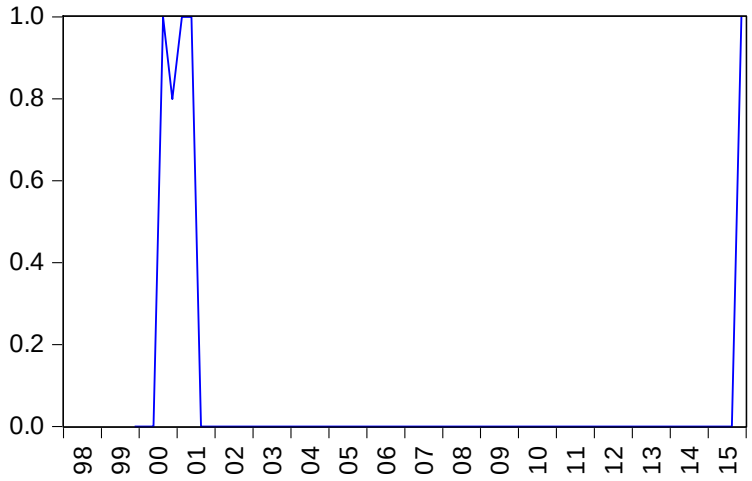
**The dynamics of external debt share and GDP cycle**



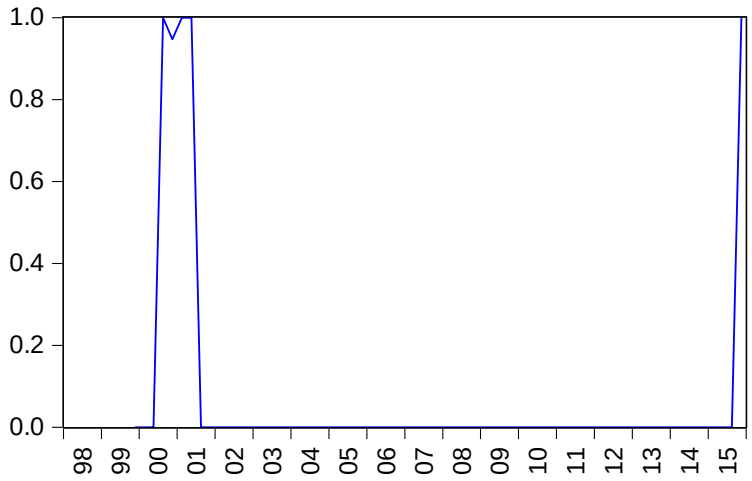

**Appendix 7**

**Probability of FPRF switch into nonlinear regime (active fiscal policy) and the dynamics of transition variable in comparison with estimated threshold**

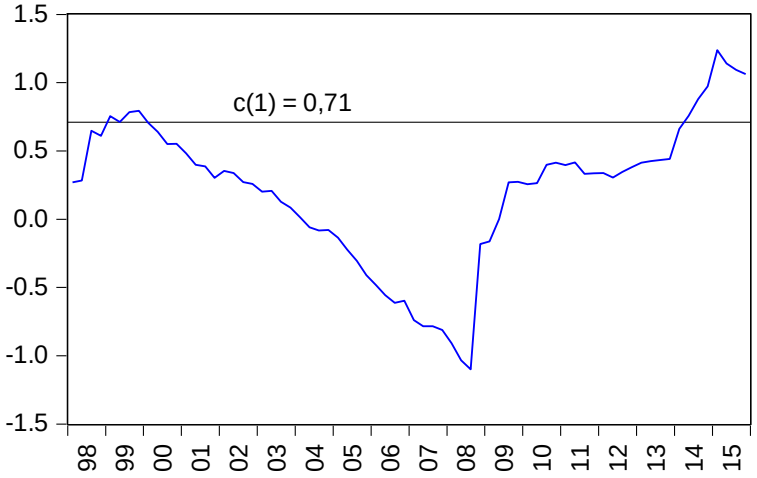
Transition function. Dependent variable - prsurpl. Transition variable - debt(t-6)=0,71




Transition function. Dependent variable - cab. Transition variable - debt(t-6)=0,71

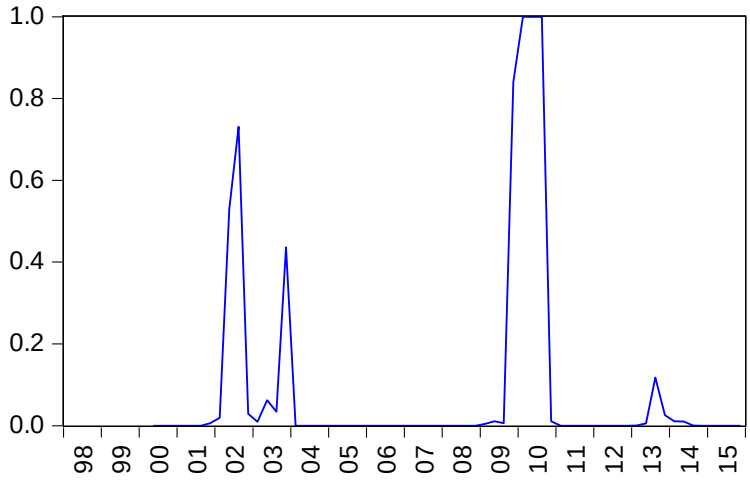



debt

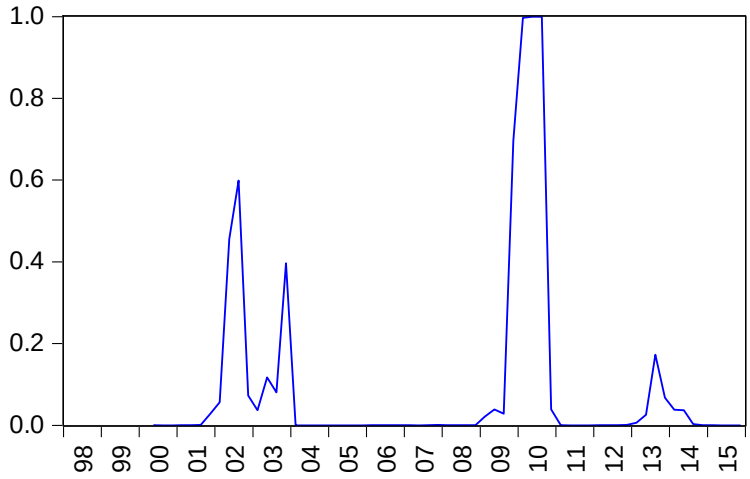


**Probability of FPRF switch into nonlinear regime (active fiscal policy) and the dynamics of transition variable in comparison with estimated threshold**

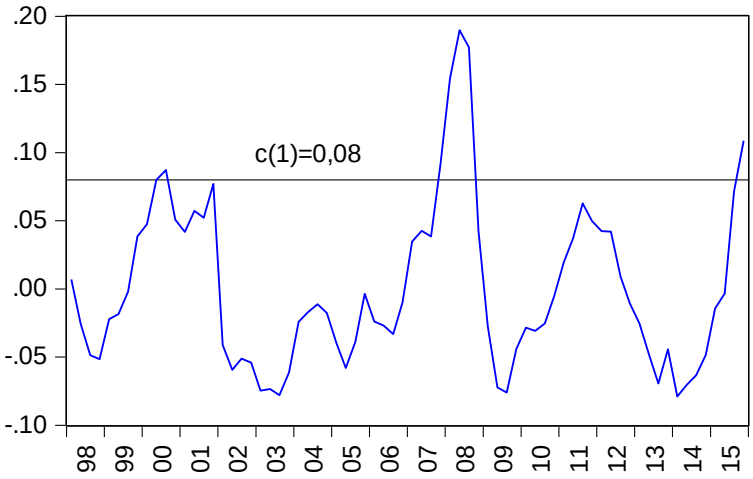
Transition function. Dependent variable - prsurpl. Transition variable - gap(t-8)=0,08




Transition function. Dependent variable - cab. Transition variable - gap(t-8)=0,08




GDP cycle



**Appendix 8**

**LSTR1 models of FPRF with one switching coefficient**

| Dependent variable | $prsurpl_t$ | | $prsurpl_t$ | | $cab_t$ | | $cab_t$ | |
|---|---|---|---|---|---|---|---|---|
| Transition variable | $debt_{t-6}$ | | $gap_{t-8}$ | | $debt_{t-7}$ | | $gap_{t-8}$ | |
| | Linear part | Nonlinear part | Linear part | Nonlinear part | Linear part | Nonlinear part | Linear part | Nonlinear part |
| Const. | 0,006* | | 0,01** | -0,02 | 0,01** | | 0,01*** | |
| d_10:03 | -0,09*** | | -0,02 | | -0,1*** | | -0,02 | |
| $pol_t$ | -0,01*** | | -0,02*** | | -0,02*** | | -0,019** | |
| $prsurpl_{t-4}$ / $cab_{t-4}$ | 0,19 | | 0,19 | | 0,19 | | 0,34** | |
| $d\_debt_{t-4}$ | 0,04** | | 0,04 | | 0,04 | | 0,03 | |
| $gap_{t-4}$ | -0,14** | 0,96** | -0,12** | 0,69** | -0,16*** | 0,73*** | -0,12 | 0,9** |
| γ | 36,9 | | 7,75 | | 88,5 | | 4,3 | |
| C1 | 0,74*** | | 0,07*** | | 0,46*** | | 0,08*** | |
| Obs. | 65 | | 63 | | 64 | | 63 | |
| adj. $R^2$ | 0,42 | | 0,41 | | 0,46 | | 0,37 | |
| Test of No Error Autocorrelation (p-value) | lag 1= 0,91 | lag 2= 0,99 | lag 1= 0,09 | lag 2= 0,1 | lag 1= 0,66 | lag 2= 0,9 | lag 1= 0,37 | lag 2= 0,5 |
| | lag 3= 0,99 | lag 4= 0,99 | lag 3= 0,2 | lag 4= 0,3 | lag 3= 0,97 | lag 4= 0,95 | lag 3= 0,61 | lag 4= 0,78 |

**Appendix 9**

**LSTR1 model of FPRF with debt ratio conditional on FPI as transition variable**

| Dependent variable | $prsurpl_t$ | |
|---|---|---|
| Transition variable | $debt\_fpi\_resids_{t-5}$ | |
| | Linear part | Nonlinear part |
| Const. | -0,001 | 0,02*** |
| d_10:03 | -0,08*** | |
| $pol_t$ | -0,01*** | |
| $prsurpl_{t-4}$ / $cab_{t-4}$ | 0,01 | |
| $d\_debt_{t-4}$ | 0,02 | 0,15 |
| $gap_{t-4}$ | - 0,14** | 0,31* |
| γ | 7,6 | |
| C1 | 0,22*** | |
| Obs. | 66 | |
| adj. $R^2$ | 0,45 | |
| Test of No Error Autocorrelation (p-value) | lag 1= 0,83 | lag 2= 0,94 |
| | lag 3= 0,99 | lag 4= 0,64 |

**Appendix 10**

## Regression of debt ratio on FPI and their cross correlogram

Dependent Variable: debt
Method: Least Squares
Date: 11/23/15 Time: 15:16
Sample (adjusted): 1998Q2 2015Q4
Included observations: 71 after adjustments
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 4.0000)

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| FPI(-1) | 0.062953 | 0.035266 | 1.785057 | 0.0786 |
| C | 0.204253 | 0.116392 | 1.754868 | 0.0837 |

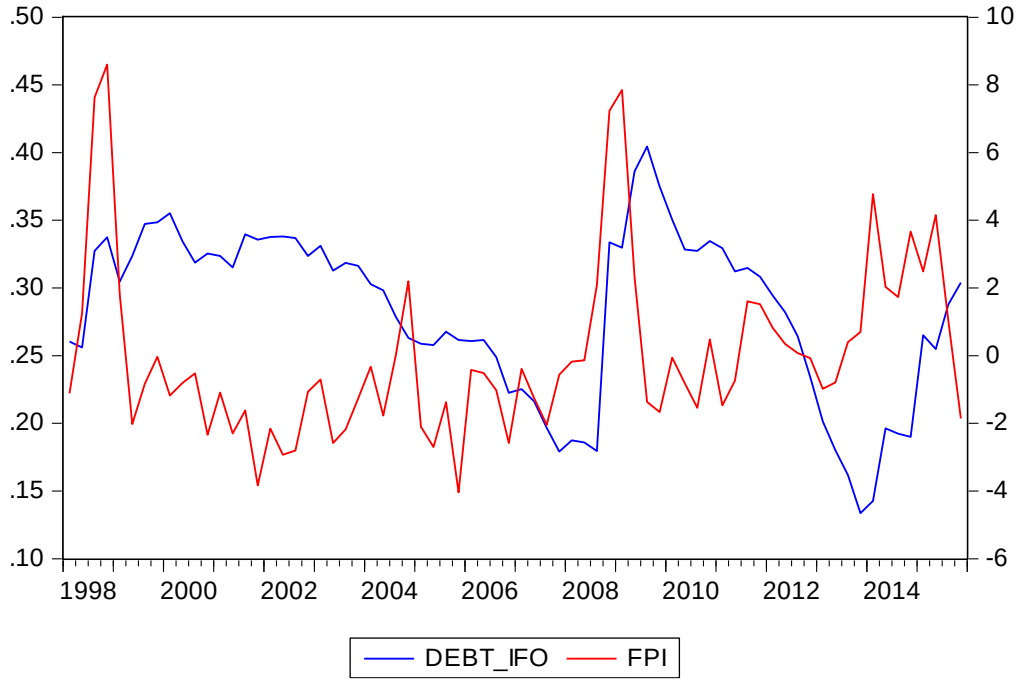
| | | | |
|---|---|---|---|
| R-squared | 0.092393 | Mean dependent var | 0.206531 |
| Adjusted R-squared | 0.079240 | S.D. dependent var | 0.538270 |
| S.E. of regression | 0.516504 | Akaike info criterion | 1.544296 |
| Sum squared resid | 18.40754 | Schwarz criterion | 1.608033 |
| Log likelihood | -52.82250 | Hannan-Quinn criter. | 1.569642 |
| F-statistic | 7.024130 | Durbin-Watson stat | 0.139033 |
| Prob(F-statistic) | 0.009964 | Wald F-statistic | 3.186428 |
| Prob(Wald F-statistic) | 0.078647 | | |

Date: 05/02/16 Time: 17:11
Sample: 1998Q1 2015Q4
Included observations: 72
Correlations are asymptotically consistent approximations

| L_DEBT_RAT,FPI(-i) | L_DEBT_RAT,FPI(+i) | i | lag | lead |
|---|---|---|---|---|
|  |  | 0 | 0.1952 | 0.1952 |
| | | 1 | 0.3028 | 0.0575 |
| | | 2 | 0.3664 | -0.0791 |
| | | 3 | 0.3852 | -0.1311 |
| | | 4 | 0.3951 | -0.1305 |
| | | 5 | 0.3608 | -0.1285 |
| | | 6 | 0.3453 | -0.1560 |
| | | 7 | 0.3393 | -0.1667 |
| | | 8 | 0.2866 | -0.1494 |

**Appendix 11**

**The dynamics of FPI and the ratio of IFO debt to total public debt in Ukraine**




**Cross correlogram of FPI and the ratio of IFO debt to total public debt in Ukraine**

Date: 05/02/16 Time: 17:19
Sample: 1998Q1 2015Q4
Included observations: 72
Correlations are asymptotically consistent approximations

| DEBT_IFO,FPI(-i) | DEBT_IFO,FPI(+i) | i | lag | lead |
|---|---|---|---|---|
| | | 0 | -0.0957 | -0.0957 |
| | | 1 | 0.0408 | -0.2947 |
| | | 2 | 0.1091 | -0.4659 |
| | | 3 | 0.1713 | -0.5097 |
| | | 4 | 0.2086 | -0.4583 |
| | | 5 | 0.1540 | -0.4282 |
| | | 6 | 0.1435 | -0.3915 |
| | | 7 | 0.1279 | -0.3065 |
| | | 8 | 0.0860 | -0.2249 |

**Appendix 12**

**LSTR1 models of FPRF with the ratio of IFO debt to total public debt as transition variable**

| Dependent variable | $prsurpl_t$ | | $cab_t$ | |
|---|---|---|---|---|
| Transition variable | $ifo_{t-5}$ | | $ifo_{t-5}$ | |
| | Linear part | Nonlinear part | Linear part | Nonlinear part |
| Const. | 0,01*** | | 0,01** | |
| d_10:03 | -0,007 | | 0,06 | |
| $pol_t$ | -0,02*** | | -0,01** | |
| $prsurpl_{t-4}$/ $cab_{t-4}$ | 0,12 | | 0,28** | |
| $d\_debt_{t-4}$ | 0,04* | -0,11 | 0,04* | -0,33 |
| $gap_{t-4}$ | -0,22*** | 0,92** | -0,16** | 0,87*** |
| γ | 4,45 | | 773,6 | |
| C1 | 0,33*** | | 0,34*** | |
| Obs. | 66 | | 66 | |
| adj. $R^2$ | 0,48 | | 0,47 | |
| Test of No Error Autocorrelation (p-value) | lag 1= 0,71 | lag 2= 0,88 | lag 1= 0,22 | lag 2= 0,42 |
| | lag 3= 0,95 | lag 4= 0,97 | lag 3= 0,63 | lag 4= 0,54 |

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